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Preface

This volume contains the proceedings of ICIDS 2011: The 4th International Conference on Interactive Digital Storytelling. ICIDS is the premier international conference on interactive digital storytelling (IDS), bringing together researchers from a wide variety of fields to share novel techniques, present recent results, and exchange new ideas. Having been hosted successfully in Europe for the past three years, ICIDS 2011 marked the conference's first venture to an entirely new continent: North America.

Enabled by the advent of interactive digital media, IDS redefines the experience of narrative by allowing its audience to actively participate in the story. As such, IDS offers interesting new possibilities for games, training, and learning, through the enriching of virtual characters with intelligent behavior, the collaboration of humans and machines in the creative process, and the combination of narrative knowledge and user activity into novel, interactive artifacts.

IDS draws on many aspects of computer science, and specifically on research in artificial intelligence and virtual/mixed reality; topics include multi-agent systems, natural language generation and understanding, player modeling, narrative intelligence, drama management, cognitive robotics, and smart graphics. Furthermore, IDS is inherently a multidisciplinary field. To create novel applications in which users play a significant role together with digital characters and other autonomous elements, new concepts for human–computer interaction are needed, and novel concepts from theoretical work in the humanities and interactive art are also important to incorporate.

The review process for ICIDS 2011 was extremely selective, and many good papers could not be accepted for the final program. Altogether, we received 72 submissions (64 full papers, 6 short papers and 2 posters/demos). Out of the 64 submitted full papers, the Program Committee selected only 17 submissions for presentation and publication as a full paper, corresponding to an acceptance rate of ∼27% for full papers. In addition 14 submissions were accepted as short papers, and 16 submissions were accepted as posters. In total, the ICIDS 2011 program featured contributions from 50 different institutions in 17 different countries worldwide.

The conference program also highlighted three invited speakers: Chris Crawford, computer game designer and writer noted for his work on Storytron (originally known as Erasmatron), an engine for running interactive electronic storyworlds; Mary DeMarle, lead writer and narrative designer for Deus Ex: Human Revolution, a recent, critically acclaimed video game with high praise for its dynamic story; and Keith Oatley, professor emeritus of cognitive psychology, author of the novel *The Case of Emily V*, which won the Commonwealth Writers Prize for Best First Novel in 1994, and of the recently published *Such Stuff as Dreams: The Psychology of Fiction*. The titles of their talks were:

Chris Crawford: Twenty Years in the Wilderness: Lessons Learned in Interactive Storytelling

Mary DeMarle: Pushing Boundaries and Redefining Rules: The Dynamics of Storytelling in Games

Keith Oatley: Stories as Simulations in Print Fiction, Movies, and Interactive Media

In addition to paper and poster presentations, ICIDS 2011 featured six pre-conference workshops: (1) Arithmetic Methods in Personality Modeling, (2) Making Interactive Stories Meaningful: Workshop on Story and Character Development Through Theatre Games, (3) Rummaging in the Geek Culture Toolbox, (4) Sharing Interactive Digital Storytelling Technologies, (5)The User Experience of Interactive Digital Storytelling: Theory and Measurement, (6) Towards a Unified Theory for Interactive Digital Storytelling - Classifying Artifacts.

We would like to express our sincere appreciation for the time and effort invested by our authors in preparing their submissions, the diligence of our Program Committee in performing their reviews, the insight and inspiration offered by our invited speakers, and thought and creativity provided by the organizers of our workshops. Special thanks are also due to our sponsors and supporting organizations, and to the ICIDS Steering Committee for granting us the opportunity to host ICIDS 2011. Thank you!

September 2011

Mei Si
David Thue
Elisabeth André
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Research in Interactive Drama Environments, Role-Play and Story-Telling

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Abstract. This paper gives an overview of the UK network RIDERS – Research in Interactive Drama Environments, Role-Play and Story-telling, running for 36 months from September 2011. It discusses the three central themes of RIDERS: theoretical work on the conflict between interactivity and narrative content, problems, issues and tools relating to authoring, and directions in evaluation. It gives a brief overview of the current position in each of these areas and suggests how RIDERS activity might be able to contribute to them. Finally it summarises the overall RIDERS programme of activity.

Keywords: Interactive storytelling, Narrative engagement, Authoring, Evaluation.

1 Introduction

RIDERS (Research in Interactive Drama Environments, Role-Play and Story-telling) is a network funded by the UK Research Councils for three years from September 2011 to bring together researchers in interactive drama environments, role-play and story-telling in a series of events. The case for RIDERS rests on the fact that these areas are researched and applied in a wide range of disciplines.

Within AI, storytelling research began with NLP work on story-grammars in the 1970s [9], aimed at the non-interactive generation of text-based stories. For example, Meehan's TALESPIN [34] used character goals and planning to produce very short fable-like stories.

However there is of course a substantial background relating to interactive storytelling and narrative in many other disciplines, often over a much longer period. Narratology – theoretical discussion on the nature of story - goes back in the west to Aristotle; and there is also extensive work in psychology (especially around autobiographic memory); drama (Improv and interactive theatre); film and television; education and training (role-play; experiential learning) and art and digital-media (interactive installations). Within computer science too, there is more generic work on interaction and its impact on the user in the field of HCI. This reflects the central importance of story in human culture and society as well as in the sense of self of the individual.

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2 And the Holodeck?

The advent of multi-media systems and then Virtual Reality – immersive real-time interactive graphic environments – in the 1990s, created a new vision of a dramatic 'holodeck'-like experience [7,35] or virtual theatre [20]. Here a highly-immersed user could act as a character interacting with other artificial characters in an interactive graphical narrative experience qualitatively different from existing media – whether novels, theatre or film. With the advent of mobile technology and augmented reality, this vision has further extended into interactive dramatic or narrative experiences in which the real world would also be a component [8, 24].

Realisation of this vision of interactive storytelling (IS) would be a highly significant research achievement with substantial real-world impact – story-based education and training systems, completely new entertainment genres, serious games, novel therapy systems, creative new artistic and performance works. The computer game industry in particular has become very conscious of the need for narrative engagement as a path to a wider gamut of player emotions than those generated by destroying virtual enemies. However, in spite of a small number of working prototype systems, primarily in the US [e.g. 3, 30, 42, 46], and a smaller number in Europe [e.g. 4, 13, 37], the vision is still substantially unrealised. Here we summarise some possible reasons, and discuss each in a little more detail in succeeding sections.

Reasons for relatively slow progress are both theoretical and practical. One fundamental challenge is how to resolve the clash between the interactive freedom expected by the user in such environments and an authorial demand for guaranteed narrative structure. Computer games have often avoided the problem altogether by using non-interactive 'cut' scenes for narrative content, effectively isolating the substance of the narrative from the interaction of the gameplay. Less commonly, pre-authored branching structures have been applied, allowing the user a limited degree of interactive freedom by offering a controlled set of choices the author can anticipate. The promise of AI-based generative techniques has been so far largely ignored, with very few exceptions (The Sims, Spore).

The big advantage of a generative approach is that it offers compact representations that can produce a very large story world. Thus an AI planning system can instantiate the variables in the action repertoire it is using with any of the set of acceptable instances in a world, where this set could potentially be very large. One abstract action can then represent a much bigger set of instantiated concrete actions. However, abstract AI representations have no more communicative power for spectator/participants in an interactive narrative than they do for creative artists. An AI planning template expressed in logical form is equally impenetrable to both. Thus generative approaches compound the challenge of how to support authors in applying such novel technologies when they necessarily have no interest in understanding how an AI planner works or the technical parameters determining character personality and affect [22, 27, 30].

They also raise the question of how, once instantiated, generative AI outputs can be compellingly presented, whether in language or in animation. This is one cause of the significant gulf between researchers and both creative artists and potential industrial applications that inhibits the take-up of successful research innovations in the field. A closely related challenge is whether and how standardised components and formalisms can be created allowing the sharing of research, the building of new systems by extending older ones and the reuse and adaptation of content.

A third significant challenge lies in evaluation – how to measure the success of an IS system and to compare one system to another. The traditional HCI measure of usability is defined as the ease with which a user can employ a particular computer-based tool to achieve a particular goal. While poor usability could certainly break the immersion of a user in a narrative experience, making it a necessary condition for a good IS system, it does not help much in evaluating the quality of the stories (or 'experiences') that are produced, making it plainly insufficient. Recent work in HCI on 'the user experience' [23] is more promising in this respect. A simple measure of length of narrative experience [13] has been suggested, as have metrics from the Humanities [40] and work on user engagement in computer games [16, 49].

Solutions to these and other challenges are inherently inter-disciplinary. Thus AI and graphics researchers have drawn on various narrative and dramatic theories from the humanities – Aristotle [29], Boal [4, 10] and Propp [37, 38] being only three of many. However, often when one field borrows from another, it grabs ideas at a partial/superficial level based on its own limited understanding. IS research needs to dig deeper in understanding related arts and humanities research domains as well as the psychology of the user.

At the same time, IS has a lot to offer such related research fields, both in concretising and refining theoretical concepts in psychology, arts and humanities, and in developing technologies that support new creative possibilities for practitioners. Thus all would benefit from interacting, through systematic debate and collaborative design activities that are currently only taking place through personal contacts and chance meetings. RIDERS will take a community building and systematic approach in exploring common and relevant areas and develop a common understanding of issues and solutions through mediation and interaction.

3 Structure and Interaction

That the characteristic feature – interactivity – of this field should contradict a basic feature of narrative, namely pre-authored causal structure, is a narrative paradox within which nearly all IS research struggles. It can be recast as a conflict between plot and an autonomous character given that a user actively participating in an interactive narrative can be thought of as a character whose actions need not be those selected by a prior plot.

Forster [17] argued that 'the king died and then the queen died' is merely a chronological sequence of events, while 'the king died and then the queen died of grief' is a plot because it includes a causal link between the events. Less often commented upon in this example is that the suggested cause is an affective change in one of the characters. Many narrative formalisms have omitted character affective state altogether because of their focus on world-based causal structure [29, 38], and while the concept of an *internal reaction* in story grammar work [2] partially covers this idea, it is largely used to capture reactions rather than as part of a character action-generation system with full causal weight.

One possible view of the unfolding process of a story is that of an iteration between events in the world and affective changes in the characters that are both responses to events and causes of them. Causal chains that contain no affective impact upon characters are arguably more like the problem-solving of adventure games than narrative, while affective change in characters with no causal impact on the world are more like social web environments than narrative.

This idea can provide a framework for thinking about the different attempts to solve the paradox.'

Thus some researchers have investigated how pre-authored plot can be dynamically modified in response to user actions [39], intervening at the point of the CAUSE between Character Actions and World State. Character autonomy is unaffected but the outcomes of character actions may not be those they intended. An alternative approach starts from the CAUSE between events and affective states and focuses on action selection mechanisms for intelligent expressive characters. In this case emergent structure could be created [4, 12].

The two approaches have inverse advantages and disadvantages, as is true in general in AI when one considers top-down and bottom-up approaches. The top-down approach begins with a plot (whether pre-written or machine generated), and it is this that directs the characters' actions. The main advantage of this approach is that it maintains a coherent narrative structure and embeds dramatic interest into this structure. However the disadvantage is that the plot may direct the characters to perform actions that are not believable, especially where replanning takes place to accommodate unexpected user actions.

This may be in relation to the character's nature or capabilities: for example, if the plot turns out to require that a quiet, shy character jumps onto a table and dances, that a crack shot misses their target or a heavily overweight character sprints a kilometre. Of course a character transgressing their basic nature may be a fertile source of narrative surprise and interest, but this requires that sufficient motivation to do so has been established as part of the character's arc, or that the violation is causally justified retrospectively. This can be difficult: if the crack shot must miss because their target is essential to the plot later, and if their response is to shoot again, the pre-determined nature of the plot becomes all too visible.

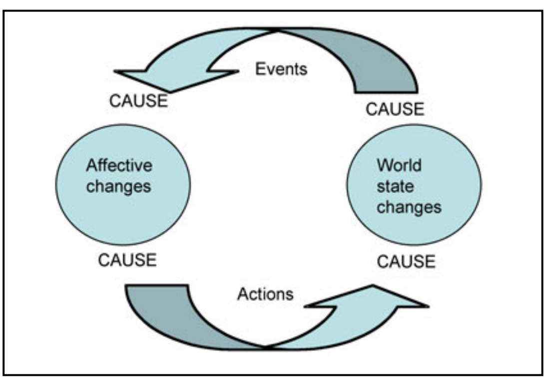

Fig. 1. A narrative loop

Similar problems arise in relation to creating inconsistencies in the character's current context. For example, in a scene with two terrorist characters, but where a known CIA agent character is in fact present, the plot may require the terrorists to have some dialogue discussing an upcoming attack, even though believability suggests that they would not want the CIA agent to overhear. A top-down approach may also simply interdict player actions that violate the plot, limiting the player's agency in a way that can be obvious enough to destroy their narrative engagement.

The bottom-up approach starts with autonomous character action-selection with an emphasis on acting believably according to their beliefs, desires and intentions, their emotional state, and their situational context. However in a pure in-role simulation approach, characters will favour the most realistic actions, and these may not be dramatically interesting [26, 45]. Even if a character does perform one dramatically interesting action, it is less likely that it will perform a sequence of dramatically interesting actions constituting a dramatically recognisable story, and less likely still that all characters will do so.

This is because characters have no dramatic intelligence: they do not "know" they are trying to tell a story; all they "know" is that they are trying to simulate a human role. In essence, such an agent's action-selection mechanism works entirely on the in-character (IC) level, while the notion of drama is an out-of-character (OOC) concern: the characters themselves are not concerned about the drama and do not take on dramatic responsibilities. They participate in the cycle of Figure 1 but do not model it.

One can contrast here the role of actors in improvisational drama, where the concept of an 'offer' – actions giving scope for mutual dramatic development – is a basic one [41]. Current approaches to incorporating dramatic intelligence into characters' action selection are based on generating a range of possible actions rather than just one at each time step and using a metric for selecting between them that involves dramatic responsibility. An initial step might be to choose the most dramatic possible action from the available set, for example by reapplying cognitive appraisal ('double appraisal') to determine its potential affective impact [25]. However this neglects the requirement for pacing in the dramatic trajectory of an interactive drama and more recent work seeks to distribute dramatic responsibility into a multi-agent architecture [48].

Both plot- and character-based approaches have looked at the role of story management, facilitation or direction [6, 27, 30, 47], which can be placed at any of the four CAUSE points in Figure 1. RIDERS has a part to play in supporting a growing investigation of story-shaping in genres such as improvisational drama [41, 45] and table-top role-play [6, 47].

4 Authoring Challenges

No matter how ingenious solutions to the reconciliation of structure and interaction might be, to turn them into interactive narratives requires authoring of content. The first issue here is that exactly what should be authored depends on the architecture of the run-time system. Thus for example, *Comme Il Faut* [31] requires the writing of a large set of social rules; *FearNot!* [4] requires the setting of character emotional parameters and the definition of AI planning action repertoires. To do this successfully requires an understanding of how these formalisms will be translated into actual story by the run-time system, and thus a background in AI technology that is never going to be widely available.

A second issue is that moving outside of linear stories with a single causal chain of events requires an increase in the amount of content while at the same time distancing the authoring of such content from the context of its presentation by the run-time system. This is not an approach to authoring generally applied in media, with the exception of live and table-top role-play. In the latter, *campaigns* are frequently designed within rich declaratively-described story-worlds represented in one or more handbooks that can be reused. These handbooks serve to define not a story in itself, but the potentials and boundaries of stories within that scenario. This can be likened to what Bruckman [11] has called a 'storyspace': "a combination of temporal, spatial and thematic mappings" that stores information about potential stories. However, the lack of representational standards for combined AI and graphical systems make the development of a database of equivalent story-world material a currently infeasible task.

A third issue is that the production of content for an interactive graphical narrative is unlikely to be a single-author task: the skill of story-writing and the skill of animation are quite different. In both film (linear narrative) and computer games (branching narrative at best) screen-play/branch flow are authored by separate team members from those making actual film footage or creating animations. Research teams usually lack the necessary range of expertise and resources, while commercial teams are disinclined to take the risks of unproven approaches.

If we view an interactive narrative as a type of knowledge-based system (KBS),then it should come as no surprise that authoring is a difficult task, since it corresponds to knowledge acquisition, long the bottleneck in the construction of KBSs. In the KBS world, the initial approach taken was that of a knowledge engineer, familiar with the AI formalisms, working with an expert, responsible for the content. This handcrafting approach has always proved problematic except for very small systems, and is therefore not a good model for interactive narrative either.

Two other broad approaches have been tried in the KBS world. One is to embed a strong model into an authoring tool that is used by the expert themselves. The key idea here is that the model allows the expert to conceptualise and structure their content at a problem-based level rather than at an AI technology level. If the model is appropriate to the expert's needs this approach can work well, and it was widely applied in medical diagnosis applications. In a weak form it may be found in the authoring tools supplied with games such as NeverWinter Nights, where as long as the user wants a story based on encounters with monsters with a few branching choices an application can be produced quickly using the database of graphical materials supplied. A number of researchers with run-time IS systems have produced authoring tools for them [e.g. 15, 21, 31, 33 and others] but without much evidence of take-up. In the absence of reported usability studies a plausible assumption is that these do not operate at a sufficiently abstracted level to allow authoring without the detailed understanding of the run-time system's technology already discussed.

The other approach developed in the KBS world rests on machine learning technologies. Here the basic idea is that structured knowledge can be induced from examples, whether given directly by the expert, extracted from existing data records, or by real-time monitoring of an expert in action. A lesson from the KBS work is that learning rules is much easier than learning more structured representations such as AI planning operators. Thus Thespian, using decision theoretic representations, is able to learn character representations [43], but there are few other examples. Induction does of course work better with greater amounts of data than a single user may be motivated to provide, and some recent approaches use web access to gather data from multiple users [22, 36].

What can RIDERS contribute to this difficult area? Again, inter-disciplinary studies seem useful; support for standardisation activities that would allow reuse of materials across different run-time systems would also be sensible. Some fields have produced greater cohesion by running competitions involving a standard benchmark problem or game engine, and the use of a common story - Little Red Cap – in authoring workshop [44] suggests this should also be pursued. Public availability of data on which narrative learning algorithms could be tried out may also be a worthwhile activity.

5 Evaluation

Evaluation is a seriously under-developed area in IS work, but again the difficulties involved offer some reasons for this. If technology is immature or content is scanty, evaluation risks only assessing these weaknesses. Research systems may derive their standing within the community from video clips shown during paper presentations, while the experience of an engaged user may be quite different [5]. While in general one might like to evaluate the user experience [23] intuitively, metrics relating to a specifically *narrative* experience appear desirable.

To evaluate the impact of an interactive narrative, one must consider what ‘impact’ means for this form, and whether it is the same as ‘impact’ in traditional, non-interactive stories, as studied in literary theory. The tendency of new media to think of themselves within the constraints of older forms is well-described in [32]:

> *“New media are new archetypes, at first disguised as degradations of older media. These degradations happen when new media inevitably use old media as content. Using the older ones as content hastens the tidying up process by which a medium becomes an art form.”*

This phenomenon is summed up in McLuhan’s famous phrase, “the medium is the message,” and can be seen in past media that have since matured. Early cinema was little different to a recorded stage play, while early television drama took the form of a visual radio play. Cinema and television now make use of the strengths of their own media, rather than trying to model other forms. The same phenomenon undoubtedly affects interactive digital media: many commercial video games take cinematic films as their model, while attempting to create an “interactive movie” has occurred more than once in the history of video games, with limited success [1]). For the medium to mature, the properties that make it unique from other media must be investigated.

In traditional narrative, the Aristotelian impact, or tension, is focused on the plot of the story. However, the difference between interactive narrative and non-interactive narrative is of course interactivity: the involvement of the user. One must question whether focusing the evaluation of impact on the plot is appropriate in an interactive medium, or whether it is using "old media as content". Here it seems much more appropriate to focus on evaluating the impact on the user. This is the way Game Masters in table-top role playing games behave: their concern is more for whether the impact of the events in the story is satisfying for their players, and less for whether the events of the game would read as a satisfying story after the fact, were someone to write them down [47].

Like any other subjective experience, narrative experience evaluation faces the issue of post-hoc rationalization if post-experience questionnaires are used, along with under-developed or ambiguous objective measures, whether observational or via the capture of physiological response data. It may be necessary to infer engagement rather than directly measure it [16]. Embedding evaluation into the user's narrative interaction [19] is one approach, learning patterns of user behaviour and trying to match these to post-hoc user evaluation data [49] is another that has been tried in computer game research.

This type of evaluation attempts a holistic assessment of a specific interactive narrative. It cannot be used on the one hand to compare different interactive narratives or on the other to establish whether specific technological innovations do or do not contribute to its degree of success.

Comparison between IS systems may in fact be utopian, or at least as subjective as the one star- five star assessments given by newspapers to films. Assessment of technology features is more feasible. For example, if an aim of an IS system is to produce empathy with its characters, as was the case in FearNot![4], then one can draw on methods from psychology to evaluate how far this is so [18]. In the same way, if an IS system is using replanning to move the narrative back towards an intended plot, one can evaluate the user's reaction to those events in the story and their impact on believability.

The development of conceptual models for IS systems, at a more abstract level than the implementational formalisms, might also allow some more generic approaches to classes of evaluation. Thus in Figure 1 above, just as one could apply story management techniques to each of the four CAUSE links (world state-events; events-character-affective state; character affective state-actions; actions-world state), so one could apply evaluation metrics of stability, believability, dramatic impact. Defining conceptual dramatic trajectories (temporal patterns absent from Figure 1) would also have an impact on generic evaluation approaches.

Events such as ICIDS already allow both evaluation techniques and the outcomes of evaluation to be shared among IS researchers. Where a network like RIDERS may be able to help is in increasing access to methods from other disciplines, whether those of ethnography and psychology, or literature and film.

6 RIDERS Activities

Unlike IRIS [14], which is funded by the EU, RIDERS has a specifically UK remit. Nevertheless it has argued successfully that developing IS in the UK also involves strengthening links with international research. RIDERS will seek to work not only with IRIS but also with the European Narratology Network (http://www.narratology.net/) and the Serious Games network GALA (http://www.galanoe.eu/), as well as IS research groups throughout the world. To this end it includes funding of four one week visits by UK researchers to international centres of excellence, for which there will be open calls as soon as the RIDERS Steering Committee has been set up.

Where IRIS includes funding for research work, RIDERS, like all UK-funded networks, is only funded for the organisation of events. Thus it cannot itself offer direct solutions to the research challenges discussed above, and will only adopt a specific stance itself insofar as its members arrive at consensus: friendly debate and honest differences will help to develop the IS field.

RIDERS will support three main types of activity: 1) A six meeting programme of events for network members on the three themes identified above; 2) Exchange visits to both UK and international labs which will enable researchers to discuss the different contexts and disciplines of interactive drama, role play and storytelling and visit relevant innovative labs/studios in academia or industry; 3) Support for PhD students to visit conferences to present work on topics related to RIDERS interests. Finally, its program includes the organisation of an IS summer school in 2013 or 2014.

RIDERS will also develop a website which it hopes will become a useful resource for the whole research community; it is committed to a set of legacy materials including a book.

Events and community-building do not themselves solve research problems, but if they result in new collaborations and the generation of new ideas, they may help to do so. On Structure and Interaction, exposing IS researchers to non computer-based forms of interactive narrative and drama can provide new inspirations. The Improv sessions in recent AAAI Fall Symposia Interactive Narrative workshops have had the effect of both increasing understanding of this form and giving the work of researchers involved in taking this into computational modelling a higher profile. One of the RIDERS meetings is projected to take the form of a live role-play weekend with the aim of providing a similar understanding for IS researchers of this interactive form. The initial members of RIDERS already span arts and humanities researchers, and opportunities to draw on the experience of practitioners will also be facilitated.

Multi-disciplinary teams have been identified above as one of the requirements for attacking issues relating to authoring. RIDERS will attempt to act as a broker between practitioners wanting to construct interactive narratives and members wanting to apply their technology to a specific domain. Again, its two meetings relating to this theme will not take the standard academic form of paper presentation but will aim to produce authoring experiences, bringing members together with one or more standard story worlds for which some material content can be supplied. The website will be developed to include a repository for such materials to allow those entering the field to make a much quicker start than is currently possible. The evaluation theme will be similarly supported with meetings in which multiple evaluation approaches will be tested out and the website will include as comprehensive a listing as possible of available techniques from all of the component disciplines of its members.

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Why Paris Needs Hector and Lancelot Needs Mordred: Using Traditional Narrative Roles and Functions for Dramatic Compression in Interactive Narrative

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Abstract. This paper proposes that we think of traditional story patterns as an available abstraction technology, containing strategies of parameterization and encapsulation that could be useful for creating digital narratives with meaningful variation of story elements. An example domain of a woman with two or more potential sexual/romantic partners is used to illustrate how such an approach could leverage the dramatic compression of narrative traditions to identify meaningful variations, in order to support coherent composition by authors and increase dramatic agency for interactors.

Keywords: Narrative Schema, Narrative Roles, Narrative Functions, Interactive Narrative, Vladimir Propp, Dramatic Agency.

1 Narrative as Role and Function

Narrative has been described as a primitive of human cognition, crucial to the development of individual psyches and to the collective meaning making that underlies all of human culture [1] [2]. Because narrative is foundational to human cognition, narrative media conventions have been a consistent focus of cultural innovation, from oral pre-history through the invention of theater, prose fiction, films, and television. The advent of digital media has expanded the palette for narrative representations of the world, and has led to the production of new varieties of narrative artifacts, which offers us the opportunity to reconsider the elements of narrative and the nature of our pleasure in creating and sharing stories. Just as games arise from our delight in synchronizing our behavior and sharing joint attention with other people [3], narrative satisfies our need to identify, imagine, and share meaningful sequences of events. Just as games display "mechanics" – like the chase and the race – that remain recognizable across time and media [4] [5], story elements – like the lover's triangle or the revenge killing – are persistent narrative patterns that provide a template for an individual writer's variation and set up expectations in the audience for what might happen next.

Narratives grow up within specific societies and subgroups, and they are elaborated into genres that cluster together smaller patterns into larger units. The similarities in story patterns have been a subject of study for linguists, anthropologists, and narrative

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theorist starting in the 19th century. The Russian formalist Vladimir Propp, in imitation of the work of the systematizing work of biologists and linguists, analysed folk tales into their component "morphemes" of character "roles" and "functions" that serve as a substitution system [6]. The functions in a Proppian system are the key events that form the basis of the plot. For example, the Villain is an important role in Russian folk tales, with the function of "causing harm or injury to a member of a family." The harm might be an abduction, a robbery, or the destruction of crops. If it is an abduction, then it sets up the narrative expectation that the Hero will perform a rescue or the abducted Victim will effect an escape. Other narrative theorists have built upon this structure of roles and functions. For example Emma Kafalenos has proposed a simplification of 10 functions that apply to a wider range of narratives [7].

1.1 Role and Function in Computer-Based Narratives

The role and function approach to narrative form has also been attractive to those who make stories. George Lucas famous drew on Joseph Campbell's hero myth structures [8] in creating *Star Wars.* Most importantly for our purposes, quest-based story functions have provided the foundation for much of the work of interactive storytelling in the past forty years. Questing hero story patterns inspired table-top games, and the earliest computer-based story games – the text adventures [9] [10]. Formulaic quests are now a staple of commercial game design, sometimes drawing on folk culture like myths and fairytales and sometimes on mass culture like comic books and fantasy fiction.

Computer scientists have also applied Propp's structures to story-generation systems. The Universe system used plot "fragments" derived from soap operas as functions [11], inserting characters into roles within these generalized events typical of the genre, and prioritizing "churn" to create narrative interest by frustrating character's goals and increasing conflict. The resultant plot summaries are recognizable as soap opera variations, but the random substitution makes them uninvolving as fiction.

Façade, structured around a visit to a quarreling couple, is the most ambitious attempt to date to extend the expressive domain of stories, avoiding both the fantasy quest of videogames and the literalistic goal-direction of early AI projects [12]. It aims for story variation similar in coherence and variety to Universe, but with a story framework drawn not from formulaic genre fiction, but from the legitimate theater. The central situation of a quarrel between a married couple during a visit by a guest was inspired in part by Edward Albee's *Whose Afraid of Virginia Woolf?* (1966)

Façade is character-driven drama, and it uses dramatic beats similar to Propp's functions but in a much more complex and generative proceduralized substitution system with multiple rules and parameters controlling the composition of an individual beat, the selection of beats, and the assembly of a sequences of beats. The Proppian story has 31 possible functions which can be combined in multiple ways to create stories. For example a story sequence detailing events from Abduction to Rescue might be a single "move" in a larger story moving from Villainy to Marriage. Narrative moves might be combined in multiple arrangements -- continuous, overlapping, recursive, or nested. The moves are similar to phrases or clauses in a sentence, and, as in language, variation results from both syntax and semantics, combining moves or substituting different tokens for the generic functions within the move.

In story telling simple structures that do not require complex processing to generate or parse can lead to compelling dramatic effects. For example, delaying a rescue by interpolating additional tasks for the hero does not create a computationally complex story, but it can keep listeners on the edge of their seats if they can be helped to keep in mind both the immediate threat and the larger "frame story". This syntactical complexity is a common tactic of epic (oral) storytelling. For example, Odysseus's journey home is told as a series of episodes in which he is threatened by particular dangers, within a larger framework of the threat posed to his wife and dependents by his absence from home. Frame stories are popular in videogames because they are similarly orienting: Mario is on his way to rescue the princess, but must navigate many difficult landscapes and fight off level-specific villains along the way. In folk tales and quest-based videogames the simple syntax of nested, congruent actions functions to focus the listener or interactor. In both media genres, and in multiple films, novels, comic books, and television programs we have learned how to pay attention to a prolonged heroic quest by focusing on individual episode, which are complete in themselves, and which also further the larger plot of the frame story.

Because it is based upon computation, the digital medium affords rich possibilities for variation within generic roles and functions, which can be generated as procedurally generated instantiations of the same objects. *Façade* can therefore focus its variation at a finer level of granularity than the oral folk tales. Although it has only 27 possible beats – four fewer than Propp's top level folktale functions -- each beat is capable of enormous variation, including anywhere from 10 to 100 joint dialogue fragments (for the two computer-controlled characters) consisting of 1 to 5 lines of dialogue [13], and dramatic actions that can last across beat boundaries.

In oral storytelling the structures that support variation are of value to the storyteller but invisible to the listener. There would be no particular pleasure in hearing variant versions of the same oral tale in succession. Variation within an explicit pattern becomes valuable, however, when character roles become identified with particular figures. For example, trickster stories are enjoyable because of the anticipation that the hero, like Odysseus, will outsmart his opponents. There would be a pleasure in hearing about a new challenge, but there would not be a pleasure in noticing variation in role token, such as the substitution of one servant for another in greeting Odysseus on his arrival.

1.2 Parallel Instantiations of Role and Function

In an interactive environment, however, interactors are invited to look for and savor variation. It is expected that the world of a videogame has some randomness built into it so that it unfolds slightly differently on successive plays, creating a sense of immediacy and fresh challenge. More importantly for our purposes, videogames are increasingly expect to provide multiple endings, not just successful and unsuccessful ones, but endings with different emotional tones reflecting different player choices. For example, the popular game *BioShock* (2007) offers three endings in which the chief enemy is killed, but which vary according to how brutally or compassionately the player has treated the "Little Sister" child-like characters. Two of the three variants have exactly the same commentary summing up the ending, but delivered in different tones of voice. The variants in *Façade* are more like those in BioShock than in the Russian folktales. The playtime is short enough that the interactor is able to repeat the scenario multiple times (and is encouraged to do so and to save the script of successive versions so as to compare and share them). The drama offers clearly contrasting endings – the visitor can be thrown out by either or both members of the couple, and can witness revelations by one or the other or both, failure of the relationship leading to the departure of one or the other spouse, and reconciliation based on different levels of honesty. In successive plays of *Façade* there are also many smaller moments of clear parallelism, such as when the interactor in the role of visitor calls attention to a photograph of the couple on holiday, triggering the beat called ArgueOverItalyVacation, and many moments of graceful transition supported by the flexibility of the generating algorithms.

BioShock and *Façade* are useful representatives of interactive narrative of the 2000's. Both build on earlier formulaic structures and patterns of interaction, and both aim at expanding the expressive power of an interactive narrative experience. The emphasis on replay in both of these very different narrative artifacts (and in even more diverse independent art narratives such as Jonathan Blow's *Braid* (2008) or Tale of Tale's *The Path* (2009) suggest that designers see the discovery of variations as an intrinsic aspect of narrative interaction. Replay is not an extra activity, not part of a meta-game, but is the expected level of participatory engagement.

Variation within formulaic roles is equally apparent in the interactive narratives of the past decade. Avatars in multiplayer worlds offer explicit variations on the roles associated with the fantasy quest, and the common practice of playing multiple characters within the same online world is similar to the practice of replaying a story game to see all the variations on a story function. Both of these practices contradict early assumptions that interactive narrative would be unsatisfying because it would not have sufficient authorial control to produce a single canonical story. In fact, interactive narratives are perceived as more enjoyable to the degree that they offer multiple variations in the instantiation of roles and functions.

Formulaic structure is the skeleton on which all stories are built, but it is a critical commonplace for scholars and fans to lament and ridicule rigid story formulas. For example, the role of a disposable character whose death makes clear the danger to the leading characters, is often called a "red shirt" after the uniform worn by doomed members of the fleet on the original *Star Trek* TV series. The death of the red shirt character is shared joke in fan communities, a too obvious convention that fans jeer at, but that writers of TV shows, films, and videogames still find useful to employ.

As educators of interactive story tellers, as designers of interactive story worlds, and as theorists interested in fostering coherent interactive narrative, we are therefore faced with a challenge of identifying the strategies that exploit the organizing and expressive power of familiar story elements to engage the interactor, and to create compelling variation.

1.3 Variation and Interactivity

As I have argued elsewhere, the digital medium offers unique affordances for storytelling by adding navigable space, encyclopedic capacity, participation, and procedurality to the representational strategies of legacy media forms. When participation and procedurality are well formed we get the characteristic pleasure of agency, and when all three are mapped to story elements we get dramatic agency [13]. One of the most frequent criticisms of interactive narrative is that it disrupts interactivity and undermines the interactor's experience of agency. For example, watching a cut scene in a videogame, or listening to the couple in *Façade* argue with one another can create impatience if the interactor does not feel that their own actions have somehow triggered this event. Variation is not enjoyable in itself, although it may be the result of virtuoso programming or clever use of procedural assets. In an interactive medium, the measure of success is the experience of the interactor. In an interactive narrative environment the experience should ideally align the pleasures of interaction – the experience of agency – with the pleasures of narrative, creating dramatic agency. The question for designer and design educators, then, is how do we align dramatic variation with interactivity?

The element common to interaction and drama is anticipation. Even the relatively passive activity of watching a traditional film or stage play or reading a novel or listening to an oral storyteller involves substantial cognitive activity. A good story will trigger possibilities in our minds, open up questions about motivation (back story) and consequences (what will happen next)? Watching a story within a known genre triggers expectations of roles and functions: a gunslinger and shoot-out in a western; a seducer and betrayal in a romantic drama; a clever doctor and a puzzling medical problem in a hospital drama. At a deeper level of abstraction, we can identify roles and functions in intrinsically dramatic situations, independent of genre, such as a powerful person with secret or a physically weak person in a dangerous situation. Story patterns derive from our common human experience, as it is shaped by familiar media conventions. Narrative design involves explicitly identifying these patterns and communicating them to the interactor in ways that shape dramatic expectations.

In mature story formats, the actions taken by the characters and the objects in the world (sometimes called existents in narrative theory) have been chosen to create appropriate expectations, to cause the audience to anticipate what is likely to happen or to form hypotheses about what happened before that is causing the present tense action In a mature medium nothing happens, nothing is brought on stage (or screen or comic book panel or described in prose) that does not in some way further the action. Whatever the viewer is invited to direct attention to is something that further defines the role (character) or the function (dramatic beat). The existents are not meant to reproduce reality, but to abstract reality into the elements most salient to communicate the few important changes of state that make up the meaningful sequence we recognize as a story.

In interactive environments our genres and conventions of representation are still relatively new compared to theater, novels, film, and television. And when we borrow conventions from these older forms we sometimes obstruct the storytelling rather than further it, because we make the interactor impatient by inhibiting interactivity while we play a tape or display a lengthy document or cut scene. We should be telling the story through the actions of the interactor. But even when the interactor is active, the activity may not connect them to the story. Many actions within virtual story worlds feel like work – actions that gamers refer to as "grinding," the repetition of unchallenging tasks to build up points for getting to more exciting parts of the game. Other actions feel too literal – a walk through too empty space for example that occupies too much of our real time. We may create a western bar, for example, as an virtual reality installation, with all the carefully selected set decoration of familiar genre movies, but if nothing interesting happens when we pick up a poker chip or order a shot of whiskey or say "Howdy" to the virtual bartender, then our narrative interest is dispersed. The abstraction system will have been built around the convention of a movie set, but the story must be embodied in the interactor's expectations and actions, not in the set design. In digital environments, we do not want to merely visit story worlds and watch stories enfold, we want to actively navigate or enact them, creating the experience that I have called "the active creation of belief " [13].

For interactive narrative to reach the level of expressive maturity of older media forms, we need to find ways to more tightly link the actions of the interactor to the expectations produced by the underlying narrative structures of roles and functions. And we need to recognize the centrality of replay and variation in the enjoyment of digital narrative, by offering variants that create meaningful and readable differences on replay.

2 Narrative Traditions as Abstraction Systems

Our aim, then, is to foster dramatic agency in our own and our students' interactive narrative environments by identifying strategies for creating interactive narratives with dramatic compression similar to more mature media genres. Roles and functions are a reasonable place to start thinking about dramatic compression because they map well, as we have seen, onto the kinds of variation that is already being practiced across multiple formats of interactive storytelling. But we must remember that reproducing the dramatic compression of legacy media is not sufficient. We must aim at a tight coupling between the dramatic elements and the actions of the interactor, linking the anticipation and expectation patterns set up by narrative schema to specific actions whose consequences produce the experience of dramatic agency.

In game design the emphasis is often upon freedom of action. But freedom of choice in a narrative game can sometimes undermine narrative immersion. So-called sandbox games like *Grand Theft Auto* are satisfying to players because of the depth and extent of the world, the number of computer-generated characters, the variety of scenes, and the freedom of motion. But when there are no consequences to our actions, the random killing and destruction may make for exciting play experiences, but they frustrate our narrative expectations.

If we are to exploit the potential of digital environments for capturing complex chains of events with the dramatic power of lasting narratives, we have to pay attention to higher levels of dramatic patterning. We have to reproduce not just the exciting incidents of a gangster film, but the moral physics of the gangster film, where killing may be commonplace, but is never without consequences, and where story role is directly linked to behavior. We have to recognize that story patterns are powerful cultural abstractions, encapsulating not just genre actions (like robbery) but genre themes (like punishment, revenge, betrayal, greed). This will require looking at story material as part of encapsulated systems of meaning. Robbery, in such a view is not a single act of a gangster character, but part of a plot in which overreaching and betrayal are key possibilities, and in which characters are defined along a well-calibrated spectrum of good and evil, with different kinds of actions available to each. To make an exciting game, we need only look for high action incidents and make them playable. To make a compelling narrative, we have to look for the underlying causal structures that motivate those actions.

2.1 Juxtaposing Variants

Our cultural heritage of story patterns is a shared mental modeling for understanding the relationships among human beings. A single play is a mimetic presentation of one situation, but the heritage of plays and novels and other story forms about the same situation make up a range of variation, a set of overlapping and competing mental models that allow us to distinguish among different situations, and to see the same sequences in many possible ways. Digital narrative can externalize this wider range of variation, while ordering it into focused areas of contrast and complementarity, so that we can think about the many ways in which a compelling scenario might play out.

A touchstone for me for this kind of narrative structure is a student project by Sarah Cooper called *Reliving Last Night* (2001) in which the same three characters – a young woman, her new potential boyfriend, and her old boyfriend - meet under circumstances controlled by three parameters: what she wears (dress or pants), what she serves the new friend (vodka or soda), and what music she plays (3 choices) while they are alone together. Depending on what choices are made by the interactor, the several segments of the story play out in clearly contrasting ways. The interface allows the interactor to change parameters and play the contrasting versions of any segment of the story – the equivalent of Propp's functions -- one after another rather than branching through on repetitive replays. The story is compelling to me because it lets us see a range of possibilities more clearly than we could through successive linear plays (as in a Choose Your Own Adventure Book) by juxtaposing the same dramatic moment under multiple conditions. In addition, each of the parameters controlled by the interactor carries with it clear narrative expectations (Would they get along better if she had put on a dress or served coke instead of vodka?) drawn from the familiar narrative patterns of the romantic comedy. The central situation, the arrival of the old boyfriend while the protagonist is alone with the new potential boyfriend, belongs to the familiar pattern of the romantic triangle. The story works because the underlying plot is readable from the specific details, with familiar story functions such as awkward flirting, acknowledging attraction, jealous confrontation, moving the plot along without losing focus.

Our story traditions make up an abstraction system for understanding ourselves and the world around us, with character roles (like the jealous lover) and event "functions" (like the first date) serving as containers – encapsulations – of more complex and variable detail. Professional writers consciously exploit such patterns, and audiences are increasingly aware of them, because of the saturation with fictional narratives that is a salient feature of the contemporary world. Computer scientists creating interactive narratives subvert the dramatic power of such situations when they make events probabilistic and causality diffuse, instead of funneling the potential events into fewer and more dramatically meaningful actions.

We could implement *Reliving Last Night*, for example, by making the alcohol consumption a minutely calibrated spectrum instead of a binary variable. We could increase the opportunities for the interactor to make a choice by elaborating a lengthy dialog in which the degree of inebriation would affect what kind of responses are available, but it would only be one of a number of factors in how well the couple got along. This might seem like the more computationally challenging and realistic approach, because after all people rarely notice when they are too inebriated to behave appropriately. But it would make for a much less involving story with unclear connections between the interactor's choices and the resulting actions, and therefore a much less successful interactive experience.

Dramatic agency depends upon choices that have a readable effect in the story world and that align with the deeper structures of expectations that we bring to any narrative experience. The ideal interaction changes a particular story function in a readable way that reminds the interactor of the overall narrative schema. And in digital narrative we can make the choice repeatable, reinforcing its importance by making clear the effects of alternate actions.

In teaching design I emphasize the importance of scripting the interactor [15], of creating patterns of expectation that interactors can act upon and then rewarding those actions with appropriate responses. In the design of narrative environments, it is important to align the expectations with story elements. We can think of this framework as made up of three overlapping layers, with a dramatic situation at the base level, genre expectations and social rituals (familiar patterns of interaction) at the middle level, and media conventions like game mechanics and familiar interface icons at the top level. A successful narrative design motivates dramatic curiosity at the base level, focuses it into specific expectations and actions at the middle level, and concretizes the actions into single mouse clicks or gestures at the top level. In a well-designed story system execution of the action would then produce a result that will reinforce the dramatic interest in the underlying situation and lead to the next interactive engagement.

2.2 Dramatic Compression of Role and Function in Traditional Stories

We can identify strategies of variation within the constraints of dramatic compression by looking at classic narratives that have stood the test of time. Since it is useful in digital design to be as clear as possible about abstraction layers, I will start with a dramatic situation independent of media conventions or genres: the scenario of one woman with two male sexual partners or suitors. This pattern brings to mind many variations, one of which is the adultery scenario in which the woman is married to one of the men but attracted to the other, a pattern that is the basis of two of the most lasting stories in Western culture, Helen of Troy, whose capture/seduction by the handsome Trojan Paris over her Greek husband Menelaus, precipitating the Trojan War, and Guinevere whose affair with Lancelot leads to the fall of her husband, King Arthur, and his Knights of the Round Table. In both stories, the fulfillment of sexual passion leads to political turmoil. In the *Iliad*, the Helen-Paris-Menelaus story, is nested within the larger frame story of the Trojan War, which is most clearly focused as the battle between Achilles and Hector. Menelaus and Paris are minor figures in comparison, and their battle is inconclusive, while the entire action of the epic builds to Achilles' defeat of Hector. Paris is less important in himself than as the less manly brother of the heroic Hector. Helen's complicity in her captivity is ambiguous and her loyalties are mixed. The tribal patriarchal values of the time make the contest between the men the central action of the epic.

A similar story of sexual transgression against a king is told with very different emphasis in the King Arthur legend, which like the story of Troy, has its roots in oral storytelling. In the Arthurian legend [14] Lancelot starts out as a heroic figure, a loyal knight to King Arthur and a chaste admirer of Guinevere. A key difference in the schema from the Helen of Troy story is the emphasis on Lancelot's ties of duty to Arthur, whose role as King, and particularly as an ideal king, reinforces the importance of the betrayal by his Queen and his favorite Knight. This makes for a new complexity in the love triangle. In addition, Guinevere is portrayed as similarly caught in conflicting emotions. The emphasis on resistance of temptation and conflicted loyalties contrasts with the simple tug-of-war plot of the Helen story in which her state of mind does not explicitly affect the action. In addition, the story includes the figure of Mordred, who like Lancelot betrays Arthur and covets Guinevere, but who is a wholly evil character who directly brings about the fall of Camelot. Mordred is the antithesis of Lancelot just as Hector is the antithesis of his brother Paris.

Looking at these two stories together can help us to articulate a pattern of potential variation for a romantic triangle plot. If we were creating a role and functions associated with the seducer based on Paris, we would not dramatize his encounters with the cuckolded husband, but focus on susceptibility to lust. We would reinforce the importance of this trait as the moral focus of the story by providing him with a contrasting character, like Hector. Variations in functions would focus on displaying how differently the two characters respond to the same temptations and to the same opportunities for selfless heroism. Paris/Hector pairs need not exist in a universe of Greek mythology or even soldiering. They could be fraternity brothers or detectives or boyfriends of Desperate Housewives. The important abstraction is the indifference of Paris to the consequences of his appetites, and the dutifulness of Hector in any situation that requires taking responsibility for others at his own expense.

The Lancelot/Guinevere story would require a more active role for the female figure, and a more prominent role for the legitimate mate, the husband figure like King Arthur. The role of Lancelot would include functions involving tests of loyalty to King Arthur, which would allow for contrasting scenes, in which he can demonstrate his Hector-like dutifulness and heroism in one context, while betraying the Arthur figure in another situation. The roles would have to involve obligations between Arthur and Lancelot, and between Arthur and Guinevere. He would have to be portrayed as a source of social order and a good person who does not deserve to be betrayed. But at the same time the attraction between the Lancelot and Guinevere characters would have to be believably strong. And the figure of Mordred would have to be introduced as a continuing threat, connected to the overarching frame story of the destruction of Camelot, a story that would have to be elaborated in its own set of character functions that would parallel the romantic plot, and whose danger would increase as it is reinforced by destructive turns in the romantic plot.

The stories are inflected by the genres in which they were most memorably told, Helen's story as an epic poem focused around war, and Guinevere's story as chivalric prose. Both stories have long oral histories before they were written down, and both exist in many alternate versions from multiple historical periods, so there are other ways of abstracting and comparing the story elements. But the parallels and contrasts that I have drawn are among the most memorable ones from the best known versions of the stories. They serve to make clear some generalizable strategies of dramatic compression that we can think of as principles of design for maximizing meaningful variation in interactive narrative:

1. Limit the number of main characters and give them clear relationships to one another based on roles within a recognizable dramatic situation.
2. Define characters along a spectrum based on a value system that is central to the story, such as chastity in a love story, courage in a war story, etc.
3. Draw clear contrasts between parallel characters, such as rivals, friends, enemies.
4. Look for opportunities to use characters as foils for one another, emphasizing the similarities and differences between them through parallel functions.
5. Create narrative events that combine functions of an overarching frame story and a coherent nested sequence.

These strategies could be used to create parameterized story systems capable of generating meaningful variants of the same situation. But interactive narrative also requires that we create patterns of interaction that lead to the experience of dramatic agency.

2.3 Roles and Functions as a Framework for Interaction Mechanics

Imagine that we have in place a parameterized representation of a story system in which a choice of sexual partner leads to social disruption, featuring story roles and functions drawn from the Paris/Helen and Lancelot/Guinevere stories, but generalized so that they can fit characters in a contemporary story. In order to move from the abstract story representation to an interactive artifact we must specify the genre in which our story will be told.

One way to do this is to move away from the triangulated pattern and the combat between the two males, and to focus on the woman, giving her more agency to choose a suitor. We can transpose the epic story into the contemporary world, and offer our central figure, whom we can call Gwen, a choice of multiple suitors, whom we can model roughly on the men in the Helen and Guinevere stories. We can choose a familiar genre in which to tell the story – such as high school melodrama. The social order represented by Camelot can be transposed into a high school election or an upcoming sports contest or a Prom. The rivalry for the beautiful woman can be transposed into the search for a date. The dating story would be nested inside the social order story: the heroine, Gwen, is trying to prepare for the election/sports contest/prom. She has a series of encounters with each of the potential suitors and the villain figure.

The initial situation should align Gwen with the Arthur figure – we can call him Artie. Artie is the conventional romantic choice, but a little boring and bossy. However, he is not as bad as his brother Manny (the Menelaus figure) who is much more controlling and much less attractive. The other young and virile suitors would be Peter (promiscuous but effusive), Lance (virtuous but untested by passion), Morton (brutal and resentful of Artie), and Hector (the most reliable guy, but one whose sense of duty may make him unavailable).

Creating an interactive narrative around these characters may involve further compression – perhaps making Manny and Morty into a single figure, and combining Hector and Lancelot as two possible directions for a single character to grow. It would also involve creating situations in which Gwen could choose which person to trust in a particular situation, and creating contrasting versions for each of the possible choices. For example, she might have a young sister visiting her and ask someone to babysit: Peter would abandon the child to flirt with another girl, Lancelot and Hector might be equally responsible with Lancelot taking her on a picnic and Hector taking her to a science museum. Maybe Artie would be the only one to engage her in conversation that shows his nurturing, empathetic side and gives him information that helps him to become closer to Gwen.

Also as soon as we transpose the situation to high school we realize that we cannot leave the central female figure so isolated as Helen and Guinevere are in their stories: she would be surrounded by female friends, which we might characterize as foils based on story patterns from Jane Austen novels. Functions in this multiform story world would be based on the kinds of events that populate teen movies – party invitations, drag races, drug and alcohol abuse – but they would all be cast to emphasize the differences among the romantic rivals, and to maximize opportunities for Gwen to make dramatically significant actions that further the frame plot of Artie and the social order and the nested plots of sizing up the rival alternate suitors. For example, Gwen might have to choose a seat in the cafeteria that is closer to the flirtatiously attractive Peter or to the shy but smitten Lance; or she might have to decide whether to help Artie raise money for charity or send a friend who is flirting with Peter.

My point in describing this sample story is not to argue for its excellence as narrative art, but to offer an example of a design process that consciously draws on established story forms and looks for ways to maximize dramatic compression through the conscious use of roles and functions.

Focusing on narrative schema such as roles and functions does not mean that we mindlessly reproduce the same story by plugging in random variations like words in a Mad Libs template. Narrative schemas persist over time, but they also change as cultures change, as authors inflect them, and as different aspects of human experience become more salient to audiences. New social realities change our notion of cause and effect patterns, and lead us to invent new ways of narrating our experiences. Computational representation offers the possibility of capturing complex sequences of contingent events at multiple abstraction levels, and under multiple organizational frameworks, so that we can focus our attention, as individuals and as members of a common culture, on expressing and sharing our cause and effect assumptions. As Merlyn Donald points out, our external media of representation serve as ratchets of culture, augmenting the functions of human memory, and helping us to get control over ever more complex systems of knowledge and social organization [24]. One of the most important legacies of our media traditions is the expressive abstraction system that we can recognize as story schema. Bringing this abstraction system into the powerful representational medium of computation is a rich source of design challenges, which can best addressing the design goal of dramatic agency, with narrative strategies that maximize of dramatic compression.

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Agent-Oriented Methodology for Interactive Storytelling (AOMIS)

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Abstract. Interactive virtual storytelling attracts a lot of research interests to create engaging, interactive and dynamic storytelling. However, it is still a great challenge to create an interactive storytelling system from text-based stories for novice. In this paper, we propose an easy-to-use Agent-Oriented Methodology for Interactive Storytelling (AOMIS) to guide novice to generate interactive storytelling system. In this methodology, interactive storytelling system is constructed as a multi-agent system of director agent and character agents. The interactive storytelling is simulated as the goal pursuing of the agents with respect to user interactions and context changes. By viewing the interactive storytelling in the perspective of goal-oriented agents, our methodology is a hybrid of plot-oriented interactive storytelling and character-based interactive storytelling.

Keywords: Agent, Methodology, Multi-Agent System, Goal.

1 Introduction

Interactive virtual storytelling attracts more and more research interests due to its immersive virtual world and engaging interactions. Currently, it is still a great challenge to create an interactive storytelling system from text-based stories for novice. Plot-based interactive storytelling ensures the coherence of story plot, e.g. Mimisis [9], Brutus [1], IDA [6], VISTA [5]. In contrast, current character-based interactive storytelling focuses on the modeling of believable characters, e.g., TALE-SPIN [8], Oz [7], Character-based Interactive Storytelling [4]. However, this approach is only suitable for presenting stories with limited interactions. The story generated from characters might be very tedious to convey a story merit efficiently. Therefore, a hybrid approach is required to bridge the gap between the plot-based approach and character-based approach for interactive storytelling, which should have the following:

1. The storytelling can be generated and presented **autonomously**.
2. The director selects storylines and the characters can perform **believably**.
3. The storytelling entities are conscious of the audience and context changes.
4. The storytelling should be presented **efficiently** in real-time.

Goal-oriented agents present human-like behaviors, which are suitable to demonstrate intelligent director and virtual characters. Though agents have been widely

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used in previous researches, limited explored properties (e.g. reactive, behavior autonomy) were not sufficient to present an engaging experience to audiences. However, there is a lack of a formal methodology with models and toolsets for novice to develop hybrid interactive storytelling easily.

Therefore, **A**gent-**O**riented **M**ethodology for **I**nteractive **S**torytelling (AOMIS) is proposed to create interactive storytelling in a virtual environment from a text-based story. By modeling interactive storytelling system as a multi-agent system (MAS), the interactive storytelling is carried out through goal planning and execution (more than task planning) by the involved intelligent agents. With the proposed methodology, story generation and presentation are not separated but interwoven. The director and characters determine the ongoing of the storytelling in different levels while interacting with audience.

2 Agent-Oriented Methodology of Interactive Storytelling

2.1 Agents and Goals in Storytelling Multi-agent System

In agent point of view, the storytelling process is achieved through goal pursuing of the agents that are involved in the multi-agent system. There are three typical agents involved in the interactive storytelling, which are scriptwriter agent, director agent and character agents. The goal of a scriptwriter agent is to create a story plot with multiple meaningful storylines which agree with user expectations. The goal of the director agent is to direct an interesting story (i.e. to show the story elements) to the audience according to user interactions, e.g., contexts, conflicts, and resolutions. Moreover, the goals of the character agents are 1) to receive the tasks assigned by the director agent and 2) to perform the tasks accordingly.

An efficient and unified goal model is required to model the complex goals and goal relations for the agents mentioned above, in order to achieve the autonomy of story generation and story performing. In our hybrid agent-based interactive storytelling system, Fuzzy Cognitive Goal Net (FCGN) was proposed [3]. It adds the fuzzy cognition capability over the generic goal net, and so it is more suitable to model the goals of agents with real-time goal updates and complex user interactions.

2.2 Methodology Overview

As shown in Figure 1, an agent-based interactive storytelling methodology is composed of the following models and components:

1. *Text-based Stories*: It denotes the original text-based story scenario by the scriptwriter.
2. *Story Parser*: It retrieves the interested concepts from the story scenario. For the characters, the concepts include the characters' emotions (sorrow, happiness etc.), behaviors (walking, sleeping, resting etc.) and characteristics (age, gender, personality etc.). For the story contexts, the concepts include

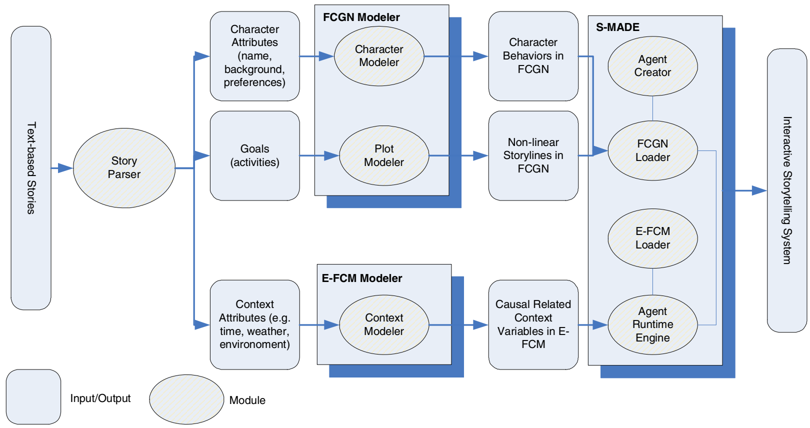


Fig. 1. A Full Picture of Agent-Based Methodology for Interactive Storytelling

the background story, time, place, objects, and world construction etc. It provides the basis for the context modeling and the character modeling.

3. *Context Modeler*: It models the real-time simulation of the context variables which are retrieved from the game story scenario. It aims to build an immersive eco-system that the virtual agents inhabit. According to the scenario, some context variables might affect the interactions of a player and the virtual characters in real-time. For example, when the weather in the game changes from sunny to rainy, the virtual character might need to find an umbrella before going out, and some of the character's activities (e.g. going to picnic) cannot be executed.
4. *Plot Modeler*: It constructs the game story plots from the story scenario. Then a plot will be assigned to the characters to perform individually.
5. *Character Modeler*: Each character modeler simulates behaviors and emotions of a character in the real-time, which might change in real-time due to the stimulus. In *"Little Red Riding Hood"*, little red riding hood goes to grandma's house. The closer she is getting to the house, the happier she becomes. However, when the wolf appears, she becomes scared. When the wolf gets closer, little red riding hood runs away.
6. *S-MADE*: It is a toolkit to create all the agents (including director agent and character agents) and load the goals into the agents [2].
7. *Interactive Storytelling System*: It is the final interactive storytelling system based on the initial text-based stories. Users are able to interact with the story director or story characters through the interactive storytelling system, in order to achieve a dynamic or personalized storytelling.

2.3 Steps to Create an Interactive Storytelling System

1) Identify the Character Agents from the Story. Two agents are required for every interactive storytelling. The first one is director agent, which schedules the behaviors of characters and handles user interactions while ensuring plot coherence. The other is the user agent, which is a representation of the player in the user environment. User profiling is very important for personalized storytelling. Besides the two kinds of agents, the characters which participate in the story and are represented by names in the story script should be figured out. They will be modeled as character agents. The main characters in the "Little Red Riding Hood" story include "Little red riding hood", "Wolf" and "Grandma" etc. Then we need to define the belief, goals, as well as the actions of the agents in the next step, which can be extracted from the script as well.

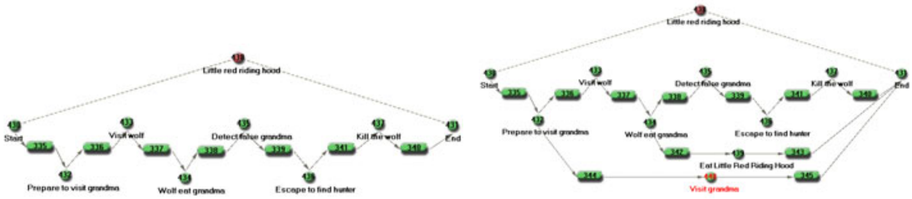
2) Identify the Goals and Actions for Each Agent and Conditions to Handle User Interactions. The goal of director agent is to present the storyline which is non-linear, and to handle different user interactions. In the "Little Red Riding Hood", some goals of the director agent are "prepare to visit grandma", "meet wolf", "talk to wolf", "wolf eats grandma", "detect false grandma", "escape from the wolf", "find the hunter", and "kill the wolf". As the current story is a linear narrative, the current goals of director agent will achieve a linear storytelling. In order to handle user interactions, we need to derive the alternative goals which might not appear in the baseline story. There are two ways:

1. Find different versions of the story; extract common goals and different goals. For one version of "little red riding hood", little red riding hood fails to find the wolf lying in the bed, and is eaten by the wolf. Therefore, another goal "did not find wolf" can be an alternative to "find wolf".
2. In order to convert a story which has only a linear version into non-linear storytelling, we need to derive new goals and the conditions that need the new goals. For example, we can consider the player who acts as little red riding hood doesn't meet the wolf on the road. Then we can have the goal "little red riding hood meets grandma".

The goal of each character agent focuses on how the agent performs in the virtual world itself as well as with others. Same as designing the goals of the director, the alternative goals of character agents could be designed in response to different user interactions.

3) Design Goals and Actions with Fuzzy Cognitive Goal Net Designer. Based on the abstracted goals and actions of the agents, we can design the goal nets with goal net designer and store them into the database for real-time execution. The director agent and character agents represent two levels of story executions. Therefore, the goals for director and characters are designed separately.

Design Goals for Director Agent. The story plot of "Little Red Riding Hood" to be presented (i.e. the goal of the director agent) is modeled as shown in Figure 2(a), in which the original story is presented. After adding the alternative scenes (goals of director agent), an interactive storytelling scenario is shown as 2(b), in which there are multiple endings of the story. For example, the little red



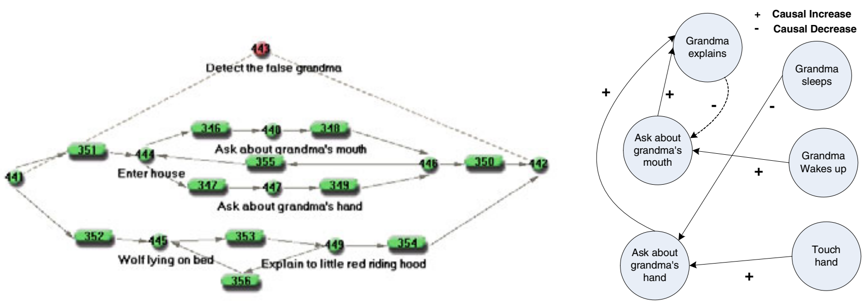
(a) Linear (b) Non-linear

Fig. 2. "Little Red Riding Hood" Story

riding hood does not find out that the "grandma" on the bed is the wolf. The wolf eats the little red riding hood. On the other hand, the little red riding hood might not meet the wolf on the way, and goes to grandma's house successfully.

The director agent selects a storyline dynamically based on the user interactions and the state of context. A sample storyline of "Little red riding hood" in real-time is that, the little red riding hood fails to recognize the "grandma" and is eaten by the wolf. However, the hunter walks nearby and kills the wolf. The little red riding hood and the grandma are saved at last.

Figure 3(a) shows the details of the scene "detect the false grandma".



(a) Scene in Fuzzy Cognitive Goal Net (b) Context in the scene

Fig. 3. The "Detect the False Grandma" Scene in "Little Red Riding Hood" Story

In the scene, two characters "wolf" and "little red riding hood" act together in parallel. By using the dispatching algorithm, the "wolf" and "little red riding hood" get their respective goals. A sample Fuzzy Cognitive Map is derived to simulate the context variables, interactions and goals in the scene as shown in Figure 3(b).

Design Goals for Each Character Agent. Director agent achieves its goal through guiding the characters agents to achieve their goals. According to the scene dispatching algorithm, we can separate the goals for the wolf and little red riding hood who act in parallel. The goals of character agent will be loaded to the agent and run in real-time.

4) Running Characters' Goal Nets with S-MADE Runtime. After the goals of agents have been created, the director agent will be executed which will in turn call other character agents to run according to the designed goal net. An interactive storytelling engine, Multi-agent development environment (S-MADE) is illustrated in details in [2].

3 Conclusions

In this paper, we propose an Agent-Oriented Methodology for Interactive Storytelling (AOMIS), which combines the plot-based and character-based approaches with goal-oriented agents. It converts a linear text-based story to a non-linear, dynamic storytelling based on user interactions in real-time. In the methodology, each agent is goal oriented and adaptive to user interactions and context changes, so that a dynamic storytelling will be presented. AOMIS has been used in research projects "Chronicles of Singapura" and "Voyage to age of dinosaurs" and received very positive comments from teachers and students.

Currently the story parser is still static and based on human labor in our methodology. In the future, we will automate the process as well as the story generation process in the virtual world to facilitate novice further.

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Back-Leading through Character Status in Interactive Storytelling

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Abstract. A key challenge in computer-based interactive narrative is the conflict between user agency and authorial control of the story quality. Valuable lessons can be learned from improvisational and especially interactive theatre, where various narrative and interactive strategies have been developed to engage users in the process of co-creating the story. In this paper, we focus on the use of character status and status shifts. Specifically, we present and illustrate a computational model of status shifts based on the cognitive semantics theory of force dynamics.

1 Introduction

Interactive narrative is a contemporary form of the age-old human creative activity of storytelling. Unlike the king in *One thousand and One Nights* who was satisfied by listening to Scheherazade's carefully crafted tales every night, modern users are eager to play a more active role in the stories. Interactive narrative offers them the opportunity to participate and influence the narrative world in a wide variety of ways. A central challenge to interactive narrative is what is known as the "narrative paradox" — the conflict between user agency and authorial control to structure the narrative for better user experience [4, 2, 9]. Generally speaking, the more freedom the user obtains to influence the story world, the harder it is to maintain the quality of the story. As Marie-Laure Ryan [13] rightfully asks, will there ever be any user, while playing the title character in a game version of Anna Karenina, who decides to kill herself in order to make the story more interesting? To many interactive narrative and game studies researchers, the answer is no [1]. As a result, effort has been put to make interactive narrative systems more algorithmically sophisticated to resolve this conflict. An example is to incorporate drama managers [11].

However, algorithmic advancements in story generation and drama management alone are not the complete answer to Ryan's question. At the end, a truly interactive narrative piece relies on the user to make major decisions for her character, and those choices will significantly impact the quality of the story.

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If it takes professional storytellers years of experience to master their art, why should we expect an untrained user to play such an active part of a great story without giving her the necessary clues and guidances?

The act of guiding and engaging the user without taking away their freedom of input and, ultimately, spurring their creativity in leading the story is as creative as constructing story content itself. Here, we look closely at parallel settings in theatrical interactive performance, including improvisation theatre (improv) and particularly interactive theatre. Although both forms have spontaneous nature and are built upon one another, improv is primarily performed by trained actors for the audience to *observe* whereas the interactive theatre (e.g., "Tony and Tina's Wedding," Disney's "Turtle Talk") is structued around untrained audience members' *participation*[17, 7]. Interactive theatre's primary concern of engaging untrained participants provides valuable insights to the narrative paradox in computer-based interactive narrative in ways that are unique and complementary to lessons learned from the improv theatre.

In interactive theatre, trained actors (*inter-actors*) engage audience participants (*spect-actors*) through a set of techniques called *back-leading* [17, 7], a metaphor from ballroom dancing. Although traditionally classified as the follower in the couple, many women developed the skill of leading the dance while appearing to be following their less skillful male partners. Similarly, a good inter-actor provides the right amount of necessary guidance to the spect-actors while still leaving sufficient creative space for the latter's creative input. This paper presents our initial work of understanding and ultimately modeling back-leading, focusing on the use of character status and status shifts and a computational model of it based on the cognitive semantics theory of force dynamics. For the rest of the paper, we first present related work and introduce the theoretical frameworks of status and force dynamics. Next, we demonstrate how force dynamics provides a useful cognitive model to understand character status and status shifts. Finally, we provide discussions and conclusions.

2 Related Work

Improvisation has recently received renewed interest for insights into interactive storytelling. A number of virtual theatre projects used insights from human improv theatre as the basis of their systems. For example, Perlin and Goldberg's *Improv* system creates animated characters who interact with users through real-time behavior-based animation [12]. Hayes-Roth's Virtual Theater Group [6] and the more recent work by Ballin et. al. [3] explicitly model character status as the constraints of character behavior along the lines of demeanor, relationship, and space. Swartjes and Theune[15] also implemented an IDS system using the late commitment concept. Recently, Fuller and Magerko's [10, 5] empirical study of improv performers identified the "cognitive convergence" and "cognitive divergence" processes that allow different performers to co-create a scene based on shared cognitive models. Compared to the above work, our focus is not how professional improv actors work with one another. Instead, we are primarily concerned how inter-actors engage untrained spect-actors and overcome the disparities of their storytelling and improvisation skills in the process of creating stories on the fly. Our work does not focus on the level of animating characters' body language as in some of the related work, but rather on the *plot-level* relationships between characters and/or the environment. Our current method is introspective, based on the experience of one of the co-authors as inter-actor and director of interactive performance projects in the past seven years.

3 Theoretical Framework

Status, first introduced by Johnstone's classic text [8], is one of the core concepts in improv and interactive theatre [14]. It describes the social and professional standing of a character and her relation to other characters as well as the environment (e.g., space and props). Generally speaking, a high-status character dominates the situation whereas a low-status one submits. Status can be seen as a top-down "motivation" to a character's actions in that "every inflection and movement [of a character] implies a status" [8] and hence determines her range of possible gestures and speech. Depending on the level of complexity, character status can be either binary (i.e., high vs. low status) or multiple degrees (e.g., status 2 out of 10). Johnstone and his followers believe that a large proportion of drama comes from how characters attempt to raise or lower their social status through different means. When the status of the characters changes in a play, he claims, it is typically the most enjoyable part for the audience to watch. A standard two-character scene can include four types of *status shifts*: 1) both lower status, 2) both raise status, 3) one raises while the other lowers, or 4) the status is reversed during the scene.

In interactive theatre, status is a simple but powerful tool to communicate to spect-actors. An intera-actor's first task is to engage the spect-actor quickly and once the latter becomes comfortable enough to make choices on her own, the inter-actor can provide more guidance on how to react to the world she is experiencing. *This is where status can be useful.* Based on our experience, an inter-actor's choice of adopting high or low status can provide useful cues for the spect-actor to respond accordingly. Once a spect-actor has established a baseline status for herself within a story, she can begin to form a hierarchy of status among other characters. Inter-actors then can use this hierarchy to position themselves within that framework and co-create the story from this foundation.

A useful framework to understand the working of status in narratives is the cognitive semantic theory of force dynamics (FD). Developed by Leonard Talmy [16], the framework captures fundamental semantic structures such as "the exertion of force, resistance to such a force, the overcoming of such a resistance, blockage of the expression of force, removal of such blockage, and the like," some of which are hard to represent under the traditional notions of causality. A basic force dynamics pattern contains two entities, an *Agonist* (the focal entity) and an *Antagonist*, exerting force on each other. An Agonist has a *tendency* towards either motion (action) or rest (inaction), and it manifests

Table 1. Comparison of Status and Force Dynamics

Status in performance	*Force Dynamics*
Main character	Agonist
Secondary character	Antagonist
Attempts to change status	Tendency to motion
Attempts to maintain status	Tendency to rest
Successful attempts	Stronger
Failed attempts	Weaker

its tendency if it is stronger than its Antagonist. To represent "The ball kept rolling because of the wind blowing on it," for example, the Agonist *ball*'s intrinsic tendency towards rest is overcome by the Antagonist *wind*'s greater force, and hence the result is the motion of the Agonist. FD can be used to describe not only physical forces, but also psychological and social interactions. Conceiving such interactions as psychological "pressure," FD patterns can manifest themselves in various semantic configurations, such as the "divided self" (e.g., "He held himself from responding") and complex social interactions (e.g., "She gets to go to the park.") In the FD framework, time is represented by sequences of *phases*. A phase describes the segment of time during which the Agonist and Antagonist have a relatively stable FD relation.

4 A Model of Status in Interactive Performance

At the fundamental level, both FD and status describe the power relationship between two or more entities and its changes throughout time. In a scene of two characters, we may select the one of primary interest to us as Agonist and the other as Antagonist. The Agonist's attempt to change her status is defined as her tendency to motion, whereas her attempt to maintain her current status is defined as her tendency to rest. The character who manages to achieve her intended status is the stronger one in the FD relation. The changing FD relations across different phases therefore offers a semantic model for status shifts. Table 1 lists the matching elements between status and FD in our current model.

Using the above FD-based model, we can analyze the dramatic structure of interactive theatre in terms of status shifts. Take the example of an interactive scene in which a spect-actor plays the role of a young musician. The first time the musician encounters the parent character, played by an inter-actor, the latter exhibits a controlling and dominating manner regarding various aspects of the musician's life. In the subsequent scene, other inter-actors' characters set up external and internal influences over the musician, possibly leading to her decision of leaving home and pursuing her dreams. In a final confrontation with the parent, the empowered musician may overcome the pressure of the parent and depart. In this hypothetical case, the inter-actors back-lead the spect-actor to co-create a dramatically interesting story.

Our FD-based model can help us further analyze the above scenario. The interaction can be divided into 2 phases, corresponding to the musician character's status shifts. In Phase 1, the Agonist (spect-actor's musician character) has the tendency to move but is hindered by a stronger Antagonist (her parent). Phase 2 is composed of the subsequent two scenes, in which the strengthened Agonist is able to overcome the Antagonist and initiate the motion. In our experience, status shifts (i.e., FD relation changes) are closely associated with the adrenaline rush and emotional satisfaction that spect-actors often report to experience. In this case, we would argue that the experience of coming up against the parent character and overcoming his control in a visceral way is essential to both the story development and the experience of the spect-actor. As in computer-based interactive narrative, the key question here is how to provide the right condition so that the spect-actor will (appear to) initiate the status shift herself — the principle of back-leading. In the case of the above scene, it is important to clearly establish the initial status of the spect-actor's character in Phase 1 and her power relation with the Antagonist. Phase 2 needs to introduce the motivations and events that could lead to the Agonist's increased strength. The forward momentum of the narrative is designed to lead to a resolution, in which the intentions of the two characters will conflict and may result in a shift in their FD relations in the end.

5 Conclusion and Future Work

In this paper, we discussed the importance and challenges of engaging the lay user in the creative process of interactive storytelling. Useful lessons can be learned from human improv theatre and especially interactive theatre in terms of how inter-actors guide, engage, and spur the creativity of untrained spect-actors on stage through back-leading. In this paper, we pay especial attention to the use of character status and status shifts. Using the cognitive semantic theory of force dynamics, we proposed a semantic model, which can be used to formally model status and status shifts in interactive theatre sessions.

As part of our future work, we plan to conduct empirical studies of interactive theatre and gather further evidence to complement our current introspective method. Our long-term goal is to test our FD-based model in computer-based interactive narrative systems in regard to the narrative paradox. Modeling character status and status shifts also opens up new possibilities of automatically assessing story interestingness. It is of special importance to computer generated interactive narrative research because it will afford the system more autonomy in story generation or drama management.

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Rereading in Interactive Stories: Constraints on Agency and Procedural Variation

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Abstract. A central problem for interactive storytelling research is how to create a story which procedurally varies as the result of a user's actions, while still feeling like a story. Research has largely concentrated on how to provide coherent variations *each time* a user experiences an interactive story, without consideration for the relationship *between* subsequent experiences. This paper examines the issues that arise when designing an interactive story system which is intended to be *reread* as the result of a *reframing*. Through a discussion of several types of reframing drawn from non-interactive films, we argue that, when an interactive story makes use of a reframing to encourage rereading, the requirements for narrative coherence, selection and ordering extend *across* reading sessions. This introduces constraints in terms of what can be varied procedurally in response to user actions which do not occur in interactive stories which are not explicitly designed to be reread.

Keywords: Interactive storytelling, rereading, constraints, agency, procedural variation, reframing, coherence, selection, ordering.

1 Introduction

Currently, most interactive storytelling systems try to support one or more of the following aesthetic categories, as first articulated by Murray [1]: agency, immersion, and transformation. Most interactive storytelling research aims to provide a sense of *agency*: the feeling that you are able to form an intention, take action within the storyworld to pursue that intention, and see your action have an impact on the unfolding events in the story. Transformation, however, particularly what Murray calls *transformation as variety*, is more problematic.

Transformation as variety requires that the reader can re-experience a story multiple times to see different aspects of the story. Mateas [2] suggests that there is, at first glance, an apparent contradiction between agency and transformation as variety. Agency requires a clear plot structure, a structure which may be disrupted by transformation as variety, resulting in a disruption of agency. However, without transformation as variety, a reader who re-experiences a story will quickly realize that their actions have no consequence, and again agency is disrupted. Agency seems to require that transformation as variety be both present and absent at the same time.

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Mateas argues that the way to overcome this apparent contradiction is for the system to enforce a dramatically meaningful but *different* plot in every variation. This raises the question: how can systems maintain narrative coherence while providing variation in the context of rereading?

2 Related Work

There are two ways in which research has addressed this question. One approach is to customize each interactive story experience to a specific *reader* – making sure that each individual reader's choices have an impact on the resulting experience. This is essentially providing variation *across readers*. This is the approach taken by most systems [3,4,5]. The second approach is to customize the experience to a specific *reading* – making sure that a given reader's choices in each individual reading have an impact on the resulting experience. This is essentially providing variation *across readings*, potentially by the same reader. Although some authors [6] state that repeated experiences by the same reader is one of their design goals, they do not make use of the fact that the reader is the same.

3 Research Problem

For an interactive story that is designed to create a sense of agency and transformation as variety, the requirement is that coherence be maintained *within each instance* of the story in isolation, even when a user re-experiences the story.

Consider, instead, an interactive story which is designed specifically to motivate *rereading*, and is intended to do so by means of a *reframing*. By reframing, we mean the revelation of new information at the end of the initial reading which fundamentally changes the reader's understanding of the story, and motivates the reader to go back and reread the story to look again at specific parts of the story related to this new perspective. For example, in the film *The Sixth Sense*, the revelation at the end of the film that the main character, Malcolm, has been dead for most of the film radically changes the viewer's understanding of the story, and in most cases creates an urge to re-watch the film [7].

Now consider a version of *The Sixth Sense* designed as an interactive story. If the reader/viewer is going back to re-experience the work with the specific goal of seeing, again, what they saw the first time, any change to the story which removes or changes those aspects of the story which the viewer is looking for will frustrate and disappoint the viewer. For example, the viewer may want to see why they didn't notice that Malcolm is dead. If the scenes that the viewer is looking for are either missing or different, they will feel frustrated.

This suggests that there are additional and different constraints on which aspects of the system can vary procedurally when the story is intended to be re-experienced as the result of a reframing. The current work on interactive storytelling, by focusing on maintaining coherence within individual experiences of an interactive story, does not address this problem (although, see [8]). In this paper, we focus on the question: what issues arise when we want to create stories that change based on reader choices, while at the same time taking into account what the reader knows when rereading as the result of a reframing?

4 Requirements to Support Rereading

We will now discuss how the intention to support rereading as the result of a reframing impacts agency and procedural variation within an interactive story. In this situation, the requirements for *coherence* are extended across reading sessions, and additional constraints are imposed in terms of *selection* and *ordering* both within and across sessions.

4.1 Coherence

The requirement for coherence means that "[n]arrative existents must remain the same from one event to the next. If they do not, some explanation... must occur" [9, p. 30]. For an interactive story where rereading is motivated by reframing, there are additional constraints imposed on coherence, not just within but also *across* readings.

Consider our scenario where a viewer is (re)watching an interactive version of *The Sixth Sense*. In this example, it is crucial that the events which the reader encounters in the first reading remain the same in subsequent readings. If the reader's actions during a second reading of the story lead to Malcolm *not* dying, or result in him discovering that he is dead much earlier in the story, then it is quite likely that the reader will not be able to re-experience the events which she was motivated to see again as a result of the reframing. This suggests that, for rereading motivated by reframing, coherence enforced within an individual reading may not be enough. If the reader is looking for something in particular, and that changes, then the reader's motivation for rereading will be frustrated.

Similarly, in the film *Vantage Point*, we are shown a series of variations on the attempted assassination of the American president, each from the perspective of a new character. Each version adds new information about the events, and puts our initial interpretation of earlier events in question, while at the same time maintaining coherence. Viewers are motivated to continue watching out of a desire to "figure out what really happened", as each version reframes the narrative and invalidates their previous understanding. In an interactive version of the film, if the user was able to take action which contradicts earlier versions, such as stopping the assassination attempt, then this motivation disappears.

The structure of *Vantage Point* suggests an additional constraint on variability for an interactive version of the film. In each variation of the story, the viewer receives changing information not just about the events in the story, but also about the roles and identities of the various characters, some of whom were the focus of earlier versions of the story. In order for these revelations to be effective, a player in an interactive version would have to be restricted in terms of the "obvious things" she might want to do to or with such characters. This places restrictions on user actions, not just based on events that have already happened, but on revelations that have *not yet happened*.

4.2 Selection

The above discussion involves constraints that are placed on an interactive story in terms of coherence across reading sessions. There are also constraints in terms of what must be shown, and what can be omitted, during rereading. This can be seen as a constraint on *selection* – determining what is to actually be shown, and what will be left for the reader to infer [9] – across readings. Stories often omit scenes which are not directly important to the story, such as the time spent for a character to travel from one location to another. Stories also tend to omit details of scenes when the scene is being shown again.

If a reader is going back to a story a second time and is *looking for something in particular*, then if what the reader is looking for is not there during the rereading, her reason for going back will not be satisfied. Coming back to our *Sixth Sense* example, even if the events of the story remain consistent and coherent (i.e., Malcolm dies and moves through the story thinking that he is alive), the reader could still find the rewatching dissatisfying if *what they want to see* is not shown. When a viewer sees the final scene in the film, she is most likely going to want to go back and look for any scenes where Malcolm was seen together with people other than Cole, to look carefully at these scenes and wonder how she didn't notice that Malcolm was dead. If these scenes are omitted from the second viewing, it is likely that the viewer will feel frustrated. What this means is that the system must take into account both *what the reader knows about the story* and *what the reader is looking for* in subsequent readings, and ensure that these scenes are not omitted.

Similarly, in the film *Inception*, the final scene introduces a reframing of sorts. Rather than completely altering the viewer's understanding of the story, instead the end of the film *casts doubt* on the viewer's interpretation, leaving the viewer wondering whether or not the main character, Cobb, has actually returned to the real world, or is still trapped in "limbo". At this point, viewers are motivated to go back and rewatch the film, in an attempt to find evidence for their interpretation of the ending. Viewers will be looking for specific scenes which can be used to support their interpretation, such as the transitions between "levels" in the dream sequences, the various times that Cobb uses his spinning top to check if he is in reality or not, or the various times that his children are shown. If, in an interactive version of *Inception*, these scenes are not present in a rewatching, the viewer will be frustrated and disappointed. This is quite different from an interactive story which supports both agency and transformation as variety, where there is no explicit relationship between what is shown in one reading and what is shown or omitted in later readings.

4.3 Ordering

In a story which is using a reframing, it is crucial that the information which reframes the story be revealed to the reader *in the first reading*. If not, then the motivation to reread will not be present. This imposes an *ordering* constraint on the fragments of the story across reading sessions.

For example, for an interactive version of *The Sixth Sense* to effectively motivate the reader to return for the purposes of following up on a reframing, the reader must actually encounter that specific ending in the first reading. If the film ended without the final scene, the reader would most likely assume that Malcolm had successfully helped Cole overcome his problem of seeing dead people, and that, having dealt with this, he may be able to resolve the estrangement between himself and his wife. It is only upon seeing the final scene that the reframing forces the viewer to reassess the entire narrative, and consequently want to go back to resolve the ensuing questions.

A similar degree of constraint can be seen in some "multiform" stories. For example, the film *Rashomon* tells the story of the death of a samurai and the rape of his wife by a bandit in a forest grove. The story is told from four different perspectives: that of the bandit, the wife, the dead samurai (through a medium), and a woodcutter who came across the scene. Each version of the story deliberately contradicts the previous version, leading the viewer to eventually doubt whether there is any way to know what "really" happened. The order of the versions is important, as each is designed to play off the impression given by the previous. For example, the woman is shown to be encouraging the men to fight in the first version, whereas she wants to die as a result of her ordeal in the second. The impact of the reversals would not be the same if, in an interactive version of *Rashomon*, the order could be changed. In particular, the final version, told by the woodcutter, undercuts all three previous versions. While it may be possible for the first three versions to be reordered, the final version *must* come last. The order in which variations are encountered is important. An interactive version of the film which aims to preserve the impact of the variations would need to impose constraints on ordering *across* sessions for this to be effective.

In addition, designing an interactive story to encourage rereading as the result of reframing also imposes constraints on the ordering of events *within* the first reading. The structure of a narrative which involves a reframing is somewhat similar to a mystery or detective story. There is, however, a key difference. Whereas in a mystery the discourse is carefully constructed such that the reader should have just enough information to solve the mystery, in a story with a reframing, the very *existence* of the mystery is kept from the reader [7, p. 56].

Once the reframing has been revealed, the reader will realize that there were actually two versions of the discourse: what she initially thought was happening, and what has now been revealed by the reframing. If, however, the reframing is revealed too early, then the reframing will be rendered ineffective. For the reframing to have the type of wide-ranging impact seen in *The Sixth Sense*, where the information revealed in the reframing reaches back and changes almost everything in the narrative, it is also important that the event which the reframing changes (in this case the shooting and death of Malcolm) comes early in the story. There must be sufficient narrative distance between the reframed event and the reframing. This ensures that the reader is only able to reconcile the reframing by actually re-experiencing the story, rather than resolving the two conflicting discourses by simply thinking through the events of the story.

This implies that the system must ensure that there are constraints on the ordering of events within each reading of the story, at least for the first reading.

5 Conclusion

In this paper, we discussed the issues that arise when an author wants to create a rereadable interactive story, where the rereading is motivated by a reframing. Most interactive storytelling research focuses on creating procedurally variable interactive stories which provide a sense of agency, and adapt, in isolation, to each reader's experience. When considering rereading motivated by reframing, however, authors need to think about how their story can adapt to repeated readings by the same reader, while taking into consideration what the reader has learned from previous readings.

The main difference between interactive stories that support rereading as a way to explore multiple outcomes or perspectives, and those that are intended to support rereading motivated by reframing, is that the latter approach imposes additional constraints on coherence, selection and ordering – not just within, but also across story sessions. Investigating the issues surrounding rereadable interactive stories motivated by reframing raises a number of issues which are not addressed by the current research, issues which can provide further insight into interactive storytelling in general.

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A Method for Transferring Probabilistic User Models between Environments

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Abstract. Chief among the inputs to decision making algorithms in narrative or game environments is a model of player or opponent decision making. A challenge that will always face designers is to specify that model ahead of time, when actual data from the environment is likely not to be available. Absent corpora of data, designers must intuit these models as best they can, incorporating domain or expert knowledge when available. To make this process more precise, we derive a theoretically grounded technique to transfer an observed user model from one domain to another. We answer the question: "How can a model obtained from observations of one environment inform a model for another environment?" We verify the accuracy of our techniques using data from previous user studies.

1 Introduction

Interactive narrative experiences are marked by two important characteristics: 1) a large space of player interactions, some subset of which are specified as aesthetic goals by authors; and 2) the affordance for players to express self-agency and interact in a meaningful way. As a result, players are (often unknowing) participants in the creation of their narrative experience. They cannot be assumed to be cooperative, nor to be adversarial. Thus, researchers have designed computational paradigms that work with players to co-create experiences without the need for goal-oriented models of player behaviors. To effectively work with a (possibly unknowing) partner, systems rely on various types of models that describe player behaviors. In this paper, we will look at probabilistic models. More specifically, we will rigorously examine how *what we learn in one narrative or game environment can be put to use in a new environment (sometimes even a new game), thereby alleviating the requirement for authors to create a new player model from scratch*. We will describe a way in which we can use quantitative or probabilistic data from one domain to estimate the change in probability in a second domain that a given alternative is preferred to another after an action has been applied to the first. Further, this will allow us to use data from other domains to develop player models for interactive narratives without the need for detailed hand authoring of the models.

The earliest work on interactive narrative is traceable to Laurel [7], who first proposed the idea of a human Drama Manager (DM) to adaptively guide actors on stage to bring about a better narrative experience for audience members. A human director can

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adapt their (possibly tacit) knowledge about how audiences may react to narrative adaptions in a variety of settings. Humans are very good at transferring knowledge between domains, *e.g.*, by learning a mental model of someone else's behavior in one setting and then applying that knowledge in another (possibly unrelated) setting.

After Laurel's initial work, progress in drama management shifted almost exclusively to algorithmic developments for computational realizations of DMs in virtual environments (see Mateas [10] and Roberts & Isbell [17] for a surveys). Unfortunately, while humans may be good at knowledge transfer between domains, computers are generally poor at transferring knowledge between domains. Therefore, the job of specifying decision making rules for different domains falls upon humans, making the lessons a computer can learn in one domain useless in other domains.

Notable among early efforts to move virtual drama management beyond "script-and-trigger" decision making are those of Bates [1] and Weyhrauch [23]. They published work on what ultimately became known as Declarative Optimization-based Drama Management (DODM) [11]. A DODM instance relies upon a number of author-specified components of the narrative environment and decision making processes, most notably (for our purposes) a probabilistic model of player behavior and a set of actions the DM can take to effect changes in player decisions. This model describes how players are likely to transition through a narrative environment, given the history of the story and DM actions. In practice, this can be very difficult to implement effectively [19,20,23].

In this paper, we derive a mathematical psychology-inspired method for transferring the observed effectiveness of a DM action from one narrative domain to another. To our knowledge, this is the first application of these mathematical psychology models to game design. It will enable authors to design their models using data from previous experiences, rather than having to engineer them based on intuition or educated guesses.

While our interest in drama management in general and the DODM formalism more specifically led us to investigate this problem, our method is not limited to narrative domains. In fact, any setting where a probabilistic model of player behavior serves as input into a decision making algorithm can benefit from increased specificity. Despite this generality, our approach is not universally applicable—there is no silver bullet. Below, we will discuss conditions that might let our method yield accurate results.

2 DODM and Related Work

First proposed by Weyhrauch [23] as a problem of pseudo-adversarial search, DODM has been studied in recent years as a formal decision making process [11,12,15,18]. A DODM drama manager is characterized by four components: 1) a set of **plot events with precedence constraints**; 2) a set of **DM actions** that *operate on plot events*; 3) a probabilistic **player model** of the progression of events that encodes the likely behavior of players; and 4) an **evaluation function** encoding author specified goals.

The player model is typically represented as a probability function $P(S'|A, S)$ which represents the probability of a story event S' occurring immediately subsequent to a story event S given that the DM has executed action A after story event S has occurred. Actions are typically modeled as "operating on plot events" and generally take one of three forms: *deny* an event, *cause* an event, or *hint* at an event. From our perspective, deniers and causes aren't particularly interesting as their outcome is deterministic; however, the result of a hint, depending on how that hint is delivered, may change significantly. Hence the need for a detailed model of probabilistic action effects. If $P(S'|S)$ is the probability that event S' is chosen by a player after event S, and A operates on S', then likely $P(S'|A, S) \neq P(S'|S)$. How much different is a question traditionally answered by authors' estimates. The main contributions of this paper are two models that enable this probability change to be estimated in a principled, data-driven way.

To date, the vast majority of the work on DODM has been abstract, so actions have represented more general methods for adjusting the likelihood a player will experience a story event they operate on. For example, in the original formulation due to Weyhrauch [23], the transition model was hand-authored based on a "best guess" of how effective a class of actions might be. This best guess used a uniform distribution over successive story events as a base case. When actions were applied to a particular story event, the weight on that event was increased and the distribution recalculated by normalizing the weights.

More recently, Sullivan *et al.* have examined two other types of player models that encapsulate "world knowledge" about the story environment [19,20]. Based on the Manhattan distance (or L_1 norm), these models attribute *a priori* weights to plot events based on the physical distance between the plot events and the player in the story environment. In order to extract probabilities, weights are normalized (as in the uniform approach). When a DM action operates on a plot event, the weight can be updated according to changes in the Manhattan distance between the player and the event trigger.

Lastly, Roberts *et al.* [14,16] have investigated the use of social psychology influence techniques [2] as a framework for actions, delegating the implementation to a separate process. By defining actions as the application of social influence in the environment, data from existing studies in other domains that estimate probabilistic changes in players' behaviors can be used to make similar estimates in a new domain. An advantage over earlier approaches is that there is a vast literature describing evaluations of the effectiveness of influence methods in various real-life settings that can be leveraged to implement a player model. In addition to data collected from other virtual domains, data from the psychology literature can be input into the algorithm we present below. We are asking: "If we learn from one domain that an action has a certain measurable effect on the probability that a player will prefer one alternative to another, what does that tell us about the effect the action will have on the probability of preferring the first alternative to a third in another domain?" For example, imagine players in an MMORPG are faced with the choice between two quests and that they prefer the first with probability 0.4. Further, suppose we know that when the "default effect" [6] is applied to the first quest as a hint they choose it with probability 0.7. Lastly, suppose we know players tend to prefer a third quest over a fourth with probability 0.5. We now want to know the probability they will prefer the first quest over a third if the default effect is applied to it. Our method will rigorously answer that question.

3 A Method for Cross-Domain Transfer of Probabilities

Here we describe our technique for transferring probabilistic data between domains.

To make things concrete, suppose $A, B, C, \ldots$ represent potential outcomes and we use a subscript 0 as in A_0 to denote the outcome in the base situation and 1 as in A_1 to denote the outcome when an action has been applied to it. In the context of an interactive narrative, these outcomes would be story events and the action applied would be a hint. Recalling the above example of quests in an MMORPG, the outcomes would be alternative quests and the action would be applying the default effect to the choice. We will use *alternative* to mean an outcome with a treatment and we will use letters X and Y when we deal with alternatives and don't specify whether they involve a base condition or condition with an applied action. We will use the letters A, B, C to represent outcomes before we specify the condition. We would like to go from two outcomes for which we have preference data in the base case to the probability the first outcome with an action applied to it is preferred to the second. More generally, we would like to calculate the probability $P(A_1 > C_0)$, interpreted as the probability that outcome A under the influence of an action is preferred to outcome C if no action is applied, if we know $P(A_0 > C_0)$, *i.e.*, the probability that outcome A is preferred to outcome C both without actions applied. This would give us a way to estimate the effect of applying an action to an outcome.

We will discuss how to obtain such probabilities based on the types of data available in the literature or that we might obtain from our own data collection. To use the model we present here, we have to assume that the model of utility and preference we base our work on accurately describes how people choose between alternatives and that the magnitude of the effect of an action strategy observed on one set of alternatives will be similar when applied to other alternatives. We acknowledge that our assumptions may not always hold; however, even if they don't hold our approach can provide a starting point that authors can tweak if their intuition tells them the assumptions are violated.

3.1 Types of Data Available

Over the years, there have been countless social psychology studies published that describe the effects of influence on real-life situations. The results of those studies are generally reported as either *numerical data* or *probabilistic data*. Both of these data are easily obtained from experiments run on narrative or game environments as well.

The numerical data experiments report findings based on quantities or scales that are directly measured. For example, Folkes *et al.* present an experiment measuring the effects of product scarcity on usage [4]. Specifically, they conducted experiments where participants were given a measured amount of shampoo in various sized containers. The results of the experiment indicate that under certain conditions the more perceived scarcity, the more the product is used by the study participants (*e.g.*, 500 ml of shampoo in a 1,000 ml bottle leads to 87 ml of use on average whereas 250 ml of shampoo in a 1,000 ml bottle leads to 121 ml of use [4]).

Another example of numerical data is that of Regan [13], who examined how reciprocity in the form of a favor can lead to increased levels of compliance. Regan's measurements were of the quantity of lottery tickets purchased under different conditions. When he reported that in the base condition study participants bought on average 1.00 lottery tickets whereas participants in the influence condition bought on average 1.91 lottery tickets, Regan was able to show reciprocity's significant effect on quantity.

On the other hand, data are sometimes reported using frequencies or probabilities. In that case, the effects of the different study conditions induce a probability distribution over outcomes, or give us a way to obtain the probability that one outcome is preferred to another. This type of data is a more natural fit with the DODM probabilistic transition model and, in fact, one of our approaches will be to translate count into frequency data. Consider the effects of reciprocity discussed by Cialdini [2]. He reports that the Disabled American Veterans Association gets a response rate of approximately 18% when soliciting donations via a mass mailing campaign. When reciprocity is invoked via an unsolicited gift being included in the mass mailing, the donation response rate rises to 35%. This is an example of probabilistic data reported in the literature.

Another example of probabilistic data is reported by Cialdini *et al.* in their study of the effect of reciprocal concessions on compliance with requests for volunteers. In that case, it was found that a mere 16.7% of study participants agreed to volunteer in the control condition, but when reciprocal concessions were employed 50.0% agreed.

3.2 The Strict Utility Model for Numerical Data

When data is given in terms of quantities rather than frequencies or probabilities, some models allow us to compute frequencies or probabilities. For example, in 1929, Zermelo proposed what has come to be known as the strict utility model [24]. This model, widely studied in the mathematical psychology literature, describes probabilistic choice in a forced-choice pair comparison system, where for every pair of alternatives X and Y, each trial asks a subject to decide if they prefer X to Y or Y to X, with no indifference allowed. Then $P(X > Y)$ represents the frequency with which (the probability that) X is preferred to Y. We say that a pair comparison system satisfies the ***strict utility model*** if and only if there is a utility function over the alternatives f that satisfies:

$$P(X > Y) = \frac{f(X)}{f(X) + f(Y)}. \tag{1}$$

This model will form the basis for one method through which we transfer numerical results from one domain to probabilities of player choice in another domain. The strict utility model is not applicable in every situation, and in Section 4 we present experimental results to verify the model. Let us consider the example from Folkes *et al.* [4] discussed above. In those results, there are five different conditions for which data are presented; however, here we will focus on two of them: A_0 and A_1, which according to our notation represent a control (A_0) in which no action (or in this case influence) is applied and treatment condition (A_1) in which an influence action is used. Suppose that the data reported for each outcome is given by a function q such that $q(A_0)$ is the quantity reported for A_0, $q(A_1)$ the quantity reported for A_1, etc. In addition to assuming the strict utility model, we assume the utility of an alternative X is proportional to the quantity reported for that alternative: $f(X) = \lambda \cdot q(X)$. While it need not be the case that λ is equal for all X in every scenario, our experimental results indicate that this assumption leads to reasonably accurate results in many cases.

We are interested in what $q(A_0)$ and $q(A_1)$ tell us about a player's probabilistic choice in a different domain. Specifically, we will show that based on the quantity data

$q(A_0), q(A_1)$, if we know $P(A_0 > C_0)$ for some C, then we can derive $P(A_1 > C_0)$. Suppose that $P(A_0 > C_0) = p$. According to the strict utility model we have:

$$p = P(A_0 > C_0) = \frac{f(A_0)}{f(A_0) + f(C_0)} \tag{2}$$

$$\Longrightarrow f(C_0) = \frac{f(A_0)}{p} - f(A_0) \tag{3}$$

Thus, we have:

$$P(A_1 > C_0) = \frac{f(A_1)}{f(A_1) + f(C_0)} \tag{4}$$

$$= \frac{f(A_1)}{f(A_1) + \frac{f(A_0)}{p} - f(A_0)} \tag{5}$$

$$= \frac{q(A_1)}{q(A_1) + \frac{q(A_0)}{p} - q(A_0)} \tag{6}$$

This therefore allows us to calculate $P(A_1 > C_0)$ given that we know $q(A_0)$ and $q(A_1)$ from previously collected data and we either know from the literature or assume the value of $P(A_0 > C_0)$. Thus, we can construct a probabilistic transition model based on the assumption of probabilities without actions.

To see how this method is applied, we use the above example from Regan [13]. We have $q(A_0) = 1.00$ and $q(A_1) = 1.91$ when reciprocity is applied. Suppose C is another outcome for which we have no reason to think it or A would be preferred *a priori*. Thus, we assume $P(A_0 > C_0) = 0.5$ in the new domain. We have:

$$P(A_0 > C_0) = p = 0.5$$

$$P(A_1 > C_0) = \frac{1.91}{1.91 + \frac{1.00}{0.5} - 1.00} = 0.656,$$

an estimate of the effect of reciprocity on two different alternatives.

3.3 The Fechnerian Utility Model for Probabilistic Data

In certain cases, the available data are presented as frequencies or probabilities rather than quantities and therefore cannot be interpreted as (proportional to) utility estimates. In such cases, the strict utility model (Equation 1) does not apply. Instead, we turn to a more general model of forced-choice pair comparisons known as the ***Fechnerian utility model*** [3,9]. The Fechnerian utility model, which like the strict utility model is also widely studied in the mathematical psychology literature, holds if there is a monotone increasing function $\phi : \mathbb{R} \rightarrow \mathbb{R}$ so that for all outcomes X, Y,

$$P(X > Y) = \phi[f(X) - f(Y)] \tag{7}$$

As before, $f(X)$ represents the utility of X. Therefore $P(X > Y)$ is a function of the difference between the utilities of X and Y. As with the strict utility model, while it need not be the case that such a function ϕ exists in every scenario, our experimental results indicate that this assumption leads to reasonable results in many cases.

Often times it assumed that ϕ is a cumulative distribution function and $P(X > Y)$ is then interpreted as the probability that X has higher utility than Y. Thurstone's early work on the topic [21,22] made the assumption that ϕ followed a standard normal (Gaussian distribution with $\mu = 0, \sigma^2 = 1$):

$$P(X > Y) = \phi[f(X) - f(Y)] = \int_{-\infty}^{[f(X)-f(Y)]} N(x)dx$$

Later, Guilford [5] and Luce [8] proposed the logistic distribution as a better model:

$$P(X > Y) = \phi[f(X) - f(Y)] = \frac{1}{1 + e^{-[f(X)-f(Y)]}} \tag{8}$$

Note that

$$\phi(x) = \frac{1}{1 + e^{-x}} = z \tag{9}$$

$$\implies x = -ln\left(\frac{1}{z} - 1\right) \tag{10}$$

Assuming the Guilford-Luce special case of the Fechnerian utility model, we derive a method for transferring probabilistic data from one domain to another. For this model and a given action, we have two known values, one unknown value, and a value supplied by authors. For two alternatives A and B, we know from existing literature or another source the probabilities that A is preferred to B in the source domain both with and without an action applied to A (specified by $P(A_0 > B_0)$ and $P(A_1 > B_0)$ respectively). The author supplies as input to the model the base probability $P(A_0 > C_0) = p$ indicating the preference of A over C they expect to see in the prediction domain. Using these three values, we can compute $P(A_1 > C_0)$ which is an estimate of the effectiveness of the action in the prediction domain.

Using the Fechnerian utility model with the logistic distribution, we have:

$$P(A_0 > B_0) = \phi[f(A_0) - f(B_0)] = \frac{1}{1 + e^{-[f(A_0)-f(B_0)]}} \tag{11}$$

$$P(A_1 > B_0) = \phi[f(A_1) - f(B_0)] = \frac{1}{1 + e^{-[f(A_1)-f(B_0)]}} \tag{12}$$

Let $\alpha = f(A_0) - f(B_0)$ and $\gamma = f(A_1) - f(B_0)$. Note that we know these values from Equations 10, 11, and 12. Suppose we know the probability A_0 is preferred to C_0 is equal to p, for some $p \in (0, 1]$. That is $P(A_0 > C_0) = p$. Further, let $\beta = f(A_0) - f(C_0) - \alpha$, so $\alpha + \beta = f(A_0) - f(C_0)$. Note that we know β since we know α and since the Guilford-Luce version of the Fechnerian utility model gives us $\alpha + \beta$.

Now we have

$$\begin{aligned} P(A_1 > C_0) &= \phi[f(A_1) - f(C_0)] \\ &= \phi[f(A_1) - f(B_0) + f(B_0) - f(C_0)] \\ &= \phi[\gamma + \beta] \end{aligned}$$

Since we know the value of γ and β, we know the effect of the action in the prediction domain, *i.e.*, $P(A_1 > C_0)$. Note that the above method works for the general Fechnerian utility model. It is just not as easy to get x from $\phi(x)$.

Using the above data from Cialdini [2], we have $P(A_0 > B_0) = 0.18$ which implies $\alpha = f(A_0) - f(B_0) = -1.51635$. Additionally, we have $P(A_1 > B_0) = 0.35$, which implies that $\gamma = f(A_1) - f(B_0) = -0.61904$. Let us find an outcome C so that in the control situation, we have no reason to prefer either A or C, *i.e.*, so that $P(A_0 > C_0) = p = 0.5$. Then we have $f(A_0) - f(C_0) = 0$ and, further, $\beta = f(A_0) - f(C_0) - \alpha = 1.51635$. Therefore,

$$P(A_1 > C_0) = \phi[\gamma + \beta] = \frac{1}{1 + e^{-[0.89371]}} = 0.71040$$

which makes intuitive sense.

4 A Sample of Numerical Results

To evaluate the effectiveness of our approach, we have run our two models using data from a number of sources. There are three parameters for our evaluation:

1. The *source data domain* provides probabilities or counts that serve as input into the strict or Fechnerian utility model, specifically $q(A_0)$ and $q(A_1)$ (strict utility model) or $P(A_0 > B_0)$ and $P(A_1 > B_0)$ (Fechnerian utility model); we will use three sources, one coming from a published paper, "*paper*", (details below) and the other two from published user studies, "*study 1*", and "*study 2*" (details below).
2. The *baseline estimate domain* provides the estimate of the preference over alternatives when no action applies, *i.e.*, $P(A_0 > C_0)$; we will use one of three sources of data, a pure "*guess"* and observations from "*study 1*" or "*study 2*".
3. The *prediction domain* is where we will gather data to determine how accurate our model is based on input data; we will compare outcomes, *i.e.*, predicted vs. observed probability $P(A_1 > C_0)$, with data from *study 1* and *study 2*.

Data for the source domain from "paper" comes from Folkes, Martin, and Gupta [4] for count data and Cialdini [2] for probabilistic data. Respectively, the $P(A_0 > B_0)$ and $P(A_1 > B_0)$ values for these are: 87, 121 for count data and 0.18, 0.35 for frequency data. The data for "study 1" and "study 2" come from published interactive storytelling systems [14,16]. Respectively the $P(A_0 > B_0)$ and $P(A_1 > B_0)$ values for these are: 52, 81 and 71, 85 for count data and 0.515, 0.808 and 0.707, 0.851 for probabilistic data. Unless otherwise specified, the "guess" input was $P(A_0 > C_0) = 0.5$.

The data from Study 1 and Study 2 were collected from a web-based choose your own adventure storytelling system. There were a number of differences between the domains, including the story itself (the setting, characters, *etc.*). Both systems utilized a branching narrative with forced choice two-alternative decisions that players were presented with. Actions in both domains were natural language utterances that were added to the story text, and designed to invoke the social psychological principle of scarcity [2]. In both stories, scarcity was the "strategy" for the action, but there were multiple concrete realizations. Specifically, there were four unique scarcity utterances in Study 1 and three unique scarcity utterances in Study 2. Thus, the input data above and analysis below is based on the average of the applications of all scarcity actions (27 times total in Study 1 and 74 times total in Study 2).

Table 1. A comparison of the predicted and observed probabilities $P(A_1 > C_0)$ using the *strict utility model* with count data under various input conditions. The "parameters" column indicates whether a paper (P), guess (G), study 1 (S_1), or study 2 (S_2) was used for the source domain, baseline estimate, or prediction domain respectively.

parameters	predicted	observed	error
P, G, S_1	0.5817	0.8077	0.2250
P, G, S_2	0.5817	0.8514	0.2696
P, S_1, S_1	0.5964	0.8077	0.2113
P, S_2, S_2	0.7700	0.8514	0.0813
P, S_1, S_2	0.5964	0.8514	0.2549
P, S_2, S_1	0.7700	0.8077	0.0377
S_1, S_1, S_2	0.6234	0.8514	0.2280
S_1, S_2, S_2	0.7895	0.8514	0.0619
S_2, S_2, S_1	0.7424	0.8077	0.0653
S_2, S_1, S_1	0.5609	0.8077	0.2478

First, consider the data in Table 1 where the results of our strict utility model for count data are presented under various conditions. In that Table, the predicted and observed probabilities $P(A_1 > C_0)$ are compared and their error (absolute difference between the observed and expected probabilities) is listed as well. We found that results were varied. In cases where S_2 was used as our baseline for $P(A_0 > C_0)$ average error was very low (0.0615); however, when either a guess or S_1 was the baseline, average error was notably higher (0.2478 and 0.2355 respectively). These contributed largely to the overall average error (and standard deviation) we observed of 0.1684 (0.0939).

Of particular interest in Table 1 are the rows where the prediction domain (third parameter) is not equal to either the source domain or baseline input (parameters one and two) because these tests are indicative of a transfer between two completely different domains. In two of those cases, *i.e.*, P, S_2, S_1 and S_2, S_2, S_1, the results are very good.

Next, consider the data in Table 2 where the results of our Fechnerian utility model are presented under various conditions. First, note that the error rate is notably lower using this version of our model with a mean (and standard deviation) of 0.0735 (0.0426) compared to 0.1684 (0.0939) for the strict utility model. Second, notice that similarly to the strict utility model, in general the best performance occurred when S_2 was used as the baseline again. In other words, our observations suggest that a large influence on the overall accuracy of our models is the baseline guess for $P(A_0 > C_0)$. As before, the rows of particular interest are those where the prediction domain is distinct from the source domain and input baseline. In most of those cases the results are very good.

To examine this effect more closely, consider the data presented in Figure 1. Those data were obtained by holding fixed the source and prediction domains and varying the baseline guess $P(A_0 > C_0)$ from 0.1 to 0.9 in increments of 0.1. We used S_1 as the source domain to predict performance in S_2 and *vice versa*. There are a few interesting

Table 2. A comparison of the predicted and observed probabilities $P(A_1 > C_0)$ using the *Fechnerian utility model* with probability data under various input conditions. The "parameters" column indicates whether a paper (P), guess (G), study 1 (S_1), or study 2 (S_2) was used for the source domain, baseline estimate, or prediction domain respectively.

parameters	predicted	observed	error
P, G, S_1	0.7104	0.8077	0.0973
P, G, S_2	0.7104	0.8514	0.1410
P, S_1, S_1	0.7227	0.8077	0.0850
P, S_2, S_2	0.8552	0.8514	0.0038
P, S_1, S_2	0.7227	0.8514	0.1286
P, S_2, S_1	0.8552	0.8077	0.0475
S_1, S_1, S_2	0.8077	0.8514	0.0437
S_1, S_2, S_2	0.9050	0.8514	0.0536
S_2, S_2, S_1	0.8514	0.8077	0.0437
S_2, S_1, S_1	0.7165	0.8077	0.0912

things to note about this figure. First, the true observed value of $P(A_0 > C_0)$ is 0.707 for the S_2 prediction domain and 0.515 for the S_1 prediction domain. In both sets of data reported in Figure 1, the Fechnerian utility model produced lowest error estimate with a baseline of 0.6, in between the 0.515 [16] and 0.707 [14] true values. Note, because the strict utility model uses count data, we can't make the same comparison. Also note that the Fechnerian utility model was generally more accurate than the strict utility model with a lower error in seven of the nine test cases.

Lastly, and perhaps most significantly, notice that change between the S_1, G, S_2 and S_2, G, S_1 series within a model is minimal. This strongly suggests the biggest source of variance in the accuracy of our model is not the transfer between domains, but the required input from the author about the baseline, *i.e.*, $P(A_0 > C_0)$. In other words, as long as the data from the source domain is an accurate representation of the effect of the action, the results in the prediction domain will be accurate provided the author's baseline is reasonably accurate. This is extremely encouraging for the use of this model. While we have not eliminated the need for authors to provide accurate information, we have reduced the amount of information through the use of our models, requiring only data from a source domain and a baseline guess on the player behavior.

5 Extension to n-Choice Alternatives

Although we have only described the strict and Fechnerian utility models for two-choice alternative situations, they can easily be applied in n-choice alternatives as well. The basic idea is to "leave one out" and consider the remaining alternatives as one "composite" alternative. For example, suppose there are five alternatives $A^1, \ldots, A^5$ and we are interested in knowing the effect of applying an action to A^3. We can use as input into our model $P(A_0^3 > \{A_0^1, A_0^2, A_0^4, A_0^5\})$ and $P(A_1^3 > \{A_0^1, A_0^2, A_0^4, A_0^5\})$. Here, if $\mathbf{A} = \{A^j\}$ we will define $f(\mathbf{A}) = \sum_{A^j \in \mathbf{A}} f(A^j)$. Thus, we would only need designers to estimate the baseline probability $P(A_0^3 > \mathbf{C})$ for some set of alternatives $\mathbf{C}$ in the prediction domain. Due to space limitations, we leave the details to the reader.

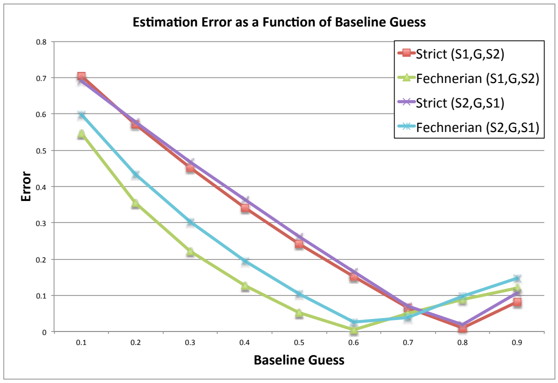

Fig. 1. A plot of the estimation error (absolute difference between observed and predicted $P(A_1 > C_0)$) as a function of baseline guess $P(A_0 > C_0)$. There are series for both the strict and Fechnerian utility models in the S_1, G, S_2 and S_2, G, S_1 settings.

6 Conclusion

In this paper, we have presented a method for transferring probabilistic behavior data from one domain to another using models from mathematical psychology. We have stated the assumptions and conditions under which this approach is reasonable to apply and shown that it can be quite accurate. Using this method, designers will no longer have to hand-author entire models using intuition or expert knowledge, but can rely on lessons learned in other domains. In addition to formally deriving two-choice alternative models, we have described how it can apply more generally to n-choice alternatives.

To characterize the performance of these models, we used data collected from various literatures as well as inputs we varied. The results from using these data and inputs suggest that 1) our models, especially the Fechnerian utility model, can be very accurate under certain conditions; and 2) the largest influence on the overall accuracy of the model is the author-provided baseline estimate for the prediction domain, and not the quality of the source data or the transfer process. What our results do not yet describe—this is a topic for future research—is a concise understanding of the conditions when our models will be most applicable and accurate. Despite this, we are encouraged that this approach will be useful for accurately constructing player models.

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Being in the Story: Readerly Pleasure, Acting Theory, and Performing a Role

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Abstract. It is common within the interactive narrative research community to conflate *interaction* with *changing the outcome* of a story. In this paper we argue that reimagining interaction as *participation* in a story opens up an important new design space for digital narratives: one which emphasizes the readerly pleasure of transforming into a character rather than the authorial pleasure of rewriting the events of the story. We draw on theories of method acting and performance as a model for participating within a story and provide examples from several recent games that support this type of narrative.

Keywords: Games and Narrative, Acting Theory, Agency, User Experience.

1 Introduction

One of the challenges facing theorists and designers of interactive narratives and games is the prevailing assumption that interaction is fundamentally at odds with story. The pleasures of reading a book and viewing a film are often pleasures of surrender, of allowing an author to weave a compelling story which whisks a reader or viewer away to a place she might not have gone on her own. In contrast, we have this conception of the interactor in a game or interactive narrative exerting her own preferences over the outcome of the story: perhaps she wants to be the hero, or the villain, or an observer, or something different? Perhaps she doesn't want the story to resolve in a traditional manner? We contend that this conception of the interactor is limiting and ultimately harmful to the project of designing compelling digital narrative experiences.

We propose a shift away from thinking of digital narrative experiences in terms of "interaction" and instead suggest that we discuss digital stories in terms of "participation". We argue that an actor performing a role on stage and an interactor playing a character in an interactive narrative or game are engaged in cognitively similar activities. This sensation of performing a role is an unusual blend of freedom and constraint; it is a type of *bounded agency* that results in a unique narrative pleasure. We position this argument alongside longstanding discussions of improvisational theater and interactive drama within the interactive narrative community and introduce a new domain of literature from which to draw our interaction metaphors: Method Acting.

To explore this in more detail we take an interaction model informed by method acting and performance theory and discuss the analytical and design implications that

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result from a commitment to this perspective. To render this concrete we consider how this model may be used to understand narrative in several commercial games, while considering new design principles for Interactive Digital Storytelling (IDS) systems that arise from its application.

2 Interactive Drama, Improvisation, and Bounded Agency

In IDS research, much has been written about interactive drama [1-3]. A common metaphor for interactive narratives is improvisational theater [4-6], in which actors collaborate within a framework of rules to create a story. Most dramatic performances are rooted in Plato's concept of *mimesis*, as articulated for modern narratology by David Bordwell [7]. Mimetic narratives are enacted rather than recounted; they are performed and *shown* in action rather than *told* by a narrator. Interactive drama positions the interactor as the main character, experiencing the story from a first person point of view. Drawing on improvisational theatre for inspiration, interactive drama proposes that the goal of the interactor is to make dramatic offers that result in meaningful changes to the outcome of the narrative. The pleasure of interaction and improvisation is a creative pleasure rooted in the desire of the interactor to collaboratively *author* the outcome of the story in conjunction with the IDS system by making choices about the actions that the main character takes. A common approach to the design of interactive drama proposes an interactive environment populated with intelligent actor agents who can improvise and perform with the interactor, as in the case of Façade [2] or the more recent experiments by Magerko into improvisational micro agents [8]. We contend that the ideal of the interactor as author is actually a trap for designers, one which leads into a dangerous territory where the pleasures of experiencing authored narrative are subverted by the well intentioned designer who is trying to facilitate creative pleasures for his interactors. One of the earliest works on interactive drama, Brenda Laurel's *Computers as Theatre* cautions against this:

> "What is the relationship between the experience of creativity and the constraints under which we perform creative acts? In fantasies about human-computer systems, people like computer-game enthusiasts and science-fiction writers tend to imagine magical spaces where they can invent their own worlds and do whatever they wish—like gods. Even if such a system were technically feasible—which it is not, at the moment (the rhetoric of virtual reality notwithstanding)—the experience of using it might be more like an existential nightmare than a dream of freedom...A system in which people are encouraged to do whatever they want will probably not produce pleasant experiences. When a person is asked to "be creative" with no direction or constraints whatever, the result is...often a sense of powerlessness or even complete paralysis of the imagination. Limitations—constraints that focus creative efforts—paradoxically increase our imaginative power by reducing the number of possibilities open to us."[1]

The desire to design for freedom and creativity in IDS parallels the game design community's desire to design for unrestricted agency.

2.1 Bounded Agency and Narrative Pleasure

Within the discourse of game design, it is assumed that providing the player with more freedom will result in more agency, and thus in more pleasure [9-11]. In the case of both unrestricted agency and improvisational theater, by offloading the creative responsibility of telling the story onto the player, the designers have effectively cut themselves out of the loop, or else placed themselves in a situation where they must author *against* the intentions of the player, rather than *with* them. We believe that it is from this problematic framing of interactive narrative that the aforementioned assumption about interaction and narrative being fundamentally at odds with each other arises.

Recent work on agency has complicated our understanding of the phenomenon in productive and interesting ways. Wardrip-Fruin et al. write that agency is not simply "free will", but instead occurs when the dramatic probabilities of a game world are in balance with the actions supported by the underlying computational engine [12]. In our previous work we argue that for narrative games, agency can be understood as a process by which the player commits to specific communicative meanings through action (or inaction) [13]. This notion of commitment to meaning argues that a player in a narrative game (or an interactor using an IDS system) receives pleasure from being able to take actions that express specific narrative meanings within the system. This treatment of agency emphasizes the narrative *context* in which an action occurs, rather than the *systemic outcome* of that action. This is a crucial departure from models of unrestricted agency because it relies on a mutual understanding between the interactor and the system of the narrative meaning of any given choice. Narrative play from this perspective sees interaction as a language which the interactor and system use to communicate with each other. Successful communication requires something that Winograd and Flores have termed *communicative competence* [14]. Due to the limitations of AI systems, in order to achieve this level of mutual communicative competence, it is necessary to design systems which reveal their interactional grammar to their interactors and obey the rules of that grammar.

We call this treatment of agency *bounded agency* and it can reinforce narrative pleasure when it aligns with the designed capabilities of the game system. It breaks down when the meanings committed to by the player are not recognized by the system or are in conflict with it. Bounded agency works when the player is performing in sync with the designed possibilities of the game or, to put it in theatrical terms, following the script. This is in contrast with the discourse around unrestricted agency in game design mentioned above. The result of this shift away from unrestricted agency to bounded agency is that it supports a participatory model of narrative game play in which the actions of the player are constrained to a small set of communicatively meaningful choices, rather than a large set of meaningless capabilities. One way to think about bounded agency and commitment to meaning is to consider it in terms of scripted narrative, which brings us to the discussion of method acting.

3 Method Acting as an Alternative to Improvisation

We propose a new approach to interactive drama by reimagining the interactor as an actor in a *scripted* drama rather than in an improvisational scene. While this might seem like a minor point, it has significant implications for design and entails different intellectual commitments about the type of narrative pleasure derived from the experience by the interactor. In an improvisational theatre model of IDS, the core interactive pleasure is a creative, *authorial* pleasure of taking actions and experiencing the consequences of those actions. By instead imagining the interactor as an actor playing a role within a play, the pleasure becomes a participatory, *transformative* pleasure where the interactor becomes a character and experiences that character's emotions and desires instead of her own. This is not a new idea for digital narratives. Murray writes persuasively about the poetics of transformation in digital media:

> "Digital narratives [offer] us the opportunity to enact stories rather than to merely witness them. Enacted events have a transformative power that exceeds both narrated and conventionally dramatized events because we assimilate them as personal experiences." [15]

We see this type of transformation as a fundamentally *readerly* pleasure. Readerly pleasures involve surrender to the story, rather than an active attempt to write a new story. As authors and designers we often assume that the pleasure we take in creating new narratives is a pleasure that our interactors want to share in. However, just as not everyone who goes to the movies wants to be a filmmaker, not everyone who engages in an interactive story wants to be an author. Shifting away from the model of improvisational theatre moves us to a place where we can think about our interactors as readers. Readers place their trust in an author to take them to places that they would not or could not get if left to their own devices; they welcome being challenged by an author and enjoy being surprised by the outcome of a narrative.

To better understand the cognitive process of transforming into a character, we turn to the literature on actor training that has evolved out of the seminal works of Stanislavski, whose writing led to the development of the American acting system often simply known as the Method.

3.1 Method Acting

Relatively little has been written about method acting as it pertains to interactive narrative, in spite of the popularity of drama as a metaphor for IDS systems. We choose to investigate method acting because as a practice it leads to a unique and participatory narrative pleasure. Acting trainer Robert Benedetti writes:

> "Actors often speak of the release that playing a role gives them from what Alec Guinness called 'my dreary old life;' acting gives them permission to have experiences they would never have in real life." [16]

Acting is a challenging activity, but it is also a deeply pleasurable one. There is something profoundly enjoyable about the experience of performing a role, becoming a character, and enacting a narrative script. Acting is a powerfully creative act, both in spite of and because of the relationship to the scripted page. Acting involves adopting a mental state in which the performance of prewritten lines can feel like a spontaneous and emergent choice. This experience is a promising template for the design of an IDS system.

Method acting has its roots in Stanislavski's teachings as interpreted and extended by the founding members of America's Group Theater, which includes Harold Clurman, Lee Strasberg, Stella Adler, and Sanford Meisner. Citing Clurman, David Krasner writes about the history of method acting, which he describes as a system for training actors with an emphasis on combining research into the life and experience of the character with the personal experiences and worldview of the actor [17]. The relationship between the actor and the character is at the heart of the Method, and is essential in understanding how these techniques can lead to a transformative experience. Acting theorist Peter Lobdell writes:

> "The Method supports actors' abilities to live actively in the center of a paradox—namely, they are at once the character and not the character. They must live simultaneously within the imaginary given circumstances of the play and on the actual stage—allowing both and denying neither."[18]

This paradox is described by Benedetti as a form of *dual consciousness* in which the actor is able to "maintain artistic choice while simultaneously becoming the character."[16] These notions highlight how the process of acting requires a particular state of mind or consciousness. Acting trainer Kurt Daw describes this as the "creative state".

3.2 The Creative State

Daw frames his book *Acting: Thought into Action* as a clarification of the Stanislavski system [19]. He attempts to explain why Stanislavski's system works through the application of ideas from artificial intelligence and cognitive science. He argues that Stanislavski had intuited a number of correct principles about how the brain works, but was lacking the knowledge to accurately describe or explain them. At the core of Daw's acting method is the concept of the "creative state". He writes:

> "Acting is creating a sense of life… Actors create this sense of life not by manipulating appearances, but by experiencing the action as it occurs. They are in the 'here and now,' a state where concentration on the details of the moment preclude the distractions of the past or future. In this sense, they have a great deal in common with those other 'players,' athletes." [19]

Acting teachers often invoke game play and childhood make-believe as models for the actor's mental state. Lobdell discusses this creative state in terms of sensory imagination.

> "The Method trains actors to invent behavioural metaphors that illuminate their characters. Strasberg's assertion that *concentration is the key to what has been loosely thought of as imagination* is central to my argument. I will frame my position around an extended discussion of actors' imaginative use of their senses." [18]

Daw also relies on the idea of sensory imagination, but he builds it into a model of embodied experience informed by cognitive science. He visualizes this as a pyramid: on the bottom and most important level is sensory processing, followed by the social layer, and the verbal, and finally the logical layer at the top. He attempts to ground his acting work in the sensory layer, which he argues is the basis for most of our experience of the world. He uses exercises that relax the mind and direct the actor's attention away from analytical thought and toward sensory reactions to induce this reactive, immediate, and creative state.

> "While doing this creative work, you may experience a feeling some people describe as *spacey* or *floating*. It is a different state. The usual first sign is a dropping away of the conscious 'voice' you hear while labeling and ordering things. A lost sense of time or a great lessening of urgency is typical. There is no longer a feeling of logical order, but instead a feeling of intense concentration on the object. For most people, this combination of effects is very pleasurable. In fact, in trying to re-create this state, the single strongest guide is a generalized feeling of well-being." [19]

The creative state described by acting teachers is similar to the immersive state of *flow,* which has been used to characterize engagement in games [20]. In Daw's interpretation of the Method, transformation occurs by working first from a sensory state of embodied cognition. Other approaches to acting take this further, arguing that *action in the world* leads to a cognitive shift for the actor. This approach to the Method most closely resembles Sanford Meisner's version of the technique:

> "The radical nature of Meisner's work is expressed in the core principle of *doing* and the manner in which this alters the basic definition of acting. The emphasis on doing, or action, as opposed to the expression of emotion is the primary characteristic that differentiates Meisner work from [others]." [21]

These current theories of method acting lead to an unexpected conclusion, namely that acting is a process that uses external perceptions and actions to transform the internal state of the actor. This runs counter to common-sense thinking about acting that imagines the actor first creating an internal world from which to motivate her performance.

3.3 The Magic If

Benedetti uses the phrase "artistic choice" to describe the acting process: actors playing roles are making choices constantly *as if* they are the character. These are deeply meaningful choices, even though they are within the confines of a scripted set of events. This notion of *as if* is key to much acting theory

> "Your experience of your character's significant choices is the mechanism by which the Magic If produces transformation. When you have entered into your character's circumstances as if they were your own, felt their needs as if they were your own, and *made the choices they make given those needs in those circumstances,* then action follows naturally and with it transformation." [16]

Our concept of committing to meaning [13, 22] aligns well with the treatment of choice in acting theory. By "fully choosing" his actions, an actor *commits to the meaning of those actions*, as if he were experiencing them for the first time. Likewise, a player may commit to meanings even within highly scripted play situations. The pleasure of agency, in these situations, is not one of changing the outcome of the story, but one of fully participating in the events of that story.

Transformation is thus seen as an *outcome* of the acting process, rather than a necessary precondition for acting. Benedetti and Daw both emphasize *choice* as a central element of a performance. It is often assumed that acting is merely reciting lines as written by a playwright, and indeed some schools of thought in the theater hold that this is all that is required of an actor [23]. However, many theatre training programs teach that acting is about making the choice that the character is making, *as if for the first time* [19]. This type of preordained choosing resembles the imaginative immersion of the "willing suspension of disbelief" [15, 24]. It is similar to the immersion engaged in by a reader rereading a book for the second time, or an audience watching a familiar Shakespeare play. Margaret Mackey describes this particular mental state as the "subjunctive mode" or the state of experiencing a narrative "as-if" for the first time:

> "Inside the world of the *as-if*, the fiction is *lived*, is *felt* as hopes, fears, assumptions, surprises: it is experienced prismatically through the lenses of human emotions coming to terms with an unknown future. As Gerrig points out, even when we do actually know the end of the story, once we step into its purview we experience it as if we do not know what will happen." [25]

When an audience watches Romeo and Juliet, they do not disregard the first four acts as meaningless because they know that the lovers die in act five. The pleasure of the experience is in experiencing it from an imagined state of innocence. This is often enhanced through anticipation of the outcome, creating an oscillation between knowing and not knowing. This is the basis for dramatic irony in narrative. The same is true for an actor, where one pleasure of playing a role is making the choices of the character within the moment, as if they were new. When done right, a performance is experienced as spontaneous and alive.

3.4 Transformation and Masks

In the above sections we have discussed how external actions and choices can lead to internal transformation. The most extreme example of this comes from a tradition in theater known as "Mask work" that stretches back to primordial rituals (according to Keith Johnstone [26]), but which has been formalized in a variety of traditions including Italian c*ommedia* and Japanese *Noh* theatre. Mask work most commonly uses physical masks, but can also use costumes and makeup as gateways into characters and identities that Johnstone argues exist within all human consciousness at some level.

> "It is not surprising then to find that Masks produce changes in the personality, or that they first sight of oneself wearing a Mask and reflected in a mirror should be so disturbing. A bad Mask will produce little effect, but a good Mask will give you the feeling that you know all about the creature in the

> mirror. You feel that the Mask is about to take over. It is at this moment of crisis that the Mask teacher will urge you to continue. In most social situations you are expected to maintain a consistent personality. In a Mask class you are encouraged to 'let go', and allow yourself to become possessed." [26]

Johnstone cites Stanislavski, who also wrote about the Mask state in *Building a Character*. In this example a student discovers a character in himself through the (mis)application of grotesque stage makeup. Astonished, he describes the experience in terms of divided consciousness [26]. Mask work is often described in terms of trance. Johnstone writes about a number of actors who report dual states of consciousness: "they speak of their body acting automatically, or as being inhabited by the character they are playing." [26]

This tradition of Mask work is especially interesting to us as theorists of interactive narrative and games, because it uses an external character representation as a cue for an internal character transformation. In games, we can imagine a player's avatar as a form of Mask with a set of powerful character associations built into it. Johnstone describes a wide variety of Masks that are tied to a range of human emotions and characters. For us this raises the question of whether or not the current generation of games and IDS systems provides the same range of Masks for interactors to put on.

3.5 Method Acting for Interactive Digital Storytelling

We propose method acting theory as the basis of a new interactor model for IDS. The interactor that we envision through this model approaches the narrative as an opportunity to transform herself into a character. This process of transformation is not one which she must attempt without external support, however. The narrative system provides her with a script, a role, and a set of actions to take within the framework of the narrative. Through the process of committing to the goals and desires of the character by taking in-character actions, the interactor experiences a cognitive transformation, entering into a new state of consciousness. The pleasure of this interactive narrative is one of participating in a story, of enacting a role and experiencing a mimetic narrative through the eyes of a character.

To put this another way, we believe that there is a pleasure that comes from "being" in a story and "doing" narratively important things. This pleasure is a form of make-believe that we all used to engage in as children, and it is rooted in the experience of following a known narrative script. We find it easy to imagine a group of children playing a game of "superheroes and villains". The pleasure of this make believe play is not a pleasure of subverting the conventions of a known genres but about experiencing what it is like to become the superhero or the villain. This approach entails us as designers to re-imagine IDS systems in order to create experiences that afford and enrich these participatory pleasures. Currently, the best examples of systems that support this type of narrative participation exist mostly in the realm of commercial digital games.

4 Examples from Commercial Games

4.1 Mass Effect II

The first game we will consider from this perspective is *Mass Effect II* (Bioware, 2010). *Mass Effect II* is a science-fiction action role playing game in which the player assumes the role of Commander Shepard, the leader of a team of human and alien scientists, warriors, and engineers who must defend inhabited space from an ancient race of sentient, starship-sized aliens who periodically destroy all other sentient life in the universe. Gameplay in Mass Effect II is divided between combat missions and extensive social interactions with squad mates and other inhabitants of the storyworld in the form of branching dialogue trees. Mass Effect II allows the player to perform the actions of Commander Shepard, along several moral vectors though ongoing dialogue options. As the player progresses in the game it is possible to create a version of Shepard that leans toward one of two moral extremes, maintains a neutral stance, or becomes a collection of different moral inflections, guided by the choices of the player. The moral spectrum of Commander Shepard is split between "Paragon" and "Renegade", but these are not a binary opposition in that it is possible to build a character with both traits well represented. While this model is outwardly simplistic, in practice it results in a complex set of evolving character possibilities depending on how the player chooses to perform the role.

The choices that the player makes are seldom about the outcome of events. Instead, much like an actor, the player makes choices about the *inflection* of the character performance. While the player is often given control over *how* Shepard will accomplish a goal, the game seldom gives the player control over *what* goal will be accomplished. In this sense, the events of the game are highly scripted, but within the boundaries of that script the player is free to explore different *performances* of the main character's personality. The resulting game narrative supports the readerly pleasures of surrender to an author while still allowing the player to participate in a highly personalized way with the world of the game, via Shepard.

One thing that complicates the nature of the character performance and transformation in Mass Effect II is the nature of the player's relationship to Shepard's dialogue. Players are provided with a number of choices on a "dialogue" wheel, which correspond to different emotional performances of the same core communicative message. The game does not provide the player with knowledge of exactly what Shepard will say, it instead gives them access to an abstracted content domain and an emotional valence for the utterance. As a result, the relationship between the player and Shepard is more like a director giving instructions to an actor on how to perform a line. This puts Sheppard "at arm's length" from the player at times.

4.2 Uncharted II: Among Thieves

Another recent commercial game, *Uncharted II* (Naughty Dog, 2009) takes a more linear and cinematic approach to interactive narrative. In this action-adventure game, the player assumes the role of Nathan Drake, a "bad boy" treasure hunter who travels the world solving historical mysteries and invariably fighting off waves of mercenary thugs. Uncharted II asks the player to surrender herself to the flow of the story by providing linear, obstacle filled environments that must be traversed and survived. Uncharted II is a highly mimetic narrative. The story unfolds through action sequences rather than through narration or other “external” text, and, unlike Mass Effect II, the player is given no control over the appearance or social behavior of the main character. Unlike many games where the main protagonist is designed as a blank vessel into which the player projects her identity, Uncharted distinguishes itself by explicitly specifying Nathan Drake’s personality and history. The player is thus given an opportunity to suspend her own identity and instead take on the character of Drake. This is slightly different from the character of Shepard in Mass Effect II, whose distinctive personality emerges as a function of the players’ choices. In the case of Mass Effect II, the choices of the player provide “inertia” to the character’s personality. Consistent actions along either moral vector will open up additional conversation options for Shepard, while also transforming the character’s appearance. In this way, the game provides external perceptual evidence of the character’s personality that reinforces the transformative process. To put this in the terms of Johnstone’s discussion of Mask work, Uncharted II provides the player with a predefined and unchangeable Mask, while Mass Effect II allows the player to slowly change the properties of the Mask. In both cases the player is given some sort of external support for transforming into a character.

4.3 Dragon Age: Origins

The third game we will consider from this perspective is the recent fantasy Role Playing Game (RPG) *Dragon Age: Origins* (Bioware, 2009). Unlike the first two games we discussed, we find Dragon Age to be unsuccessful at creating opportunities for character transformation. Dragon Age is a return to an older style of RPG in which the player creates a generic hero character by selecting a class, a gender, an appearance, and some abilities at the beginning of play. Bioware made an interesting choice to reflect the personality and choices of the player in the actions and attitudes of the NPC companions to the hero, rather than in the personality of the hero itself. This is emphasized by Bioware’s decision to make the player character the only character in the game without fully voiced dialogue. The result is that we often felt like a bland, indistinct silent observer rather than a particular hero with a personality and motivations. In this case, the design choices did not provide us with a character to transform into, and so the experience was oddly rudderless, in spite of a rich and branching set of choices within the world of the narrative. Unlike the first two games we discussed, Dragon Age lacks any Mask for the player to put on. Instead, the player is invited to simply project herself into the game world.

These three examples from commercial games demonstrate how we can use the perspective of method acting to unpack and analyze the design of interactive narrative experiences. They also point to several design choices which can be made by designers seeking to support transformative participatory narrative pleasure.

5 Conclusions

In this paper we have argued for a new perspective on Interactive Digital Storytelling that emphasizes participation and transformation as the core narrative pleasures. We have drawn on the literature surrounding method acting to provide a model for the cognitive experience of transforming into a character, and connected it to theories of bounded agency in games. To illustrate how this model may be used to understand narrative interaction, we have used it to briefly analyze three recent narrative games.

One crucial lesson about designing for participatory transformative experiences that emerged from this analysis is the importance of a well specified player-character. In actor training, character transformation revolves around a commitment to the goals, intentions, desires, plans and actions of the character being played. In order for this process to work, the actor must understand these aspects of the character's psychology as they are expressed through the script of the play. If we are to offer this same experience to our interactors it is necessary to either provide them with this information about their characters (as in the case of Uncharted II) or provide them with the means of expressing a permutation of these qualities and traits (as in the case of Mass Effect II). In the second case, it is of paramount importance that the character expressed by the player be legible to both the player and the system. Dragon Age: Origins illustrates how rendering the character illegible to the player can impede the process of transformation entirely.

IDS research needs new models of interactor desires and expectations. We need a more robust understanding of how the brain experiences narrative, of the different types of narrative pleasure to be had, and of the literacies and languages needed by our interactors to get the most out of the systems we design. In this paper we propose one possible new direction for the field that leverages the cognitive experiences of game players and actors in order to open a new design space for interactive drama.

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Supporting Rereadability through Narrative Play

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Abstract. In this paper, we investigate the use of *narrative play* as a means of encouraging rereading in interactive stories. To explore this, we created a storytelling game in which the reader/player takes on the role of a film director whose objective is to shoot a film in the face of a series of complications. We discuss the iterative design and playtesting of the prototype of our game, and argue that our design encourages a different type of rereading which involves a shift away from the usual concern for "narrative closure" and more towards a desire to *do better*. We also discuss the use of storytelling games as a way to explore new forms of interactive storytelling by focusing on the mechanics of interactive storytelling, rather than technical implementation details, without losing sight of the need for an eventual computer-based implementation.

Keywords: Interactive storytelling, rereadability, narrative play, storytelling games, prototyping techniques.

1 Introduction

It is commonly agreed that the experience of an interactive story must provide a sense of *agency*, the feeling that the reader/player is able to take action which impacts the story [1]. This implies that, for each reader of an interactive story, the storytelling system should respond with a variation of the story which matches the choices that this reader has made. In addition, if the same reader encounters an interactive story more than once, the system should respond with variations which match each successive set of choices.

Most solutions to interactive storytelling [2,3,4,5] focus on customizing the story experience to different readers, ensuring that each reader's choices will result in a feeling of agency. Those approaches which do consider supporting repeated satisfying experiences for the same reader [6] focus on maintaining consistency within reading sessions, using variety as a way to motivate rereading. However, the tendency for readers of these type of stories to look for some form of narrative closure makes it is difficult to motivate rereading beyond a few repetitions [7].

There are, however, other interactive experiences which people want to re-experience, namely challenge-based games such as Tetris. It is worth considering how these games motivate and reward repeated play, to see if the approaches

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used in these games can be applied to interactive storytelling. In each play session of a game such as Tetris, there is a challenge which the player must repeatedly overcome through the performance of some specific actions, such as rotating and positioning a block. Overcoming this challenge provides a sense of satisfaction. In addition, the player often ends the game with a sense that they *could have done better*. The desire to do better is one of the main motivations for replay [8].

This suggests that a different approach to the problem of motivating rereading is to provide an experience in which the reader is clearly making choices, directly related to the narrative, at which they could do better next time, and to provide a way in which this experience can be repeated, while at the same time incorporating variation. One form which potentially satisfies these requirements is *storytelling games*, non-computer-based games in which players are competing to tell a story [9]. Examples of storytelling games include *Once Upon a Time*, *The Extraordinary Adventures of Baron Munchausen* and *Dark Cults*.

Storytelling games usually consist of a set of game elements (pieces or cards) which represent narrative elements (characters, events, locations, or objects). Players take turns placing these pieces, with the placement constrained in different ways. As players place their pieces they tell a continuation of the story to this point, which must be somehow related to the piece they are placing. The winner is the first player to achieve some goal, such as discarding all pieces while meeting the placement requirements. The player's moves, placement of pieces, and winning condition may relate somewhat to storytelling, but often are more directly related to gameplay. This tends to result in storytelling being subordinated to gameplay in many storytelling games, such as *Once Upon a Time*, where winning is largely about getting rid of your cards as fast as possible [10].

2 Related Work

There has not been much work looking at the intersection of storytelling and gameplay in storytelling games. Hindmarch has concluded that the way to balance game and story in storytelling games is to accept that the "*process* is the point, not the *output*" [11] (emphasis added). In contrast, Wallis has put forward the goal of creating storytelling games "in which the story created and the gameplay used to create it are equal, which is both fun and creates a satisfying story" [9], suggesting the possibility of support for both gameplay and storytelling. Mitchell and McGee suggest that a combination of narrative moves and gameplay moves is essential for the design of successful storytelling games, encouraging what they call *narrative play*. They claim that the way to accomplish this is to "ensure that *all* narrative choices have strategic/gameplay consequences – and that all strategic/game decisions have narrative impact" [10].

3 Problem Statement

The concept of narrative play provides a clear metric for designing and evaluating storytelling games (and, by extension, interactive story systems). By necessity, non-computer-based games are designed to be replayed. So a successful storytelling game will tend to be a good model for something rereadable/replayable. Ways in which a reader could "do better" in the context of narrative play include getting better at creating the final story, and getting better at making real-time storytelling decisions. So, one question that arises is whether games that support narrative play will also encourage replaying.

This paper addresses the question: how can we create interactive stories which provide repeated satisfying experiences through narrative play?

4 Method

To address this question, we created an interactive story in the form of a *storytelling game* designed to provide choices which involve narrative play. We conducted 4 rounds of iterative playtesting and redesign using this prototype. The study involved 3 participants, all of whom were all graduate students in the same department as the researchers. One of the participants took part in the playtesting twice.

Fig. 1. An early prototype of our storytelling game

The sessions involved a combination of playtesting and a semi-structured interview, which made it possible to vary the materials presented to the participants in such a way as to uncover the underlying processes at work during the participants' experience of the storytelling game. The study materials consisted of a paper prototype of the storytelling game (see Figure 1). The prototype made use of printed paper cards and plastic tokens to represent the various story elements, and a set of written rules.

Participants were asked to play through the storytelling game once. After the session, the researcher asked the participant a number of questions related to the experience of the storytelling game, and the participant's motivations to re-experience the story. During the interview, the researcher and the participant sat at the table where the prototype had just been played, with the prototype left as it was at the end of the playtesting session. This allowed both researcher and participant to make reference to the game and to directly manipulate game elements as part of their discussion. Each session took approximately 2 hours.

Data collection consisted of researcher notes and an audio recording of the session, which was later coded and analyzed. Any physical artifacts created during the session, such as the text written on the description cards, was also collected to aid the analysis, and photographs were taken of the final game state.

5 Design of the Storytelling Game

The design of our storytelling game is intended to support rereading through narrative play. We will now discuss how we arrived at this design, and give a detailed description of the game itself. Over the course of the four playtesting sessions, the design evolved in response to issues observed by the researchers. The description given below is that of the final version of the game.

We consider a work to be *rereadable* if the reader/player wants to re-experience the story immediately after a given session with the work. To support this, our approach was to design for a sense of *difficulty and challenge* for the reader/player as they go through the work, and a sense of being able to *do better next time*. However, unlike a challenge-based game such as Tetris, we wanted to tie both the difficulty and the feeling of being able to do better to the *narrative*, not just the gameplay, within the work. To do this, we made use of the concept of *narrative play* as discussed above: the idea that the core action that the reader/player is performing over and over again should be both a narrative move *and* a gameplay move. This means that the action taken by the player moves the narrative towards a narrative goal, and at the same time moves the game state towards a gameplay goal. There should also not be any way for the player to win solely by narrative moves or solely by gameplay moves.

In our storytelling game, the reader/player takes the role of a *Director* of a movie. The Director's goal is to plan, and then shoot, an action/spy movie with a story in the style of a *James Bond* movie. During planning, the Director arranges a set of cards, representing events, settings and characters, to form an outline of the scenes of a movie. In addition, the Director writes a short, 1-2 sentence description of each scene. During shooting, scenes are "shot" one at a time. After each scene is shot, *Fate* will introduce *complications* which disrupt the Director's plans. Each complication involves a change in the configuration of the movie, such as making a character or setting unavailable, introducing a new event or setting, or removing a shot scene. The complication is chosen such that the story will not be coherent if the complication is not resolved.

The complication creates what Mitchell and McGee call "narrative problems that the other players must address in their narrative moves" [10]. To resolve the complication, the player must take action to restore coherence. which involves revising the story, by either replacing or rearranging the events, characters and/or settings, or by changing the description of a scene. The player's action is both a narrative move, as it moves the story towards a desired narrative state, and a gameplay move, as it involves overcoming an obstacle and moving the state of the game towards the winning condition.

Most storytelling games are competitive experiences involving several players. In our game, there is only one player: the Director. The role of Fate, who creates complications for the Director, is played by the researcher. Our observations and discussion are focused on the experience of the Director, with the assumption that in a computer-based implementation of the game, the role of Fate would be taken on by the storytelling system. We discuss the implications of this approach in detail later (see Section 7 below).

6 Observations from Playtesting Sessions

We will now discuss the observations from our playtesting sessions. We found that players did indeed seem to be making both narrative and gameplay moves as they went through the game, and that our intention of creating a storytelling game which involves narrative play had been achieved. There was, however, still some tension between the narrative and gameplay elements of the experience, in particular in terms of the ways in which players went about resolving complications. There were also problems with the difficulty of resolving complications, which were, at times, perceived by players as either too easy or too hard to resolve. Despite these problems, we observed that players wanted to replay the game, and wanted to do so, not to reach any form of narrative closure, but instead to *do better* at telling their story.

6.1 Supporting Narrative Play

Our intention when designing our storytelling game was to support narrative play, which requires that players make a combination of narrative moves and gameplay moves to move towards a goal which combines both narrative and gameplay objectives. We will now discuss the ways in which player behaviour suggests that we achieved this design objective.

One important component of narrative play is that the actions which players take in the game encompass both narrative and gameplay moves. When asked "what are you doing", players tended to focus on "arranging events and characters" as the main activity during the planning phase, and "dealing with complications" as what they were doing during the shooting phase. These actions involve both manipulation of the game elements, and manipulation of the direction of the story, which overlaps both narrative and gameplay.

When asked to describe their best and worst moves in the game, players clearly described those parts of the experience where they had successfully recovered from complications as their best moves. For example, when faced with a particularly difficult complication, one of the players recalled that he was able to overcome the problem by requesting a "rewrite", which allowed him to swap out one event card for another. He characterized this as a risk, as he would not know what event he would get, but he felt it was a risk worth taking, and it paid off, as he was able to use the new event to overcome the complication. The players described the complications as difficult and challenging, and felt that they were crucial to the experience, without which it would not have been as enjoyable, although they still could have created a story.

An interesting observation made by one of the players was that there seemed to be a trade-off between creating events which were somewhat "bland" or general, and therefore more easily adaptable to complications, versus more specifically detailed and therefore more interesting but also "riskier" events which made the story more engaging, but would be harder to adapt. The fact that players were thinking about this type of trade-off, which is very much about gameplay, but were thinking of it in terms of the impact on the narrative, further reinforces our claim that the storytelling game has successfully incorporated narrative play. This is an important point in support of the presence of narrative play in the game, since narrative play requires that obstacles placed in the way of players create both gameplay and narrative difficulty, and must be overcome by both narrative and gameplay moves.

This sense of risk and reward ties in to the notion of the difficulty of the complications. One of the players played the game twice, and, after the second session, commented that the experience didn't seem as hard as the previous session. When asked why, he initially commented that he had "got better" at writing the descriptions, and had tried to plan for the need to possibly adjust the events to accommodate complications. However, on reflection, he added that he also felt that the complications were "not as difficult" in the second session. It turns out that the complications within the second session were mostly focused on upcoming scenes, those which had not yet been shot. In comparison, the complications in the previous session had involved disruption to scenes which had already been shot. It may be that those complications which disrupt parts of the story which the player felt had already been fixed are more difficult to overcome. This raises the problem of balancing the difficulty of complications, which we will come back to later (see Section 6.2 below).

After completing the game, players were asked how they felt about the experience as a game, and whether they felt that they had "won" the game. One player described that he felt satisfied with the game, and that he felt that he had won, because the resulting story was "Bond-esque" and "would make a good Bond movie." When asked what would be considered losing the game, players suggested that if they ended up in a situation where it was "hard to recover to a coherent story", they would have lost the game. This is interesting, as we did not explicitly state the losing condition, only that the objective of the game was to "shoot a movie". Players immediately brought to bear their understanding of what a story, in this case a movie, should be, and used criteria such as coherence and dramatic tension to judge whether they had achieved their goal as a player. This is worth investigating further.

The players' perception of the winning and losing conditions of the game, and the ways in which the players described their actions, are consistent with our desire to have the experience involve both actions which involve manipulating the gameplay elements in an attempt to overcome obstacles (rearranging characters, events and settings to resolve complications), and a simultaneous attempt to tell a story. There were, however, some problems with the design, which led players to occasionally focus solely on the narrative elements of the experience, rather than the gameplay. We will now discuss these issues in more detail.

6.2 Tension between Narrative Moves and Gameplay Moves

One problem that arose with our design was the tendency for players to try to resolve complications *purely through narrative moves*, rather than through a combination of narrative and gameplay moves. The intention was for players, when faced with a complication, to have to reconsider their plan for the story, and then resolve the complication through a combination of both rearranging the various story elements, and editing the scene description. However, there were several instances where players found that it was enough for them to simply edit the description.

For example, during one of the sessions, the player had planned a scene in a particular setting. The complication which was chosen was that the setting had become unavailable, and had to be swapped out for another setting. The combination of the new setting and the existing event as it had been described in the scene description did not make narrative sense. To resolve this, rather than making any direct changes to the game elements, the player was able to reword the description of the scene to incorporate the new setting. In this case, the player is making a narrative move, but is not actually manipulating the game elements, making it difficult to see this as a gameplay move.

The problem here is that the complication did not actually impact the story structure, since the setting was not particularly important for the current scene. To solve this, the design would need to specify that the complication chosen must create sufficient impact to force the player to make both a narrative and a gameplay move. This is difficult, since it requires that Fate (whether controlled by a human or the storytelling system) have some notion of both the story structure and how the complication will change that structure.

It is also important that the complication not create too much of a disruption to the structure, to the extent that the player has no way to repair the story. This is essentially a question of game balance, which needs to be resolved through further playtesting and iterative design.

6.3 Reasons to Replay

When asked, all of the players said that they wanted to replay the game. What is more interesting is their explanations as to *why* they would want to replay. When asked, they explained that they felt that they could do better next time they played. When probed as to what they mean by "do better", they said that, if they were to play again, they felt that they would be able to get better at handling complications, and that a measure of whether they had done better would be how much the story felt like a "Bond" movie. They also were able to list specific ways that they would advise other players to approach the game. For example, one player said that he would advise players to spread out characters across different settings, so that if a setting is removed due to a complication, the character would not be completely removed from the movie. He also suggested that, if possible, the player should try to shoot the final scene as early as possible, to make sure that it is in the movie, although he did admit that this may be a "false sense of security", given that complications can impact shot scenes as well as upcoming scenes. This can be seen as the recognition by the players that there is the possibility of developing a *strategy* for doing better at the game. It also suggests that there is a certain level of tension within the game, as shown by the player's desire to get the final scene shot so that it would be out of danger.

The fact that players want to repeat the experience of our storytelling game to *get better* at overcoming difficulty, in the form of complications, and that they felt that they could indeed get better at this, suggests that there is a different form of motivation here than the desire for closure that occurs in other interactive stories. One key difference with our storytelling game is that the player is in the role of the *teller* rather than the *receiver* of the story. Although the designer of the storytelling game has set the rough parameters for the story, in the form of the settings, characters and events, and the player's cultural awareness of the "Bond" genre provides a rough framework with which to structure the story, the actual, specific details of the story are coming from the player herself.

However, this change of role on its own is not enough to create a desire to replay. When asked at the end of the planning phase whether they were happy with their story, players all said that they were. They said that they would not go back and do the planning phase again, as they were quite happy with the outcome. Once they had finished the shooting phase, during which they were forced to overcome a series of complications which disrupted their story, we asked them again if they wanted to replay. At this point, all players said that they would want to play the game again. When probed as to why, one answer was that they would like to try different ways of structuring the story during the planning phase, so that they could better handle complications. They also said that they might try different recovery strategies during the shooting phase.

Interestingly, although several players felt that the final story at the end of the shooting phase was *better* than their original plan, they still wanted to go back and try again, to see if they could do a better job of "maintaining the original story". To probe about the apparent contradiction between their perception that the final story was better than the original, and their desire to do a better job at maintaining the original (and presumably not-so-good) story, we asked whether the player would prefer not to have had the complications. The player said that this would have been less satisfying, as the process of overcoming complications "adds realism", and makes him "appreciate the difficulty" of creating a story. This particular player suggested that he would be interested in seeing the “making of” the story, in the form of a replay of the process. This is similar to watching recordings of gameplay, such as speed runs of *Super Mario Brothers*, where what is appreciated is the skill required to overcome various obstacles. Another player mentioned that he would judge other players’ ability at the game, not based on the quality of the final story, but on “how well” the players had done at overcoming complications during shooting.

What is happening here is that the players are very much focused on the process of telling the story, but are, at the same time, motivated to replay to *tell a better story*. This is very different from the desire to go back and re-experience the interactive story to find narrative closure. It is interesting that the prospect of telling a different story is not enough to encourage replay. After playing through the planning phase, the players were happy with their story, and didn’t have any desire to try again. However, after the shooting phase, they *did* want to replay. It is the challenge which they faced during the shooting phase, and the possibility that they could improve at overcoming this challenge, which motivated replay.

It is important to note that, although we began by introducing the problem of encouraging *rereading* in interactive stories, throughout the discussion above we have been referring to “players” and their desire to “replay” a storytelling game. This raises the issue of whether the “reader” is still a reader, and whether repeat experiences of a storytelling game can be considered “rereading”. This problem is not unique to storytelling games, as it is not clear whether someone experiencing any interactive story is a reader, a player, or is taking on some new, not yet clearly defined role. Resolving this issue is beyond the scope of this paper. However, it is important to acknowledge the problematic nature of the terminology, and how this reflects the complexity of the underlying issues.

7 Prototyping with Storytelling Games

In this paper, we have been exploring ways in which narrative play can encourage rereadability in interactive storytelling systems through the use of a storytelling game. We will now discuss how this approach can be used more generally as a way to explore ideas about the design of interactive storytelling systems. There are a number of lessons that can be drawn from our experience, both in terms of the possibilities and the possible problems with using this approach.

For the work we have presented here, we have been using a non-computer-based prototype to explore design ideas for interactive storytelling systems. This approach allows exploration of conceptually interesting but potentially computationally challenging designs. What this involves is crafting a set of rules and related materials, which can then be used to play through a paper-based version of an interactive story experience. This can either involve a system which is designed to be played by several people, mediated by the storytelling system, or can be a system which is eventually intended to be a single-user experience. In the latter case, the “system” is replaced by a human, who takes on the role of the computer, and closely follows the rules which describe the system’s behaviour. It is this second approach which we have used in this project.

7.1 Advantages

There are several advantages to this approach. Complex systems which may require that designers and implementers solve difficult technical problems can be approximated through the use of a human as the "artificial intelligence" within the system. For example, in our "spy game", we have specified a design where the human player, the Director, has to resolve complications created by Fate, as represented by the storytelling system. These complications must be chosen such that they disrupt the coherence of the current story, in such a way that the player is challenged, but has a chance to resolve the problem.

This is an approach to interactive storytelling which is the inverse of what is usually considered in the research community – rather than the system maintaining coherence in the face of player actions, the player must maintain coherence in the face of system-generated complications. This is a potentially interesting approach, but without some form of playable prototype, it is only an idea, and there is no evidence that it would actually lead to an interesting experience for players. Rather than expend the effort to solve the computational problems involved, it makes more sense to first attempt to gain insight into how people will respond to this type of design by creating a prototype in which the role of Fate is played by a human, who closely follows the rules specified by the designer so as to mimic the behaviour of the not-yet-implemented storytelling system. This can be done through the use of a storytelling game.

In addition to allowing designers to quickly get feedback as to how people will respond to a new design idea, this approach also allows designers to engage in iterative design, tweaking the rule system and the story content on the fly, in response to observations of how players respond. Since the system is implemented as a set of written rules and physical cards, the system can be revised without any need for programming. This allows for rapid iterations, and also puts the author/designer directly in control of the design process, without the need for a programmer and/or an authoring system to act as an intermediary.

This is very similar to the type of paper prototyping advocated in the game design community [12]. Unlike paper prototyping as performed by interaction designers, where the main focus is on the interface behaviours [13], game prototypes, and the type of storytelling games we have described, are intended to provide insight into the ways in which people respond to the rule systems and design choices at the system level.

7.2 Possible Problems

There are, of course, possible problems with this approach. The experience of playing a storytelling game with other people, even when there is only one other player who is acting as the "system", is a social experience. This may interfere with the designers' interpretations of the player's reactions, as the actual, single player experience will not include this social dimension. For example, in our study, players mentioned that part of the enjoyment of the experience came from the fact that another person, the researcher, was sharing the experience with them, even though the researcher's contribution was limited to playing the role of Fate. We attempted to minimize this problem by having the person playing the role of Fate stick as closely as possible to the rules as set out by the designers, and not engage in any unnecessary communication with the player. This is an issue which anyone using this approach needs to be mindful of both when designing the study, and when interpreting the results of the study.

A more problematic issue is that of the potential computational complexity of the system being designed. Although the use of a human to mimic the "system" removes the immediate need to solve the implementation problems, it is crucial that researchers using this method are aware of, and take into consideration, the actual technical issues involved in implementing their designs. Otherwise, there is the danger that ideas will be proposed which could never be implemented, making their actual contribution to the development of the field negligible. For example, in our study we avoided the problem of implementing a computational system to determine the complication with which to confront the player, which is a potentially difficult technical problem. For this system to be implemented, the system would need to be able to determine which changes to the Director's story would make it no longer coherent. Similarly, once the Director has attempted to resolve the complication, the system would need to be able to determine whether or not the complication has actually been successfully resolved. As mentioned above, this is essentially the inverse of the typical drama management problem, where the system needs to have some means of knowing when a player action has disrupted coherence, and take action to resolve the problem. In both situations, there is the need for some representation of the story which captures a notion of "coherence", and a set of actions which can be clearly specified in terms of how they change the structure of the story. This is clearly a non-trivial problem, the complexity of which we need to keep in mind when discussing our results.

8 Conclusion

In this paper, we have explored the possibility of supporting repeated satisfying experiences of interactive stories through the use of *narrative play*. We created a prototype storytelling game using this approach, in which the player takes on the role of the Director of a movie who must attempt to tell a story in the face of a series of complications created by Fate.

Our playtesting of this prototype suggests that this is a promising approach. Our storytelling game managed to successfully combine the process of telling a story with gameplay. We saw that players were motivated by the desire to *do better*, which they articulated in terms of both developing better strategies to overcome complications, and in terms of telling a better story. This is a very different form of repeated experience from the type of rereading seen in other interactive stories, which tend to encourage a focus on narrative closure. There were, however, some problematic issues, including the question of how to balance the difficulty of the complications faced by players, and how to maintain a focus on both narrative and gameplay moves as players progress through the game.

We also discussed the methodology which we employed: the use of a prototype storytelling game as a way of exploring new paradigms for interactive storytelling. We have shown that this is a useful approach, but that it also raises several potential problems for researchers, the most important of which is the need to keep in mind the implementation issues which a new design idea may involve. This methodology provides a new way in which researchers can explore innovative approaches to interactive storytelling at the design level, while maintaining awareness of the attendant technical challenges.

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Extensible Tools for Practical Experiments in IDN: The Advanced Stories Authoring and Presentation System

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Abstract. Research on the emerging form of interactive digital narrative (IDN) concerns both theory and practice. The approach discussed here combines a theoretical framework introduced previously with a concrete implementation in the form of the Advanced Stories Authoring and Presentation System (ASAPS), a software package that aims to foster experimentation by providing tools which are easy to use. Furthermore ASAPS differentiates itself from other authoring tools by emphasizing extensibility and collaboration with other software. Therefore, the first implementation of this tool set foregrounds a flexible, modular architecture over computational sophistication.

Keywords: Interactive Storytelling Tools, Authoring System, Interactive Narrative, Digital Media Narrative, Story, Plot, Protostory, Narrative Design, Narrative Vectors.

1 Introduction

The technical complexity of the digital medium constitutes a considerable obstacle in the way of creating a larger number of forms of interactive digital narrative (IDN). The mastery of the technical aspects alone requires highly specialized knowledge in several areas to create the visual, procedural, and participatory aspects. Amongst these requirements is working knowledge of various software tools on the computer for creating and editing graphics as well as an understanding of programming and user interface design. Even more daunting is the high level of technical expertise required to create an AI-based work in line with Mateas' and Stern's Façade [1].

Few potential creators command this advanced level of technical knowledge. In order to enable more experiments with IDN as an expressive form, it is important to simplify access to the procedural and participatory power of digital media. For this purpose, a number of authoring tools like *Adobe Flash* or *Processing* exist in the market today. In principle, many of these tools should enable the creation of IDN works and indeed have been used in this capacity. However, many researchers in this field have felt the need to create more specialized tools to better serve the needs of IDN practitioners. A short but by no means complete list includes Storyspace [2], Agent Stories [3], Art-E-Fact [4], the authoring part of the IS engine [5], DraMachina

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[6], Adventure Author [7], Scenejo [8], Bowman/Zócalo [9], Scribe [10], Inscape [11], FearNot! authoring tool [12], Rencontre [13], and Wide Ruled [14]. Additionally, there are commercial programs like Chris Crawford's Storytron/SWAT[1] and freeware solutions like the Korsakow[2] system or Inform[3].

These software packages clearly provide many valuable insights on how to implement specific authoring tasks and provide excellent solutions to authoring IDN artifacts. At the same time, many of these authoring tools are wedded to particular approaches and concepts, which influence users in their choices and potentially limit the scope of works created with it. From this perspective, existing IDN authoring tools can be broadly described as belonging to three categories: tools incorporating particular traditions, tools incorporating specific approaches, and tools designed to be more general. Some examples in the first group (incorporating particular traditions) are: Storyspace (Hyperfiction), Inform (Interactive Fiction), Recontre (Hyperfiction), and Korsakow system (Interactive Cinema) Examples in the second group (specific approaches) include: Agent Stories (Agent-based narrative with story clips), Art-E-Fact (directed graph-based dialogue), IS engine (Character-based approach with hierarchical plans), Bowman/Zócalo (Domain Elaboration Framework incorporated with a planning system), Adventure Author (Branching dialogue trees), Scenejo (Story graphs in combination with dialogue patterns), Scribe (Front end for interactive drama in a training environment), FearNot! (Emergent narrative from the interaction of planned agent behavior), Narratoria (Branching narrative), Wide Ruled (Text-based author-goal driven story planner).

Tools in the second group represent particular underlying approaches and are therefore most clearly subject to the respective limitations. For example, Storyspace[4] was designed around the assumptions and goals of the Hyperfiction (HF) tradition [2] in IDN and therefore incorporates a metaphor based on nodes, offers provisions for creating hyperlinks and features a map view to navigate the resulting structure. The emphasis on nodes and links results in reduced attention paid to other areas. Storyspace offers only limited procedurality in the form of "guard fields", or hyperlinks that are initially hidden and appear after some conditions are met.

The third group (represented here by DraMachina and Inscape) exemplifies a "pragmatic" approach [15]. The collaborative European research project *Inscape* shares our integrative view on IDN, and is meant to enable the creation of many different types of IDN experiences [11]. What is missing in the Inscape project is a general definition of IDN shared by all the project partners. An mid-project overview lists seven papers on issues related to theoretical issues of IDN from very different perspectives, from suggestions to apply narrative theory [16] to a proposal for making stories by recording interactive experiences [17]. Unfortunately development on the tool seems to have stopped.[5]

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[1] Available from `http://www.storytron.com`

[2] Available from `http://www.korsakow.org`

[3] Available from `http://inform7.com/`

[4] `http://www.eastgate.com/storyspace/`

[5] At a demonstration at the ICIDS 08 conference in Erfurt, the presenter identified problems with the 3D engine in *Inscape*, and its commercial developer as a major obstacle for continued development.

While authoring tools in the first two group limit authors by incorporating only particular traditions or research of IDN, the *Inscape* project exposes a problem with an approach on the opposite side of the spectrum - when a clear distinction of IDN vs. other forms of digital expression such as digital movies is omitted, it becomes difficult to evaluate resulting artifacts as IDN works.

1.1 Lessons for IDN Authoring Tools

The lesson for IDN authoring tools from this discussion is fourfold. First, several traditions and many promising approaches exist within the field and it would be valuable to combine them. Secondly, authoring tools that only incorporate specific traditions or particular research approaches are limiting as a basis for IDN experiments aiming for a broad integrative perspective across the entire field. Thirdly, when IDN is taken as a term equal to “any kind of interactive experience” it is in danger to become arbitrary. Fourth, the disappearance of *Inscape* serves as a warning that sustainability should be a consideration when creating IDN authoring tools.

Consequently, an innovative approach towards an authoring tool should be able to incorporate and integrate multiple traditions and various practical approaches within IDN. At the same time, the tool should be grounded in a broad definition of interactive narrative to preserve the focus on IDN. Lastly, the new architecture should be based on the realization that at this early stage of IDN practice it is impossible to avoid certain misconceptions. Therefore, it is essential that a practical approach for IDN should make provisions for future revisions and continued development.

2 Advanced Stories Authoring and Presentation System (ASAPS)

ASAPS[6] is a platform for IDN experiments that reflects these considerations. The World Wide Web with its robust, revision-friendly and extensible architecture provided the model for the ASAPS software architecture with a markup language (ASML), an authoring tool (ASB), and a playback engine (ASE).

The conceptual basis of ASAPS is derived from a descriptive model of stage drama with the three categories of set, character and plot, which is expanded to include four aspects - settings, environment definitions, character definitions, and narrative design. The extension to four categories is necessary to define a complete protostory [see 18]. While the legacy categories of character and plot are roughly equivalent to character definitions and narrative design, set is insufficient as a category in IDN. Some aspects of set in the participatory experience of IDN are internal (for example the definition of virtual locations, specific rules of physics or constraints in a virtual society), while other aspects of set pertain to the concrete presentation and the human-computer

[6] The author programmed ASAPS and developed the ASML language. The Advanced Stories Group (ASG) at the Georgia Institute of Technology, founded by the author as part of his PhD research work was instrumental in developing the underlying concepts, and creating example narratives. Especially valuable were the many contributions by Katharine Fletcher, including user interface design for ASB. For a list of ASG contributors, refer to the ASAPS website (http://advancedstories.net).

interface. ASAPS reflects this distinction in the two categories of settings (for definitions related to the presentation and interface) and environment, which contains definitions for virtual environments and general rule sets. (see Figure 1).

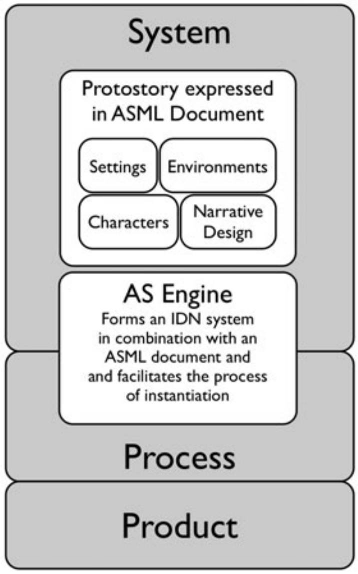

Fig. 1. Overview of concepts in ASAPS

This model provides a clear separation of different aspects of the overall narrative experience – a perspective authors are familiar with from work in established media forms like film and the stage drama. This similarity lowers the threshold for practitioners wanting to experiment in IDN while allowing them to focus on the level of protostory.

The *settings* category contains definitions for the overall look and feel of an IDN experience. Additionally, settings for debugging functions are placed here that aid an author during the development of an IDN.

The descriptions in the *environment* category define spaces in which the narrative takes place including the available props. *Environment* is also the place for definitions of rule sets that shape the experience within the narrative world - for example a physics system or a system of rules pertaining to emotions or the societies the interactor is placed in. Additional rule sets would describe the progress of time, or a historic period and the associated social rules in which the IDN takes place. In the current implementation of ASAPS, environment is used for place definitions in the form of background graphics (*nodes)*, and *props*, which encompasses the concept of theatrical props and effects (overlays, short animations).

The concept of *characters* encompasses active characters that an interactor commands and non-player characters (NPCs) controlled by the overall narrative. *Characters* must be able to change in the course of an IDN and react to actions. Currently, *characters* have *states* in the form of different graphical representations and numerical variables (called *counters*). ASAPS allows an author to associate such variables with a character in order to provide a dynamic mechanism for expressing changing character traits and achievements. Additionally, these variables can be used for other aspects such as tracking overall progress. Furthermore, a character in ASAPS can have an *inventory* for items found during the course of an IDN.

The legacy notion of *plot* is superseded by *narrative design* [see 18], a flexible structure an author of an IDN creates that defines a *protostory* and contains *narrative vectors*. The contents of the categories of *environment* and *characters* supply material for the narrative design. The concrete design consists of assemblages of atomic narrative units, called *beats*, a metaphor taken from stage drama [see 1]. Combinations of beats constitute *narrative vectors*, or substructures of the overall narrative design that shape the course of an IDN.

This concept is implemented in the form of ASML (Advanced Stories Markup Language), an XML-based markup language, which describes complete IDN experiences in human-readable form. The current ASML specification consists of four top-level entities (Settings/Environment/Characters/Plot) and 14 beat functions (TitleScreen, DurScreen, IntroText, ConversationChoice, MovementChoice, PickProp, VideoBeat, SWFBeat, SetGlobal, ConditionCheck, RandomBeat, AddRemoveInventory, SetCounter and EndScreen).

3 Conclusion

The aim for the first iteration of ASAPS was to create a robust foundation that facilitates future revisions and enables additions by third parties. Conceptually, a flexible framework should allow experimentation and the integration of different perspectives in IDN.

Several observations demonstrate the validity of the technical approach. In the course of the development of ASAPS from 2006 to 2011, the ASML markup language has undergone many changes, including the introduction of a new top-level category (settings) and the addition of several new beat types. ASAPS was flexible enough to accommodate these changes in its different parts, which is testimony to the extensibility and robustness. Additionally, the system has been successfully used to create IDN projects, including by a class of 24 students at the Georgia Institute of Technology.

More research is needed to fully evaluate the success of the practical implementation of prototstory, narrative design, and narrative vectors. In order to gain a better understanding of the advantages and shortcomings of the current implementation, a public beta test will be conducted, which should result in many more examples to analyze and allow for a more conclusive evaluation.

The long-term goal is to establish ASAPS both as a lightweight IDN authoring system of its own and as an interface and a middleware that allows access to different IDN systems. Similar to the way WWW enabled access to different media types and communication between different systems, ASAPS could serve this function in the IDN space. With an established middleware, that hope is that researchers could concentrate on specific issues - for example dialogue generation - and use exchangeable components for other aspects of IDN like the user interface.

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A Knowledge-Based Framework for the Collaborative Improvisation of Scene Introductions

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Abstract. This article describes a framework for the mixed-initiative collaborative creation of introductions to improvised theatrical scenes. This framework is based on the empirical study of experienced improvisational actors and the processes they use to reach shared understanding while creating the scene. Improvisation is a notable creative act, where the process of creating the scene is as much a product as the scene itself. Our framework models the processes of narrative scene establishment. It is designed to allow for the collaborative co-creation of the narrative by both human and computational improvisers. This mixed-initiative approach allows either type of improviser (AI or human) to deal with the ambiguities that are inherent to improvisational theatre. This emphasis on equal collaborative creation also differentiates this framework from existing work in story generation and interactive narrative.

Keywords: Collaborative environments for interactive storytelling, semantic knowledge for interactive storytelling, virtual characters and agents.

1 Introduction

Improvisation is a well-known form of several types of entertainment, including music and theatre. Because of its ubiquity in creative domains, improvisation is a growing area of interest for researchers in the computational creativity field. Improvisation (or "improv") in an artistic domain (e.g. improvisational theatre) has been defined as the creation of an artifact and/or performance with aesthetic goals in real-time that is not completely prescribed in terms of functional and/or content constraints [1]. Studying improvisation, and improvisational theatre, in particular, provides a unique perspective on human creative processes and narrative, informing the development of computational agents capable of improvisation.

Our previous work on the study of improvisational actors has culminated in the construction of an agent-based framework for playing *Party Quirks*, a well-known improvisational game, in collaboration with human improvisers [2]. *Party Quirks* was selected as the initial domain for developing an improvisational framework in part because the game inherently lacks a narrative aspect; it focuses on the process of cognitive convergence (improvisers "getting on the same page") without concern for

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telling a coherent story. The work presented in this paper builds on our previous work by introducing a knowledge-based framework for collaboratively creating the elements present in the introduction of an improvised scene with a narrative (i.e. the *platform* of a scene). The platform defines four aspects of a scene: the location of the scene, the characters within the scene, the relationship between those characters, and the shared (joint) activity which the characters are participating in.

Generating an improvised scene differs significantly from canonical approaches to story generation. First and foremost, the processes involved in improvising the story are appreciated as much as, if not more than, the story itself. The entertainment value of improv comes from watching the formation of a narrative directly in front of the audience and not solely from viewing a performed scene (as in traditional theatre). In other words, *the process is part of the product* in improvisation. Second, improv performances contain inherent ambiguities that must be resolved by both the audience and the actors. Finally, improvisation is an imperfectly coordinated multi-agent process, whereas canonical story generation is single-agent. Each improviser has a different conception (or *mental model*) of the narrative and can only share this model through the performance. This lack of coordination between the multiple authors of the scene is an additional source of ambiguity in improvisational performances. This differs from less improvised settings (e.g. a screenwriting meeting) where coordination is less constrained. In generating the platform, we need to understand how improvisers reach a shared model of the scene through performance alone.

The work presented in this paper is part of ongoing research into improvisational actors, focusing on gaining an understanding of human creativity with respect to the collaborative creation of stories. We then apply this understanding to developing intelligent improvisational agents. As part of this effort, we studied performances by experienced improvisational actors. Based on data collected from these performances, we introduce a new conceptual framework for the co-creation of the platform of a scene by human and computational improvisers. This joint co-construction occurs within a game of *Three Line Scene*, an improvisational teaching game used for learning how to establish the platform quickly. In this game, two actors have to create a complete platform for an improvised scene in only three lines of dialogue. The framework defines the agent's knowledge representation as well as the processes the agent applies to interpret ambiguous information and map those interpretations to instantiated facts about the reality continuously being co-constructed on stage.

2 Related Work

We have studied how improvisers deal with *cognitive divergences* (i.e. when actors are not "on the same page") within the context of the improv game *Party Quirks* [3]. Although *Party Quirks* contains no narrative development, it is a game that clearly illustrates the types of offers (presentations made by improvisers) that actors use to resolve divergences on stage. The same processes can be used to resolve divergences in narrative-oriented scenes as well [1].

Our current work uses the game *Three Line Scene* to apply our studies of human improvisers to a narrative context. In this game, two actors take turns presenting dialogue and motions with the goal of establishing a complete platform in three turns.

This game forces actors to make strong offers that contribute multiple elements to the platform at once and to accept and augment previous presentations [4]. In addition to dialogue offers, actors utilize distinct motions, which can convey information about a character or the joint activity [5]. We use *Three Line Scene* as the basis for our framework due to its simple rules, generative capabilities, and focus on the platform.

Most improvisation research has focused on music [6, 7]. Emergent music creation work [8, 9] has led to improvisational agents that can co-create in a musical performance [10]. Theatrical improvisers cannot rely on explicit meta-communication and rarely use pre-established structures (i.e. stock characters, narrative structure, etc.) analogous to those available to improvisational musicians (i.e. chord progressions, key signatures, etc.). Sociolinguistic studies of theatrical improvisation have found that all of a theatrical improviser's actions and dialogue are generated and presented within the performance as offers for the scene [11]. The collective responses to these offers – which can be accepted or rejected, augmented or redirected [4] – create the improvised narrative. Implementations of theatrical improvisation agents [12-15] have typically focused on portraying particular aspects of improvisation informed by classic improvisation texts rather than on creating narratives. The fields of story generation and interactive narrative can benefit from applications of improvisational techniques to create interesting narratives without predetermined planning [16].

Story generation employs intelligent agents to create stories. Story generation systems typically use a single agent [17] or multiple agents capable of communicating about the content and the presentation of the narrative [18]. In contrast, our work focuses on multiple agents creating a story without explicit communication within the context of a performance.

Interactive narratives incorporate humans into the story process by allowing users to influence the path and outcome of an adaptable story. Interactive narrative systems typically have fixed, pre-authored story elements that make up the atomic elements of co-creating a story. Human interactors influence the selection of atoms through various mechanisms (e.g. navigating the social space of a story world [19] or uttering dialogue that maps to positions on the story's Aristotelian arc [20]). In some cases, agents in interactive narrative systems have advance knowledge of the characters and an intended narrative. In other cases, agents do not contribute directly to the creation of the emergent narrative but influence the outcome from a directorial role [21]. A common factor among these systems is that although humans and agents co-create a story, they do not do so as equals. Our framework lays the foundation for agents that equally co-create an emergent narrative with a human interactor, where each player adds something new to the narrative with each play they make.

3 Platform Creation Framework

We have developed a framework for implementing an agent capable of playing a modified version of *Three Line Scene*, which omits the aspects of narrative that occur later in scenes. We note that this framework is a human behavior model, rather than a cognitive model, of improvisation. That is, we do not claim that human improvisers carry out the exact processes described below. We do, however, believe that this framework models the knowledge necessary to establish the platform of a scene.

The omission of narrative aspects beyond the platform allows us to focus on the collaborative construction of the platform as an initial point in developing agents that can co-construct narratives with humans or other agents. The computational agent uses a modified version of Sawyer's definition of "platform" [11] to reason about the state of the emerging scene. Sawyer's definition, derived from the common practices of improvisers, identifies four elements of the platform: the *characters* in the scene, their *relationship* to each other, the *joint activity* they are engaged in, and their *location*. Sawyer notes that relationship and location can often be inferred from the characters and joint activity, respectively. Therefore, our agent's knowledge structure focuses on reasoning about the characters and joint activity. This reduces both the amount of authoring and computation needed to reason about the platform.

In addition to the character and joint activity aspects of the platform, our knowledge structure contains other types of elements that are necessary for interpreting the scene and making presentations. The first of these are *motions* and *actions*. A motion is a physical representation of a movement while an action is an intended or interpreted meaning of a motion. For example, an agent may hold out one hand shaped as a loosely closed vertical fist. In this case, the motion is *hold out fist*, while the action may be *give bag*. A single motion can portray multiple actions, so holding out a fist in this manner could also be interpreted as *give bottle*. Finally, our knowledge structure contains icons that convey aspects of a scene that would typically be presented through dialogue rather than through some physical motion. Such aspects include presentations about another improviser's character and explicit instantiation or clarification of an element in an improviser's mental model.

The agent's knowledge base is divided into four *categories*: motions, actions, characters, and joint activity. The agent also organizes its knowledge of the scene based on which improviser it is associated with – that is, it keeps knowledge of its own character, actions, and motions distinct from those of the other improviser. Each computational agent tracks the *current instantiation* (motions or icons that either improviser has presented) and its own *mental model* (elements it supposes are in the scene that have not yet been explicitly confirmed). The agent treats elements in its mental model as true until provided with evidence (a presentation from the other improviser) to the contrary. The agent uses the elements it supposes to be true when expanding its mental model. It does not consider other elements in knowledge categories where it already supposes some element to be true. Actions that the agent chooses to present are a special case; the agent will ignore actions already in its mental model so as to avoid repeating actions. The agent will always consider instantiated elements to be true.

Because the categories of our knowledge structure are highly inter-related, we need an approach to show approximately how related any two items are. We have adopted a fuzzy logic approach similar to the one used in the *Party Quirks* framework [2] to represent the association between two elements in our knowledge structure. Every element within our knowledge structure is connected to elements in related categories with a degree of association (DOA), which could be considered a bi-directional version of degree of membership (DOM) in fuzzy logic. Whereas DOM is unidirectional, where some element is a member of a set to some degree, DOA is a bi-directional relationship representing the extent to which two items are related, where

0 means that the items have no association whatsoever, and 1 means that the items are highly correlated with each other. Table 1 shows a sample DOA table of the degrees of association between possible characters and joint activities.

The agent assumes that the other actor intends to communicate their mental model clearly in order to reach a shared understanding about the scene [3]. Therefore, when expanding its mental model, the agent adds one of the most iconic interpretations of what it has seen or what its mental model implies. Iconicity (or its inverse, ambiguity) is a measure of the uniqueness of the DOA values between a single element and every element of another category. (See [2] for greater detail on how ambiguity is calculated.) For example, suppose the agent is considering what it knows about the other actor's character given that it thinks the joint activity is *gambling*. If most characters have a medium degree of association with gambling, then these characters are not iconic gamblers. In this case, a character with a very high or very low degree of association with gambling would be an iconic, and therefore preferable, choice. The agent only considers elements that are among the most iconic possible interpretations. Considering iconicity first ensures that the agent presents a choice that is easily distinguished by the other agent regardless of its DOA with other elements in its mental model.

3.1 Simplifications

We have made some simplifying assumptions for the purposes of modeling a computational improviser. First, we made the decision that the agent's mental model does not include theory of mind – that is, the agent does not track what it supposes is in the other improviser's mental model of the scene. Agents can use theory of mind to model other interactors, evaluate the outcome of actions, and update goals [22]. In *Three Line Scene*, models of other interactors would provide insight into the causes of and possible resolutions to cognitive divergences. We find it valuable to evaluate whether our agent can correct divergences without keeping a model of the other actor's behavior before attempting to implement a theory of mind system.

Furthermore, agents are limited to communicating with motions and icons, where one icon represents one element of the agent's mental model. Icons avoid the issue of addressing natural language generation and processing. This allows us to focus on the cognitive process of setting up a platform rather than the detailed mechanics of verbal communication. Using icons avoids the use of "canned" language, while still allowing for the direct communication of ideas between two agents (i.e. communication that

Table 1. Sample knowledge structure table for the *Tiny West* domain shows the degrees of association that different characters have with different joint activities

	Robbery	Showdown	Drinking	Apprehending	…
Outlaw	0.9	0.8	0.8	0.8	…
Gunslinger	0.7	0.9	0.8	0.6	…
Sheriff	0.8	0.8	0.7	0.9	…
Banker	0.8	0.2	0.5	0.4	…
…	…	…	…	…	…

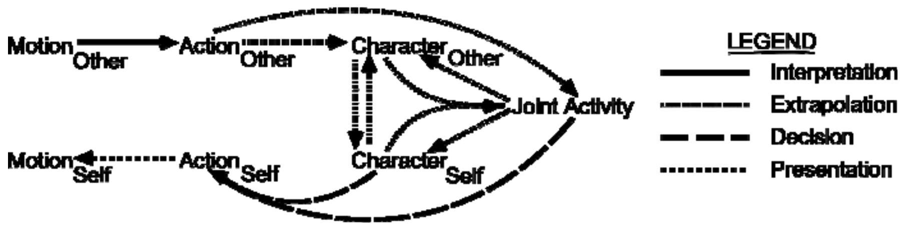

Fig. 1. Organization of knowledge structure categories throughout the turn process

does not need to be interpreted through ambiguous motions and actions). While the framework could accommodate ambiguous icons (i.e., icons that might represent multiple elements), this would greatly increase the complexity of authoring. In our observations of improvisers, ambiguous motions tended to create more divergences in setting up the platform than ambiguity of language, so we do not feel that this added complexity will be valuable at this stage. In addition, the use of icons also simplifies the interactions between human improvisers and the computational agent. It provides a common set of symbols that both the human interactor and the computational agent can understand. Ideally, the icons will be designed so that the human can understand what they represent and be able to use them with little to no instruction.

3.2 Turn Process

This section describes the process our narrative agents take in our modified version of *Three Line Scene*. We presume that agents use this process throughout the game, except during the first turn. In our analysis of improv actors in unconstrained narrative scenes, we noticed that actors would start scenes with potentially ambiguous motions rather than dialogue. Additionally, this turn process is based on interpreting previous offers and extrapolating from knowledge about the scene, neither of which is possible when considering the first move of the scene. Hence, we presume that an improviser selects an arbitrary motion and presents it as the initial move in the performance.

A turn in this framework is divided into five phases: *perception*, *interpretation*, *extrapolation*, *decision*, and *presentation*. The agent *perceives* the previous presentation, *interprets* the motions and/or icons and checks for divergences, *extrapolates* the interpretations to build its mental model of the scene, *decides* which mental model elements to present, and *presents* the elements with a motion, an icon, or both. Figure 1 summarizes our knowledge structure and shows which element categories can be reached from other categories during each turn phase. The details of each phase are discussed below.

In order to visualize the turn process, it is helpful to focus on a limited data set. For such purposes, we present *Tiny West*, an example story world designed for the purpose of illustrating our framework. *Tiny West* represents a limited set of characters, actions, and joint activities typical of the western genre in cinema. The iconic nature of the elements of this genre makes it valuable for highlighting strong and weak degrees of association. Furthermore, given the cultural prevalence of westerns, the relationships between the elements are fairly well-known and consistent across media, leading to less debate over specific values for the sake of authoring.

Perception. The agent receives as input whatever was presented by the other agent in the previous turn. We presume that our agents have perfect perception; that is, they observe icon and motion presentations without error. This perfect perception eliminates the uncertainty that arises in viewing a presentation so that agents can focus instead on the semantic ambiguity of a presentation. Motions remain open to interpretation about which action they represent. Icons represent a single element of the knowledge base, so they can be directly added to an agent's mental model.

In our *Tiny West* example, George opens the scene by randomly choosing a motion, presenting the motion *quickdraw*. As explained above, choosing a random motion to begin with is a legitimate move for theatrical improvisers. Ann perceives the *quickdraw* motion and adds it to her mental model.

Interpretation. Once a presentation is perceived, an agent must interpret its meaning. A single motion can potentially portray multiple actions, so the agent must select a single interpretation for that motion. First, the agent finds all possible actions that the motion may have been intended to portray. As described in Section 3, the agent only considers iconic elements when expanding its mental model. This ensures that the agent selects something that is likely to be what the other actor intended. The agent probabilistically selects from the iconic interpretations, favoring those with higher DOA. The agent adds the interpretation to its mental model as part of what the other actor has contributed to the scene.

In the *Tiny West* example, Ann interprets the *quickdraw* motion. She considers iconic actions with given the *quickdraw* motion. The iconic actions are *draw gun* (DOA 0.8), *show off* (DOA 0.6), and *stick up* (DOA 0.9). Ann probabilistically chooses between the three. She interprets *stick up* as the intended action and adds it to her mental model.

When an agent interprets an icon, the icon may introduce a divergence in the agent's mental model. Such a divergence occurs when the instantiated element conflicts with some other element in the same category in the agent's mental model. In this case, the instantiated element supersedes the mental model element. Once the agent replaces an element of its mental model, it must update the rest of the model to ensure that all elements are still associated with each other, as the newly instantiated element may have a DOA of 0 with something already in the mental model. The agent sets an acceptability threshold when it considers the association between elements of two categories. For all categories where the agent has an element in its mental model, the association between elements in connected categories must be above the threshold. If they are not, the agent replaces elements below the threshold with new elements that are above it, selecting probabilistically based on DOA.

Suppose in a later turn that George has *showdown* as the joint activity in his mental model, but this has not been instantiated yet. If Ann presents an icon for the joint activity *robbery*, George removes *showdown* from his mental model and replaces it with *robbery*. This resolves the divergence [3], and George can move on to extrapolation.

Extrapolation. The agent considers what else may be true in the scene based on the updated contents of its mental model in order to add new information to the scene [4]. This phase is not meant to simulate the exact cognitive processes that a human improviser uses; rather, it approximates the behavior of making inferences from previous presentations. The agent arbitrarily selects an interpreted element and tries to extrapolate to an element in another knowledge category. The choice of where to start from is ultimately insignificant, as every element of the current instantiation and the agent's mental model feeds into the extrapolation process. Given the selected element, the agent selects one of the two reachable categories to consider after accounting for what has been instantiated in the scene (e.g. if roles for both characters have been instantiated, then the agent will not consider characters). The selection is arbitrary when both categories are available – that is, when nothing from either category has been instantiated yet. In practice, as the scene continues and more platform elements are instantiated, it becomes increasingly likely that one of the categories cannot be selected. From the available category, the agent selects an element based on its iconicity and DOA as described in Section 3.

Extrapolations influenced by multiple categories need to be represented compactly to reduce authoring. The agent takes the fuzzy AND (i.e. a minimum function) [23] of the DOA between its own character and a potential joint activity and the DOA between the other improviser's character and that joint activity. This prevents the need for authoring an association cube between both sets of characters and joint activities. If the agent has not added both characters to its mental model, it does a regular extrapolation from whichever character it has in its mental model. Similarly, the other improviser's motions and actions both inform what character they may be, since different characters portray the same action with different motions. To represent this without an association cube between motions, actions, and characters, the agent extrapolates from an action to a character with a DOA approximately the same (within one standard deviation) as the DOA between that action and the initial motion.

We presume that the agent does not necessarily try to define every aspect of the platform during each turn. To do so, the agent would make several assumptions based on elements that are only in its mental model. The fewer assumptions the agent makes, the less likely it is to encounter divergences later. After each extrapolation, the agent decides whether to continue extrapolating. This decision is weighted based on how many extrapolations the agent has made on this turn. Continuing to extrapolate becomes less likely with each pass. If the agent makes another pass at extrapolation, it returns to the beginning of the process, working this time from the newly extrapolated element. If the agent ends the extrapolation phase, it moves to the *decision phase*.

Continuing with our *Tiny West* example, Ann extrapolates from George's action. Actions extrapolate to joint activities (see Figure 1), so Ann considers which joint activities are iconic given *stick up*. Both *robbery* and *showdown* are iconic given *stick up*; these activities have high DOA (0.9 and 0.7, respectively) while all others have low DOA. Ann probabilistically selects *robbery*. She decides to continue extrapolating. From joint activities, she can extrapolate to either her own character or George's character. She decides to extrapolate to her character. *Outlaw* and *banker* both have high DOAs with the joint activity *robbery* (0.9 and 0.8, respectively), while other characters tend to have mid-range DOAs. Both are iconic. Ann probabilistically selects *banker*. Since Ann has now extrapolated twice, she is less likely to continue extrapolating. She decides to stop extrapolating now.

Decision. The agent decides to present an icon (a substitute for dialogue), an action, or some combination of the two. If the agent only has the other improviser's character in its mental model, it must present that with an icon. (An action cannot convey information about the other improviser's character.) Otherwise, there is no preference among the three choices, as each adds to the scene and would be valid for a human improviser. The agent arbitrarily decides which of these to present. If it chooses to present an icon, the agent selects an icon representing an arbitrarily chosen element of its mental model. If it chooses to present an action, the agent takes the fuzzy AND of the DOA between its own character and an action and the DOA between the joint activity and that action. Potential actions must be iconic for both the agent's character and the joint activity. If the agent does not have both its own character and the joint activity in its mental model, it selects an action based on the elements that are in its mental model. Finally, the agent adds the selected action to its mental model.

In *Tiny West*, Ann must now decide which aspects of her mental model to present and how. She decides to only present an action. She considers the actions that both her character *banker* and the joint activity *robbery* are associated with. The relevant actions are *give money* and *stick up*. Both *banker* and *robbery* are iconic and have high DOA with *give money* (both DOA 0.8, while other characters have low DOAs). The fuzzy AND of their DOAs with *give money* is 0.8. *Banker* is moderately associated with *stick up* (0.6), but so are most other characters, so this DOA is not iconic. *Robbery* is iconic and has high DOA with *stick up* (0.9 while most other activities have a low DOA). However, since the combination of *banker* and *stick up* is not iconic, Ann does not consider the *stick up* action further. Ann selects *give money*, as it is the only viable action for her to choose, and adds it to her mental model.

Presentation. If the agent decided to present an icon, it displays the icon it has selected. If the agent decided to present an action, it first converts that action into a motion. As mentioned earlier, different characters portray the same action with different motions. Thus both the agent's character and the selected action affect the motion it presents. Like in the extrapolation phase, the agent presents a motion that has approximately the same degree of association (within one standard deviation) with the action as that action has with the agent's character. (If the agent's character is not part of its mental model, the agent selects a motion as if it were extrapolating from actions to motions.) Again, this avoids the need for a motion-action-character association cube. The agent displays its motion, adds the icon and/or motion to its mental model, and concludes its turn.

Having chosen an action to present (*give money*), Ann must choose which motion to use to present that action. *Give money* is strongly associated with *hand over bag* (0.6) and *hand over money* (0.9). The DOA from *give money* to *hand over money* is closer to the DOA from *banker* to *give money* (0.8) than the DOA from *give money* to *hand over bag*. Ann chooses *hand over money*, which she then presents to George.

4 Discussion

This framework models the improvisation process for the construction of the platform in a narrative scene. In improvisational theatre, the process used by improvisers to create a scene is at least as important as the resulting scene itself. Our work is an extension of improvisational agents built for non-narrative games, based on the analysis of experienced improvisational actors [1]. While this work does not describe a cognitive model of improvisers, it does describe the behaviors used to establish the platform in a narrative scene.

Our framework represents the collaborative creation of the platform by both human and computational improvisers. This equal partnership in co-creating a story improves upon story generation and interactive narrative literature. We are presently unaware of any mixed-initiative story generation systems, although work has been proposed for mixed-initiative control of believable agents in interactive digital storytelling [24, 25]. Interactive narrative systems rely on pre-authored content. While users can affect the direction that an interactive narrative takes, they remain beholden to the content that has been written. In our approach, human users are true co-creators; there is no existing narrative content for the user to follow.

This framework currently assumes that improvisers, both computational and human, make only "good" plays. This is a reasonable assumption, as human improvisers are trained to advance the scene with each decision they make. In its most basic form, advancing the scene consists of accepting the previous offer and adding something else to the scene. Given this aspect of improvisation training, we designed our framework so that a computational improviser only makes good plays. While human interactors can still make "bad" plays, a computational agent can deal with an unusual offer from a human player by treating the offer as a divergence and adapting its play accordingly, as described in the Interpretation and Extrapolation phases.

A computational agent's ability to improvise inherently relies on its knowledge base. One might argue that a human improvising with a computational agent using this framework is just as limited by authored content as someone taking part in any other interactive narrative system. However, in an interactive narrative, the agent works from a set of preconceived story elements. In this framework, a computational agent works from a known knowledge base that is not connected to any portion of a narrative. While we do intend to limit interaction so that a human improviser cannot easily stray from the knowledge base, we still believe that a human improviser/co-creator is significantly less constrained than they would be in an interactive narrative.

We have described *Tiny West*, an example story world, to illustrate the framework and the agent turn process. *Tiny West* contains four characters, five joint activities, seven actions, and 14 motions, which means authoring approximately 200 DOA ratings. The DOA authoring requirements for this system are exponentially related to the number of elements in the knowledge base. However, these concerns do not affect the processes we have described. The improvisation turn process scales regardless of the size of the knowledge base.

We plan to evaluate this framework by asking people to improvise with computational agents. We used a similar evaluation technique with our *Party Quirks* system, including evaluation by a panel of experts at the 2011 Chicago Improv Festival [2]. People without improvisation experience will provide feedback about the interaction experience, particularly the use of icons. Participants will be asked if, at the end of the improvised scene, they could identify the elements of the platform that had been established. If participants describe the actual elements of the platform, then these results will validate the framework. We also plan to ask expert improvisers to compare the actions of the computational agents to the decisions they would have made in the same situation. Similarly, we intend to ask whether the framework prevented them from taking an action that they wanted to take (excluding authoring limitations). Ultimately, however, this framework is not an end. This work is one piece in understanding human creative processes with respect to improvisational theatre. Future work in conceptual blending, declarative knowledge, and procedural tacit knowledge for improvisation will all add to the richness of this work.

Improvisational theatre is a unique source of information for the study of human creative and cognitive processes. By studying expert improvisers, we have gained a greater understanding for how humans collaboratively create a narrative and how ambiguities in the creation are identified and repaired. The development of this framework is one step in a continuing research effort to create intelligent agents capable of performing these same processes in concert with humans. Future work will further explore narrative, investigating how an established platform affords the collaborative mixed-initiative creation of plot. With such an understanding, we will be able to develop agents that can improvise a complete narrative-rich scene.

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A New Approach to Social Behavior Simulation: The Mask Model

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Abstract. This paper proposes a new perspective, based on the concept of social masks, for the simulation of a realistic NPC (Non-Player Character) behavior. The Mask Model goal is to support AI techniques for autonomous agents by encouraging or discouraging behaviors according to the social environment and by providing knowledge about possible reactions to the agent actions. In this approach, the NPC tendencies are controlled by the interactions of three overlapping mask layers: self-perception layer, social layer and interpersonal layer. The masks mould the tendencies, the feelings and the ethics of a NPC. By changing the links between characters and masks, a wide variety of different behaviors and story-lines may arise. The paper present an algorithm for the selection of the actions and an example implementation.

Keywords: Virtual characters, social behavior, autonomous agents, emergent narrative.

1 Introduction

The recent years have seen the outburst of games that reproduce an entire world in which the player can experience daily life, interact with the characters and immerse himself in the illusion of living in a different reality. Therefore the NPCs (Non-Player Characters) have become increasingly important, evolving from mere puppets with some standard answers to more complex entities, able to react to the user's actions.

The approach to the simulation of NPCs social behavior herein presented can be applied as a further enhancement to already existing techniques, and may be particularly useful for supporting autonomous agents. The main issue we want to address is that the NPC behavior is usually weakly correlated to his social and cultural environment and to other character's presence and expected behavior.

For example, let us assume that Alan is brooding hostility toward Bill. In a simple scenario, Alan may tend to assault Bill whenever they meet. However, in the real word, a person must take into account many variables. For example, the two characters may be in a public place, thus Alan cannot attack Bill without compromising himself. Peer pressure and social rules may succeed in convincing him to restrain himself, or to express his hostility only through words (maybe insults) or even hide it completely. If moreover character Cindy, the lady both

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of them are in love with, is present, both men may want to pretend to behave as righteous gentlemen.

Psychology studies have shown that humans tend to exhibit a social performance that leads them to play different roles under different situations (see [4,5,16]). In the Mask Model the character tendencies are controlled by the interactions of three overlapping mask layers representing the social and the interpersonal interactions influencing a character. A mask can mould the character behavior and its psychological characteristics, it also may contain some "social expectations" that a NPC can use to predict other character's reactions. This knowledge is useful to autonomous agents to build more farsighted and realistic plans.

The paper is organized as follows. Section 2 summarizes the relevant related work, Section 3 introduces the concept of mask, Section 4 shows how mask layers may be used to built a character, Section 5 discusses how the masks affect the selection of an action, Section 6 presents an example of an implemented scenario, Section 7 concludes the paper, pointing out advantages, limits and eventual developments of this approach.

2 Related Work

Many works have shown the usefulness of both weakly and strongly autonomous agents in virtual storytelling. The former ones are usually getting directions from a drama manager to pursue the author goals [10] and may use different AI techniques such as case-based reasoning [15], planning [17] or reinforcement learning [12]. The strongly autonomous agents [1] try instead to create an emergent narrative thanks to the interactions between themselves, the player and the environment. One of the classic solutions for building autonomous agents is the BDI (Belief-Desire-Intention) architecture, since it enable the agent to "react to an environmental change in many different ways, which do not have to be explicitly specified by designers" [3]. A good examples of a storytelling system based on BDI agents is MIST [13].

Social behavior management is an intriguing challenge for interactive storytelling. Prom Week [11] addresses the problem of creating games based on relationships and social interactions among characters. Similar solutions are found in PsychSim [8], a multi-agent capable system that deals with social interactions based on models of social influence. In Mascarenhas et al. [9] it is noted that "cultural aspects have been largely neglected so far, even though they are a crucial aspect of human societies" and is proposed to use rituals in synthetic characters to generate cultural specific behaviors. Lee and Nass [7] shows that users prefer to interact with computer agents that share the same cultural background. The Storytron technology [2] develops in detail many concepts exposed in this paper, but, unlike in the Mask Model, uses inclination equations for dealing with the character behavior.

Several studies have been conducted on the psychological and social concepts of mask and on social relations as a performance. The concept of mask has been the nucleus of the work of the Nobel laureate writer Pirandello [14], who argues that every man is forced to wear a mask by the society and that everyone tends to show a different mask to different people. The concept of social relations as a performance was extensively studied by Goffman [5], who introduced a new outlook on social interactions described through the metaphor of a drama with actors, roles, props, setting, audience and a stage. A good essay on the concepts of mask and dramaturgical social psychology is found in Edgley and Turner [4]. In the work of Strauss [16] we find an in-depth study of this subject and a good description of the social masks according to which "everyone present himself to the other and to himself, and sees himself in the mirrors of their judgment. The masks he then and thereafter presents to the word and its citizens are fashioned upon his anticipation of their judgment."

3 The Mask

The Mask Model aims at supporting AI techniques for autonomous agents by encouraging or discouraging behaviors according to the social environment and providing knowledge about possible reactions to the agent actions. Therefore the Mask Model is designed to work with different types of autonomous agents and IA techniques. The basic requirement is that agents must be able to perceive the world around them and execute a set of actions.

The Mask Model can be useful to manage both round and flat characters. Round characters are characters whose personality is fully delineated by the author, while flat characters are only useful in carrying out some narrative purpose or, as in many video games, in offer services and information. We can say that the round characters make the story, but the flat characters make the world come alive.

Using the Mask Model instead of scripts to create and handle a round character permits a more structural approach since it allows to decompose the personality of a character in various components and in different layers (as we will see in Section 4). It also allows the character to reason on the basis of the other characters "social expectations", hence casting him or her in the social and cultural conventions of the world. The Mask Model should bring additional benefits with regard to the management of a multitude of flat characters for which a script approach might be too heavy or too monotonous. We will see how, by combining together a relative small number of simple masks, it is possible to create the illusion of deep behavior, making flat characters more alive and realistic.

According to the presented approach, a mask is defined as a set of characteristics and behaviors expected by a reference entity. Breaking the expected behavior is considered morally wrong by the entity and may lead to penalties. On the contrary, respecting it is encouraged and may bring advantages. Masks can be used to describe relationships, as well as many cultural aspects, like the four types of culture manifestations described by Hofstede [6]: values, rituals, heroes and symbols.

Any character can be linked to one or more masks. The link that connects a person to a mask is associated with two values representing the character *role* and the *level of influence* that the mask exerts on the character.

The role is needed to discriminate among the behavior expected from different kinds of characters. For example, the mask "culture of kingdom X" may have a different expected behavior for slaves, free men or nobles. In the same way, a young lady will expect a different behavior from her lover or from her acquaintances. Usually the role is a label such as "believer", "noble","servant", "lover", "client".

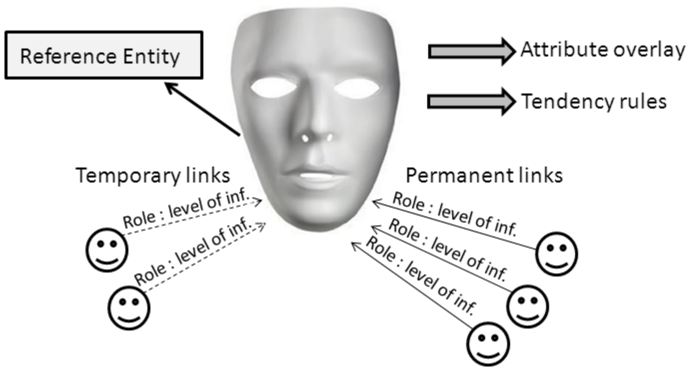

Fig. 1. The mask structure

A character may have more than one role for the same mask and the role can contain a reference to an entity that we call *role entity.* The latter is obtained by writing the role in the form "role → entityID". For example, we can say that Bill's role is not "generic servant" but specifically "servant of Rupert", by using as role "servant → Rupert". Thus some suggested reactions to Bill's actions could involve Rupert.

The level of influence is represented by a value between 0 and 1, according to how much the mask affects the morality, the ethics and the feelings of a NPC. If the reference entity is a religion, a low value would describe a moderate believer, a high value would point to a fanatic ready to even kill for it.

Each character has some persistent masks and may be subjected to the influence of other masks activated by the environment. The persistent masks represent the values, the education and the imprinting that affect a character. They may however be lost or acquired as a result of certain events.

The masks triggered by the environment are activated when the character falls within the sphere of influence of a reference entity, establishing a temporary link. For example, let us imagine a town where people follow strict religious rules and misconduct is regarded as scandalous or even heretical: a character that ordinarily does not follow that religion may decide to adapt his behavior when he enters the town, either for peer pressure or for fear of punishment.

The masks should be created by abstracting the main philosophies, religions, socially encouraged behaviors linked with different cultures, political views and opinion leaders in the world. A mask should be built when it is presumed that it will have an appreciable number of links or when it is needed for some special reason.

Each mask is composed by three parts (see Figure 1):

– a link to the reference entity,
– an overlay (even partial) on the attributes of the character,
– a set of tendency rules.

The reference entity can be a social entity (such as a government, a religion or a group of people with a common ideology), a single person or even the character himself. We will see a possible classification in the next section.

The overlay allows to change some characteristics of the characters in either an absolute or relative way, for example by setting the attribute "generosity" or "hostility" to a new value, or incrementing or decrementing them by n points. This is particularly useful in implementations that take into account various psychological components associated with an intensity (like "Prom Week" [11]). A mask can have different overlays for different roles and the overlay effect is to be weighted with the level of influence.

A tendency rule dictates an action that is encouraged or prohibited by the reference entity. It is expressed in the form:

rule_id - affected roles : { *precondition* → *action(entity)* } *: strength*

Its meaning is simple: if the character fills one of those roles when the preconditions are triggered, an action on a certain entity is either suggested or discouraged. An action can have one or more arguments and may also be a mental act used to modify a mental state. The arguments can be entities introduced in the precondition, the role entity, the mask reference entity or the character itself.

Each tendency rule is associated with the rule *strength* which reflects the significance of the rule for the reference entity and is represented by a value between -1 and 1. A negative value implies that the behavior is discouraged, whereas a positive value spells encouragement.

This mechanism is made flexible by the possibility of using the body of a rule as a precondition to another rule, thus allowing to model the expected social reactions to an action. For example, we can have *rule_1 - citizen :* {*true* → *steal(object)* } *: -0.5*, that formalizes that stealing is always morally wrong for this mask. Then we can add *rule_2 - policeman :* {*(believe(rule_1(X))* → *arrest(X)*} *: 0.8*, to dictate that a cop will have the strong duty of arresting the thieves. Another possibility is to set a precondition about any action with a strength less or greater than a fixed value. For example any action by a certain role that has a strength $<$ -0.5 will be considered very immoral and thus cause a standard negative response.

It is also important to notice that a character has usually access to the rules denoting the other roles, for example a thief will know that a cop is supposed to arrest him. This knowledge can be effectively used for a wiser selection among plans that involve other people, as it will be shown in Section 5.

4 The Mask Layers

An important feature of this approach is that the character tendencies are controlled by three overlapping mask layers (see the example in Figure 2):

- self-perception layer,
- social layer,
- inter-personal layer.

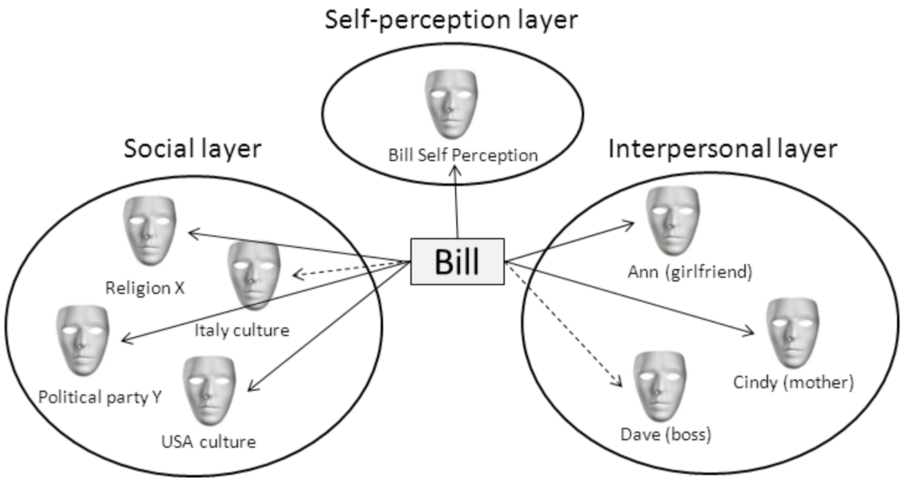

Fig. 2. A example of mask layers. Solid arrows represent the permanent links, dashed arrows temporary links. From the latter we can see that Bill is in the sphere of influence of Italy and his boss. Role and influence were omitted to simplify the picture.

The *self-perception layer* consists of a single mask that represents the idea that a character has about himself. It is useful to modulate the deepest trends of a character and is also needed to model elusive concepts as self-deception. In a real implementation it is neither needed nor advisable to create a mask for each character, but it is suggested to build a mask at least for a handful of major characters or opinion leaders of the simulated world. For the minor characters it is much easier to use a neutral mask and let their behavior be controlled by other masks.

The *social layer* is made up of all the masks related to the macro-social aspects. The masks of this level represent both the values of a person and his respect for the rules of the social environment. In the first case, the masks are always active, or at least as long as such values are alive: it is the case of the faith in a religion or the loyalty to a certain group. In the second case, the masks will be activated only when the character enters the sphere of influence of the reference entity.

The *inter-personal layer* collects all those masks that have as reference entity another character. As for the *social layer*, they may be always active or get activated only in the presence of this particular character. The first case models the behavior of a person so strongly influenced by a second character that he acts according to that persons values and expectations. For example, a widower may continue to act as his wife wanted him to do, as a tribute to her memory. Or a soldier could be so influenced by his commander to pattern his behavior after him. In the second case a mask is activated by the presence of a person and the mechanism is the same as the one described for the environment.

5 Solving Conflicts and Selecting an Action

In many multi-agent systems, an agent selects a goal to pursue and consequently applies the plans necessary to achieve it. However, this does not sit well with the human way of thinking. Often the actions needed to achieve a goal are as important as the goal itself for a human being. So the focus must be shifted from the simple goal to more complex "goal-plan" pairs.

In the BDI architecture it is common to have different plans that can accomplish a goal and the criterion for choosing them is usually left to individual implementations. For example, if the goal is "obtain 100 gold coins" we can do that by finding a job, by stealing, by asking a friend for them. Any of the plans may have different sub-goals and sub-plans from which to choose. In our approach the agent should look at the different paths leading to a goal to find and execute the one which has the greatest *likelihood* for it in a certain social context. Of course, the very same technique can be used also for basic agents who select only atomic actions.

This requires the evaluation of both rational and emotional/ethical aspects. In fact a mask can either recommend or discourage a certain action regardless of the goal. This can lead to irrational behaviors: this kind of NPC can perform acts against his own interest and purposes, for sentimental, ideological or religious reasons. In addition, different masks could be in contradiction with each other: for example, love may encourage actions in conflict with religion or political ideology.

The likelihood of an action is calculated by combining the *weight of the pros and cons* and the *weight of the perceived moral soundness* of the action.

The *weight of pros and cons* is obtained by estimating the total gain achieved by the character because of an action. By gain we mean any improvement to the character condition. This can be attained in many ways, for example by reaching a previously established goal, or by improving his or her health or by increasing the level of intimacy with another character. These considerations must be translated into a value between -1 and 1. The estimate gain of an action will be negative if such an action has a probability to damage the character. However we should take into consideration two types of gain, a direct one and an ensuing one. The first include the immediate benefits or harms obtained through an action. The second are the benefits or damages resulting from the actions that can be set in motion by the tendency rules which suggest a reaction to the original behavior.

To compute the ensuing gain we need to introduce the concept of visibility, probability and estimation of the success of an action. Any action performed in the world may be visible to some entity while remaining concealed to others. Therefore, before selecting an action, the character needs to estimate its possible spectrum of visibility. This value can be expressed as a percentage that reflects the probability for a certain action to be discovered by an involved role. It is worth noting that the estimation of visibility can be made only on the basis of what the character actually knows. In fact the character may think that his or her actions have no visibility whereas it is not so. The other factors to be taken into consideration are the probability of the ensuing actions and their estimation of success: for example, a thief should estimate the probability that a policeman may decide to arrest him after learning of the violation and the probability that he will be successful in doing this.

Combining this factors we obtain a value that we call *ego* esteem E:

$$\mathsf{E} = \alpha \mathsf{g} + (1 - \alpha) \sum_{i=1}^{n} \mathsf{v}_i \mathsf{p}_i \mathsf{s}_i \mathsf{g}_i \tag{1}$$

where g is the direct gain; v_i, p_i, s_i are respectively the visibility of the initial action, the probability and the estimation of success of the ensuing action; g_i is the ensuing gain for the i-th rule (with i ranging from zero to the maximum number n of rules activated by the initial action). In the absence of other pieces of information, the probability of the ensuing action can be derived from the strength of the tendency rule. The parameter α is a measure of the character impulsivity and varies from 0 to 1. A character with a high α will dive into an action without thinking too hard about the consequences, whereas a character with a low α will consider carefully all its possible outcomes.

The *weight of the perceived moral soundness* of the action depends both on the influence of the relevant masks and on the strength of the tendency rules associated with the action for each mask. The summation of the products of these two values associated with every involved rule gives the weight of the perceived moral soundness of an action, which we call super-ego esteem S:

$$\mathsf{S} = \sum_{i=1}^{n} \mathsf{r}_i \mathsf{m}_i \tag{2}$$

where r_i is the strength of the i-th rule (with i ranging from zero to the maximum number n of rules activated by the initial action) and m_i is the influence of the relative mask.

If a character is strongly influenced by a mask, even a relatively low strength rule will be followed. Conversely, if a character is only slightly affected by a mask, he or she will tend to follow only the most important rules associated with it, or even disregard them at all. Therefore S will be positive if the action is encouraged and negative if it is discouraged.

In some cases the masks may end up in conflict with each other. For example a cop may fall in love with Bonnie, a thief. The mask which has as reference entity "the culture of city X" will push him to arrest all those who steal, whereas the mask relative to the reference entity "Bonnie" will refrain him from taking that very same action against his loved one.

Finally the likelihood of an action L is estimated by combining E and S.

$$\mathsf{L} = \beta \mathsf{E} + \gamma \mathsf{S} \tag{3}$$

where β and γ, varying between 0 and 1, represent respectively the character rationality (in a selfish sense) and morality. A character with a high β and a low γ will tend to act in a rational way to pursue a personal advantage, even disregarding his moral and his ideals. A character with a high γ and a low β will be idealistic and will be ready to behave irrationally and even to sacrifice himself for his values or his emotions.

The resulting L value is used to trigger the selection between concurrent actions. The mechanism for the selection of a "goal-plan" pair based on the L value computed for each action may change according to the agent's architecture and implementation. However we suggest to select the "goal-plan" pair for which the sum of L values is maximum.

6 Example of Implemented Scenario

The Mask Model has been implemented in a simple text-based prototype in java. As an example in the following we will show how a simple scenario can have many outcomes by changing only the environment and the mask links.

Let us consider three character: Ann, Bill and Cedric. Ann, while being engaged with Bill, has also an affair with Cedric. We created three masks: "Athens culture", "Sparta culture" and a generic "Romantic Relationship" mask.

The first two masks describe some social rules of a very pacific culture and those of a more aggressive one. The former contains rules that in case of hostility suggest to talk and discourage to fight. The latter has an opposite philosophy. They both have the special role "is_here" that denotes the temporary link that is created when a character enter in their sphere of influence. The romantic relationship mask (from now on RR) encourages actions like giving a present or a kiss and discourage actions like betraying or harming the other person. Furthermore as self-perception mask we used a neutral mask for every character, in order to see more clearly the effect of the other masks.

With such a minimal initial set we already have 1331 possible link configurations (assuming that no one will have a cultural background including both Athens and Sparta) and two possible spheres of influence on our environment: thus 2662 possibilities that may, at least theoretically, lead to different storylines.

The initial situation is that Bill discover Ann and Cedric kissing, and from this seed many different things can follow. We ran different simulations by changing the links and the environment.

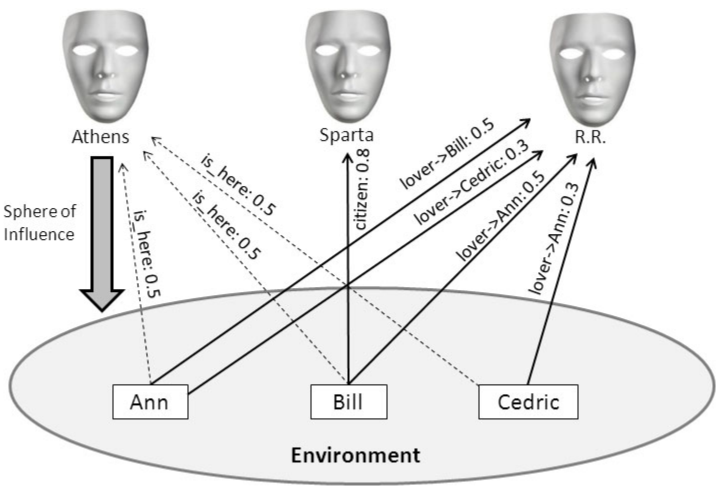

Fig. 3. A possible configuration of the example scenario. Solid arrows represent the normal links, dashed arrows temporary links. Here the environment is subject to "Athens culture" sphere of influence.

The input data are the environment and a set of links that dictate the tendency and attitude of the characters like: *Environment: Sparta; Bill is lover→Ann : 0.5 ⇒ R.R. ; Cedric is lover→Ann : 0.3 ⇒ R.R. ; Ann is lover→Bill : 0.5 ⇒ R.R. ; Ann is lover→Cedric : 0.3 ⇒ R.R.* For the sake of the example we made every role and mask "public", that is every character knows the other character masks. In a realistic scenario a character have to infer this information, for example, from the other characters outlook or behavior.

The output is a sequence of actions like:

"*Ann and Cedric are kissing, Bill sees that Ann and Cedric are kissing, Bill is hostile to Ann, Bill is hostile to Cedric, Bill attacks Cedric, Cedric dies, Bill tells Ann 'Go away', Ann cries.* "

In this situation the environment lies in the sphere of influence of the Sparta culture, thus Bill has no problem in physically attacking Cedric, but at the same time the mask that represents his love for Ann prevents him to hurt her. If we just change the environment to Athens the outcome will be different:

"[first steps are the same], *Bill is hostile to Cedric, Cedric tells Bill 'I am sorry', Bill tells Cedric 'Go away', Cedric goes away, Bill tells Ann 'Go away', Ann tells Bill 'I am sorry'.* "

In the previous cases Ann, Bill and Cedric had no cultural background themselves, therefore they adapt their behavior to the environment. But what will happen if we add "Bill is citizen : 0.8 ⇒ Sparta", making Bill a devout spartan? This is the situation show by Figure 3.

"[first steps are the same], *Bill is hostile to Cedric, Cedric escape, Bill tells Ann 'Go away', Ann tells Bill 'I am sorry'.* " We can see that here Cedric does not even try to argue, but he escapes immediately. The reason is the "social expectation" reasoning: Cedric knows that Bill is a spartan and knows that spartans do not hesitate to take revenge for a betrayal in a violent way and since he is under the Athen influence he decides to avoid the battle.

We can also change some quantitative value, like reinforcing the link from Ann to the R.R. mask for the "lover→Bill" role bringing it up to 1, thus making Ann desperately in love with Bill. Furthermore we hide roles and masks to prevent Cedric to predict the actions of the rival.

"[first steps are the same], *Bill is hostile to Cedric, Cedric tells Bill 'I am sorry', Bill attacks Cedric, Ann defends Cedric, Ann dies, Cedric cries, Bill cries, Cedric is furious with Bill, Cedric attacks Bill, Cedric dies.* "

We can thus see how simply changing the link and their strength encourages every time a different behavior, yielding a lot of different stories and situations.

7 Conclusion

In the previous sections we presented the Mask Model and discussed how it aims at simulating complex social behaviors. The combinatory explosion, the nightmare of many storytelling systems, may here be used as an ally, to build dramatic situations and articulate behaviors by combining in different way masks, roles and influence values. If the domain masks are well built, the behaviors will turn out deep and realistic.

In my opinion, the strong points of this method may be found in:

– a wide variety of simulated behaviors,
– the "social expectations" included in the masks can be used by a character to create more realistic plans,
– the ability to easily create flat characters by combining masks together.

The third goal is achieved by defining a set of typical masks to generate a large number of stereotyped characters. For example, it is possible to generate a crowd of believers in religion X, or a sect that follows the political ideal Y. It may be useful to introduce some small random differences between these characters, but, thanks to the masks, the unity of purpose will be maintained. In the same way a combination of masks can be used to generate characters with certain characteristics.

The main limit of this approach is that it needs a preparatory work on the domain to create the masks and set up the initial links. This work may be not trivial, thus it is necessary to weigh carefully costs and benefits. Especially for very limited story world the Mask Model may be a overkill.

As far as future developments, we are working on finding the best strategy to generate and maintain the links between character and masks and on being able to foresee, at least partially, their impact on the story world. The final cost of the Mask Model will depend on how efficiently it will be possible to do this.

We plan to implement a system which aims at creating interactive stories by exploiting the Mask Model. The NPC will be allotted some degrees of freedom and the author's goals will be satisfied by a drama manager acting on the masks, the links and the environment.

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Perceived or Not Perceived: Film Character Models for Expressive NLG

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Abstract. This paper presents a method for learning models of character linguistic style from a corpus of film dialogues and tests the method in a perceptual experiment. We apply our method in the context of SpyFeet, a prototype role playing game. In previous work, we used the PERSONAGE engine to produce restaurant recommendations that varied according to the speaker's personality. Here we show for the first time that: (1) our expressive generation engine can operate on content from the story structures of an RPG; (2) PERSONAGE parameter models can be learned from film dialogue; (3) PERSONAGE rule-based models for extraversion and neuroticism are be perceived as intended in a new domain (SpyFeet character utterances); and (4) that the parameter models learned from film dialogue are generally perceived as being similar to the character that the model is based on. This is the first step of our long term goal to create off-the-shelf tools to support authors in the creation of interesting dramatic characters and dialogue partners, for a broad range of types of interactive stories and role playing games.

Keywords: Story dialog, statistical natural language generation, character design.

1 Introduction

Stories are told through plot structure and narrative, but also critically through dialogue — what a character says, how he says it, and how he reacts to what other characters say. It is widely agreed that progress in interactive story and narrative systems is being hampered by the current approach to dialogue creation, which relies on an individual practitioner's expertise in the creative writing of dialog, often written and rewritten many times [8,16,15]. This places a hard limit on the underlying system states that can be expressed [25]. Moreover, the problem is exacerbated when authoring stories that the user is intended to experience many times, with different story trajectories depending on the user's choices and history. It has been suggested that natural language generation techniques promise to overcome the dialogue authoring bottleneck for interactive stories and games [25], but surprisingly little work has been done on language generation for story dialogue, as opposed to generating narrative descriptions [2,20,3,4,1].

Writers commonly identify two primary challenges in dialogue writing [22]. One is the challenge of revealing subtext. Good dialogue does not explicitly state character

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personality (e.g., *I am a friendly person*), character emotional state (e.g., *I'm feeling hesitant*), or character motivation (e.g., *I intend to flatter you*). Rather, the most important message in most good dialogue appears as subtext, either dramatized or established indirectly by what characters actually say. The second challenge is determining how characters say what they actually say, often referred to as ”finding the voice” of each character. Professional writers have developed a number of practices — such as eavesdropping in public, tape recording themselves acting the part, or creating meticulously researched character backgrounds — to help them find character voices.

This paper tests an approach to automatically creating “character voices” based on a corpus-based statistical expressive language generation engine that is trained on the IMSDb corpus of film screen plays [11]. These automatically created character voices are also intended to reveal subtext about character personality and emotion. Our method consists of three components: (1) learning models of character linguistic style from film dialogue screen plays, e.g. the dialogue in Figure 1 from Quentin Tarantino's *Pulp Fiction*; (2) using the learned models to control the parameters of PERSONAGE, an expressive language generation engine [12]; and (3) experiments on human perceptions of the character utterances created using these models. We test our approach in the context of our prototype role playing game SpyFeet [18,19], a game intended to support dynamic quest selection and dialogue generation, determined by user choices and user relationships with game characters [21].

We believe this sort of corpus-based approach is a much stronger first step than, for example, asking authors to directly tune the parameters of a natural language generation engine. The expertise required to understand the parameters involved, and their interactions, is far removed from the expertise of creative writing — while authors are quite accustomed to presenting character voices through examples, or describing a character's voice as similar to another's (or a blend of familiar voices). Further, being able to explore a landscape of utterances produced through examples could also prove a powerful tool for novice (or even expert) authors who are considering possibilities for character voices. Our initial results, described here, demonstrate that an approach of this sort can produce significant and recognizable variations in linguistic style, even using corpora as small as the utterances of a single character in a screenplay.

Section 2 explains how we use a corpus of film screen plays to learn models of the linguistic style of film characters. Section 3 presents our experimental design, where we first establish human perceptions of the personality of film characters, and then test perceptions of the personality of utterances generated using both learned character models and Big Five personality models. Section 4 presents our experimental results. In previous work, we used the PERSONAGE engine to produce restaurant recommendations that varied according to the speaker's personality, where personality was defined using the Big Five theory of personality [14,12]. Here we show for the first time that: (1) our expressive generation engine can operate on content from the story structures of an RPG; (2) PERSONAGE parameter models can be learned from film dialogue; (3) PERSONAGE rule-based models for extraversion and neuroticism are perceived as intended in a new domain (SpyFeet character utterances); and (4) the parameter models learned from film dialogue are generally perceived as being similar to the modelled character.

SCENE: JACKRABBIT SLIM'S, AFTER FOOD HAS ARRIVED

VINCENT: What do you think about what happened to Antwan?
MIA: Who's Antwan?
VINCENT: Tony Rocky Horror.
MIA: He fell out of a window.
VINCENT: That's one way to say it. Another way is, he was thrown out. Another was is, he was thrown out by Marsellus. And even another way is, he was thrown out of a window by Marsellus because of you.
MIA: Is that a fact?
VINCENT: No it's not, it's just what I heard.
MIA: Who told you this?
VINCENT: They.

Mia and Vincent smile.

MIA: They talk a lot, don't they?
VINCENT: They certainly do.
MIA: Well don't be shy Vincent, what exactly did they say?

Vincent is slow to answer.

MIA: Let me help you Bashful, did it involve the F-word?
VINCENT: No. They just said Rocky Horror gave you a foot massage.
MIA: And...?
VINCENT: No and, that's it.
MIA: You heard Marsellus threw Rocky Horror out of a four-story window because he massaged my feet?
VINCENT: Yeah.
MIA: And you believed that?
VINCENT: At the time I was told, it seemed reasonable.
MIA: Marsellus throwing Tony out of a four story window for giving me a foot massage seemed reasonable?
VINCENT: No, it seemed excessive. But that doesn't mean it didn't happen. I heard Marsellus is very protective of you.
MIA: A husband being protective of his wife is one thing. A husband almost killing another man for touching his wife's feet is something else.
VINCENT: But did it happen?
MIA: The only thing Antwan ever touched of mine was my hand, when he shook it. I met Anwan once at my wedding then never again. The truth is, nobody knows why Marsellus tossed Tony Rocky Horror out of that window except Marsellus and Tony Rocky Horror. But when you scamps get together, you're worse than a sewing circle.

Fig. 1. Scene from *Pulp Fiction*

2 Learning Character Models

Procedurally generating interesting dialogue requires a large number of parameters for manipulating linguistic behavior. Our general idea is to develop corpus-based statistical models of character linguistic style by counting linguistic reflexes (features) in film dialogue, and then use these models to control the parameters of the PERSONAGE generator [14,12]. For concreteness, the PERSONAGE parameters that we wish to control with our character models are shown in Table 1. More detail is available about how PERSONAGE works elsewhere [14,12].

Corpus and Features. Our corpus consists of 862 film scripts from the IMSDb website, representing 7400 characters, with a total of 664000 lines of dialogue and 9599000 word tokens. Our snapshot of IMSDb is from May 19, 2010. We use the IMDB ontology to define groupings of character types according to the following attributes: GENRE, DIRECTOR, and YEAR. Note that most films belong to multiple genres. For example, *Pulp Fiction* belongs to crime, drama, and thriller. This allows for characters to be grouped in multiple categories. We hand-annotated CHARACTER GENDER because we thought that gender might affect linguistic style [9].

The linguistic reflexes (features) that we count in the screenplays are based on previous studies of features useful as indicators of a person's personality, gender or social

Table 1. PERSONAGE's generation parameters

Parameter	Description
Content Planning	
VERBOSITY	Control the number of propositions in the utterance
REPETITIONS	Repeat an existing proposition
CONTENT POLARITY	Control the polarity of the propositions expressed, i.e., referring to negative or positive facts
REPETITIONS POLARITY	Control the polarity of the restated propositions
CONCESSIONS	Emphasize one attribute over another
CONCESSIONS POLARITY	Determine whether positive or negative attributes are emphasized
POLARIZATION	Control whether the expressed polarity is neutral or extreme
POSITIVE CONTENT FIRST	Determine whether positive propositions — including the claim — are uttered first
INITIAL REJECTION	Begin the utterance with a mild rejection
Syntactic Template Selection	
SELF-REFERENCES	Control the number of first person pronouns
SYNTACTIC COMPLEXITY	Control the syntactic complexity (syntactic embedding)
TEMPLATE POLARITY	Control the connotation of the claim, i.e., whether positive or negative affect is expressed
Aggregation Operations	
PERIOD	Leave two propositions in their own sentences
RELATIVE CLAUSE	Aggregate propositions with a relative clause
WITH CUE WORD	Aggregate propositions using "with"
CONJUNCTION	Join two propositions using a conjunction, or a comma if more than two propositions
MERGE	Merge the subject and verb of two propositions
ALSO CUE WORD	Join two propositions using "also"
CONTRAST-CUE WORD	Contrast two propositions using "while", "but", "however", "on the other hand"
JUSTIFY-CUE WORD	Justify a proposition using "because", "since", "so"
CONCEDE-CUE WORD	Concede a proposition using "although", "even if", "but/though"
MERGE WITH COMMA	Restate a proposition by repeating only the object
Pragmatic Markers	
STUTTERING	Duplicate the first letters of a restaurant's name
PRONOMINALIZATION	Replace occurrences of the restaurant's name by pronouns
NEGATION	Negate a verb by replacing its modifier by its antonym
SOFTENER HEDGES	Insert syntactic elements to mitigate the strength of a proposition
EMPHASIZER HEDGES	Insert syntactic elements to strengthen a proposition
ACKNOWLEDGEMENTS	Insert an initial back-channel
FILLED PAUSES	Insert syntactic elements expressing hesitancy
EXCLAMATION	Insert an exclamation mark
EXPLETIVES	Insert a swear word
NEAR EXPLETIVES	Insert a near-swear word
TAG QUESTION	Insert a tag question
IN-GROUP MARKER	Refer to the hearer as a member of the same social group
Lexical Choice	
LEXICON FREQUENCY	Control the average frequency of use of each content word, according to BNC frequency counts
LEXICON WORD LENGTH	Control the average number of letters of each content word
VERB STRENGTH	Control the strength of the verbs

class [13,6,17,9]. Table 2 enumerates our feature sets. For most features, there is a particular parameter in PERSONAGE (in Table 1) whose parameter value should be affected by that feature's presence or absence in a character's dialogic utterances. The **Basic** features capture aspects of style such as how much a character talks and how many words they use (the VERBOSITY parameter). The **Dialogue Act** features are based on a dialogue act tagger trained on the NPS Chat Corpus 1.0 [5]. The **First Dialogue Act** is the Dialogue Act of the first sentence of each turn. Several dialogue act features indicate the use of the parameters INITIAL REJECTION or ACKNOWLEDGMENT. Others we do not currently utilize. **Pragmatic Markers** include both categories of pragmatic markers and individual word count/ratio. Pragmatic marker features indicate which aggregation

Table 2. Feature Sets ordered by PERSONAGE modules

Feature	Description (Label)
Basic	number of sentences (NumSents), sentences per turn (NumSentsPerTurn), number of verbs (NumVB), number of verbs per sentence (VBPerSents)
Polarity	overall polarity (polarity-overall), polarity of sentences (polarity-sents)
Dialogue Act (DA)	Accept, Bye, Clarify, Continuer, Emotion, Emphasis, Greet, No-Answer, Reject, Statement, Wh-Question, Yes-Answer, Yes-No-Question, Other
First DA	Same as DA but only look at first sentence of each turn
Merge Ratio	merging of subject and verb of two propositions (merge-ratio)
Passive Sentence Ratio	passive sentence count (passive-ratio)
Concession polarity	polarity for concessions (concess-polarity)
LIWC Word Categories	Each prefixed as LIWC-
Pragmatic Markers	wc-taboo, wc-seq, wc-opinion, wc-aggregation, wc-softeners, wc-emphatics, wc-ack, wc-pauses, wc-concession, wc-concede, wc-justify, wc-contrast, wc-conjunction, wc-ingroup, wc-near_swear, wc-relative
Tag Question Ratio	tag question ratio (tag-ratio)
Word Length	average content word length (avg-content-wlen)
Verb Strength	average sentiment values of verbs (verb-strength)

operations to use such as JUSTIFY-CUE WORD (See Table 1) or which pragmatic markers to insert, such as EMPHASIZERS or SOFTENER HEDGES. The **Merge Ratio** uses a grammar operating on part of speech labels that looks for verb+noun+conjunction+noun. The **Passive Sentence Ratio** uses scripts from http://code.google.com/p/narorumo, under source/browse/trunk/passive to detect passive sentences. These scripts implement the rule that if a to-be verb is followed by a non-gerund, the sentence is probably in passive voice. The **Concession Polarity** feature is based on finding the polarity for the concession in a sentence if it exists, using the Polarity feature set. The **LIWC** tool provides a lexical hierarchy that counts the use of different types of words, including cue-words, emotion words, and pronouns *inter alia*. These map to both aggregation operations and pragmatic markers. The **Tag Question Ratio** is also based on a set of regular expressions. The features **Word Length** and **Verb Strength** control the lexical choice parameters. **Word Length** first uses WordNet tags to find content words (noun, adjective, adverb, and verb), and then takes the mean of their length in characters. **Verb Strength** is the mean sentiment scores of all verbs. Lexical frequency is approximated from combining the features LIWC-6LTR and word length.

Method. Fig. 2 shows the flow of our experiment. In sum, our method is:

1. Collect movie scripts from The Internet Movie Script Database (IMSDb).
2. Parse each movie script to extract dialogic utterances, producing an output file containing utterances of exactly one character of each movie (e.g., *pulp-fiction-vincent.txt* has all of the lines of the character Vincent).
3. Select characters from those with more than 60 turns of dialogue.
4. Extract features representing the linguistic behaviors of each character.
5. Learn models of character linguistic styles based on the features.
6. Use character models to control parameters of the PERSONAGE generator.
7. Evaluate human perceptions of dialogic utterances generated using the character models.

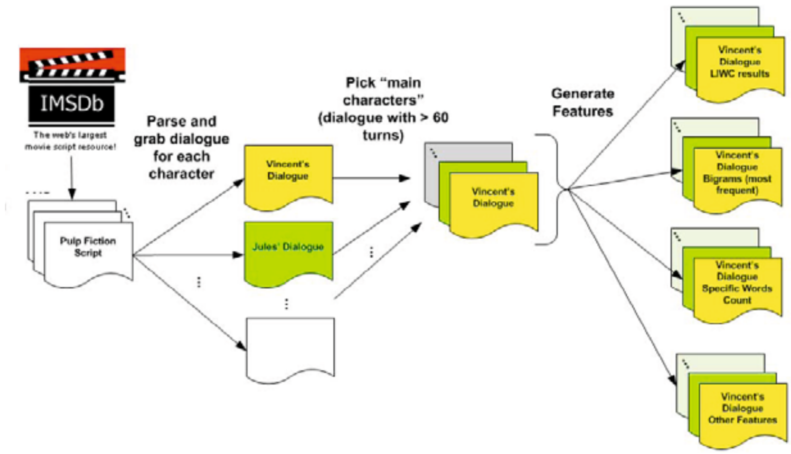

Fig. 2. Method

Character Models. Sample character models derived from the procedure above are provided in Table 3. Each model parameter in the left-hand side of Table 3 was described in Table 1. Table 4 illustrates the result of applying these models of character to SpyFeet utterances, and shows some of the variation that we are currently able to produce. For example, the Annie Hall characters, Alvy and Anny, have significant Z-scores(2.12 and 3.28 respectively) for the tag question ratio feature. The tag question ratio represents the placement of phrases like *you know?* and *would you be?* at the end of sentences. The feature value maps to a value of 1.0 for the PERSONAGE tag question insertion parameter, causing utterances generated using the Annie or Alvy character models to include the use of tag questions. The Annie and Alvy models also lead to significant z-scores for the LIWC-WC feature. LIWC-WC is is the word count for a character and maps to the verbosity parameter in PERSONAGE. The significant z-score value for LIWC-WC causes an increase in the verbosity parameter for the Alvy and Annie models, and as a result, utterances generated using these models have more words than those from models with lower verbosity values such as Vincent or Indy.

There are many different ways we could learn such models [10,23,24]. Here, we estimate models using vectors of features representing individual characters, and then derive distinctive features for that character by normalizing the feature counts against a representative population. For each feature x_i, the normalized value z_i is calculated as:

$$\frac{x_i - \overline{x_i}}{\sigma_{xi}} \tag{1}$$

There is a choice about the population of characters used for the normalization, i.e. which set of characters are used to calculate the mean $\overline{x_i}$ and the standard deviation σ_{xi}. For example, for a female character, obvious choices include all the characters, all the female characters, or all the female action characters. Here we normalize individual characters against all of the characters of the same gender. Any z-score greater than 1 or less than -1 is more than one standard deviation away from the mean. Z-scores greater

Table 3. Sample Learned Character Models

Parameter	Alvy	Annie	Indy	Marion	Mia	Vincent
Content Planning						
Verbosity	.79	.78	.36	.65	.49	.18
Repetitions	.38	0	0	0	.28	.51
Content Polarity	.09	.77	.15	.15	.15	.50
Polarization	.39	.72	.22	. 21	.22	.57
Repetitions Polarity	.54	.79	.29	.29	.29	.64
Concessions	.83	.83	.83	.89	.89	.58
Concessions Polarity	.56	.26	.56	.26	.26	.49
Positive Content First	0	1.00	0	0	0	1.00
Initial Rejection	0	0	0	0	0	0
Syntactic Template Selection						
Use of First Person in Claim	.39	.6	.39	.39	.39	.54
Claim Polarity	.57	.57	.57	.49	.56	.50
Claim Complexity	.71	.31	.47	.15	.56	.56
Aggregation Operations						
Period	.05	.04	.24	.04	.24	0
Relative Clause	0	0	.95	.97	.53	.3
With cue word	.44	.51	.05	.34	.31	.25
Conjunction	.30	.21	.22	.18	.08	0
Merge	.61	.87	.83	.65	.59	.77
Also cue Word	.12	.05	.05	.05	.07	.05
Contrast-Cue word	.76	.85	0	.84	.76	.96
Justify-Cue Word	.97	.48	0	.61	.61	.45
Concede-Cue Word	1.00	0	0	1.00	0	.25
Merge With Comma	.27	.42	.5	.5	.32	.5
Pragmatic Markers						
Stuttering	.54	.54	.04	.04	.54	.09
Pronominalization	1.00	1.00	1.00	.75	.5	1.00
Negation	0	0	0	0	0	0
Softener Hedges	1.00	1.00	0	1.00	0	0
Emphasizer hedges	0	1. 0	0	0	1.00	0
Acknowledgements	1.00	1.00	0	0	1.00	0
Filled Pauses	1.00	1.00	0	0	0	0
Exclamation	0	0	0	1.00	0	1.00
Expletives	0	0	0	0	0	1.00
Near Expletives	0	0	0	0	0	0
Tag Question	1.00	1.00	0	0	1.00	0
In-Group Marker	0	0	0	1.00	0	0
Lexical Choice						
Lexicon Frequency	.19	.19	.28	.19	.55	.18
Lexicon Word Length	.21	.13	.21	.13	.78	.28
Verb Strength	.59	.59	.5	.61	.5	.49

and less than +-1.96 indicate significant differences of the use of that linguistic feature by that character compared to other characters. However for experimental purposes we map any z-score greater than 1 or less than -1 into one or more PERSONAGE generation parameters. There are three different ways in which our mappings of feature counts to parameters could be incomplete: (1) We have a parameter in PERSONAGE but none of the features we count are good indicators that we should use it (e.g., Competence Mitigation); (2) We have a feature we count but no parameter to map it to (e.g., LIWC-Discrep); or (3) There is some aspect of linguistic style that is essential to expressing a particular character's style, but we currently do not have a feature that indicates when a character has that style, nor do we have any existing parameter that could manifest that linguistic reflex.

Table 4. Utterances for SpyFeet generated using Film Character Models

Film	**Character**	**Generated Utterances**
Annie Hall	**Alvy**	I don't know. People say Cartmill is st-strange, alright? Err... on the other hand, I don't rush to judgment. Right, I am not sure, would you be? I will tell something you because you br-brought me cabbage. Oh I am not sure. Wolf wears a hard shell. On the other hand, he is ge-ge-gentle, isn't he? I see, I don't know. I respect Wolf, wouldn't you? He, however, isn't my close friend. Yeah, I don't know. Sparrow conveys excitement to my life, so I am fr-fr-friends with her.
Indiana Jones	**Indy**	I don't rush to judgment, but people say Cartmill is strange. I will tell something you since you brought me cabbage. Wolf is gentle but he wears a hard shell. Wolf isn't my close friend. But I respect him. I am friends with Sparrow since she brings excitement to my life.
Annie Hall	**Annie**	Come on, I don't know, do you? People say Cartmill is strange while I don't rush to um.. judgment. I don't know. I think that you brought me cabbage, so I will tell something to you, alright? Yeah, I am not sure, would you be? Wolf wears a hard shell but he is really gentle. I see, I am not sure. Obviously, I respect Wolf. However, he isn't my close friend, is he? Come on, I am not sure. Because Sparrow brings excitement to my life, I am friends with her, you see?
Pulp Fiction	**Vincent**	Basically, I don't rush to judgment. On the other hand, people say Cartmill is strange, he is strange. Yeah, I can answer since you brought me cabbage that. Everybody knows that Wolf wears a hard shell. He, however, is gentle. I respect Wolf. However, he isn't my damn close friend. Oh God I am friends with Sparrow because she brings excitement to my life.

3 Experimental Setup

Our goal is to test the character models and mappings as described above. The simplest way to do this is to ask human participants to rate a set of utterances produced using different models in terms of similarity of linguistic style to the mimicked character. However our concern was that a single linguistic cue could act as a "give-away" for the intended character. For example, if the Annie character from Woody Allen's *Annie Hall* uses tag-questions (among other linguistic style differentiators), perhaps the use of tag-questions *alone* in a test utterance would cue a human participant that the test utterance was intended by the experimenters to mimic Annie, especially if the human participant was only asked to select between two different examples.

Therefore, we designed an experiment to first indirectly test the similarity in perceived personality of, e.g. the Annie character as written in the film, to the personality of utterances of SpyFeet characters produced using an Annie model of linguistic style. Our experimental method consists of three phases each intended to establish human perceptions of different aspects of utterances generated using character models. In **Phase I**, we select 3 scenes from each of the original films, illustrating the utterance styles of 6 characters (3 male and 3 female). We collect perceptions of the personality of those characters using the Ten Item Personality Inventory (TIPI) [7,12]. In **Phase II**, using the PERSONAGE generator, we generate dialogic utterances for the characters in the story of the SpyFeet RPG, using both (1) the film character model; and (2) six rule-based personality models from our previous work (high and low values for extraversion, neuroticism and agreeableness) [12]. We collect perceptions of the personality of SpyFeet characters whose linguistic style is controlled by these models (6 film character models and 6 personality models), again using the TIPI [7]. In **Phase III**, using all the utterances generated in Phase II, for each film character model, we generate a page showing the participant (1) the three scenes for each character (from Phase I); and (2) **all** of the generated utterances using all of the film character models and all of the rule-based personality models. Then we ask participants to judge on a scale of 1. . .7 how **similar** the generated utterance is to the style of the film character as illustrated in the three scenes. Participants are instructed to use the whole scale, and thus effectively **rank** the generated utterances for similarity to the film character. Each phase supports different analyses of the perceptions of SpyFeet characters. Using the data collected in Phase I, we establish participant perceptions of film characters on the Big Five personality traits of extraversion, neuroticism and agreeableness. Then using the data from Phases I and II, we examine the correlations between perceptions of the film character's original utterances (Annie, Alvy, Vincent, Mia, Indiana, Marion) and SpyFeet utterances that were generated using the learned models of the film character. Our **Hypotheses** are:

- H1: The rule-based models for personality expression (previously tested in the restaurant recommendation domain), will be perceived as expressing that personality in the SpyFeet story domain (Phase II).
- H2: Utterances generated using character models will be perceived as being more similar to that character than utterances generated using another randomly selected character model (Phase III).

4 Experimental Results

29 subjects (13 female and 16 male, ages ranging from 22 to 44) participated in a web-based experiment.

Phase I. We made no predictions about the results in Phase I. Our goal was to establish personality judgements for the six characters and test whether, in terms of Big Five traits, the characters are perceived as having distinctive personalities. Table 5 shows the mean values of the TIPI scale judgements for Big Five traits of Extraversion, Emotional Stability and Agreeableness for the six characters.

We combined the personality judgments for a character for all three Big Five traits into a single vector and computed paired t-tests (two-tailed) on these vectors to

Table 5. Big Five Personality Scores for Film Character Original Utterances

	Character					
Trait	Alvy	Annie	Indy	Marion	Mia	Vincent
Extraversion	2.8	4.4	4.2	5.5	4.8	4.6
Emotional Stability	2.0	2.5	5.0	3.8	4.4	4.1
Agreeableness	4.0	4.5	3.3	3.9	4.0	4.1

determine whether characters were perceived as having distinct personalities (within subjects). The results indicate that the personality of Alvy is perceived as being significantly different from all of the other characters (df = 90, $3.3 < t < 7.4$, $p < .001$). However Indy is only different from Alvy (df = 90, t = 4.8, $p < .0001$). Marion is only different from Alvy and Annie (df = 90, $3.3 < t < 7.4$, $p < .001$), Vincent is only different from Alvy and Annie (df = 90, $2.3 < t < 6.6$, $p < .02$), and Mia is only different from Alvy and Annie (df = 90, $3.1 < t < 7.4$, $p < .003$). These results suggest that the differences in perceived personality across different characters are small, with the Tarantino and Spielberg characters being perceived as having similar personalities. However as we show below in Phase III, there are distinctive differences in their linguistic styles that are perceivable. Our conclusion is that Big Five traits may be too coarse to effectively distinguish different film characters.

Phase II. Our prediction (Hypothesis H1) was that rule-based models for personality expression will be perceived as expressing that personality in the SpyFeet story domain. Our results for H1 are mixed. We tested whether utterances generated with high and low extraversion models, high and low agreeableness models and high and low emotional stability models are perceived as expressing those traits. A paired t-test comparing the extraversion ratings of high ($\overline{x}$ = 5.2) and low extraversion ($\overline{x}$ = 3.3) utterances showed significant differences (df = 28, t = 7.7, $p < .0001$), as did a paired t-test comparing the emotional stability ratings of high ($\overline{x}$ = 5.5) and low ($\overline{x}$ = 2.7) emotional stability utterances (df = 28, t = 10.8, $p < .0001$). However differences in high ($\overline{x}$ = 3.4) and low ($\overline{x}$ = 3.4) agreeableness were not perceived in the SpyFeet domain, when we used the agreeableness model that had previously been successful in the restaurant recommendation domain (df = 28, t = .72, p = .47 ns). There are several possible reasons for this: perhaps the limited set of utterances tested, as shown in Table 4, do not do a good job of showing the variability in agreeableness that the PERSONAGE generator is capable of, or perhaps manifesting agreeableness in the SpyFeet domain requires the addition of new parameters to PERSONAGE, or perhaps our mapping from features to parameters is either incomplete or faulty.

Phase III. Our prediction (Hypothesis H2) was that utterances generated using character models would be more similar to that character than utterances generated using another randomly selected character model. Table 6 shows the average similarity score judgments between utterances produced with a particular character model and the utterances of that character in the original film. For example Row 1 shows the judgments for the similarity of utterances generated with each character model to the utterances of the Alvy character in the original *Annie Hall* screen play. Similarity scores are scalar values from 1. . .7. The strongest possible result would be a diagonal matrix with 7's along the diagonal and 0's in all the other cells, i.e. a only utterances generated with a particular character's model would be judged as being at all similar to that character. In general, what we are looking for is a matrix with the highest values along the diagonal.

Table 6. Mean Similarity Scores between Characters and Character Models. Significant differences between the designated character and each other character are shown in **bold**.

Character	Alvy	Annie	Indy	Marion	Mia	Vincent
Alvy	5.2	**4.2**	**2.1**	**2.6**	**2.8**	**2.3**
Annie	4.2	4.3	**2.8**	**3.4**	3.9	**2.9**
Indy	**1.4**	**2.2**	4.5	**2.8**	**3.3**	**3.8**
Marion	**1.6**	**2.8**	3.7	3.1	**4.1**	**4.2**
Mia	**1.7**	**2.4**	4.3	3.2	3.6	4.3
Vincent	**2.1**	**3.2**	4.5	**3.5**	**3.6**	4.6

We conducted paired t-tests comparing the similarity scores of each other character model to the similarity scores for the matching model (e.g. we compared similarity scores for utterances generated using Alvy's model to utterances generated using Indy's model, collected in the context of the participant looking at the screenplay for *Indiana Jones*.).

For *Annie Hall*, utterances generated using the Alvy model (first row of Table 6) are significantly more similar to Alvy than utterances generated using any other model (df = 28, 3.16 $<$ t 8.35, p $<$.004). The utterances generated using the Annie model (first row of Table 6) are significantly more similar to Annie than utterances generated with the Indy (df = 28, t = 3.75, p $<$ .0008), Marion (df = 28, t = 2.08 , p $<$ .05), and Vincent (df = 28, t = 2.90 , p $<$ .007), but not different than utterances generated with the models for Alvy (df = 28, t = .09,ns), and Mia (df = 28, t = .85, ns).

For *Indiana Jones*, utterances generated using the Indy model (third row of Table 6) are significantly more similar to Indy than utterances generated using any other model (df = 28, 2.67 $<$ t $<$ 7.99, p $<$.01) Utterances generated using the Marion model (fourth row of Table 6) are also significantly more similar to Marion than utterances generated using Alvy (df = 28, t = 4.70 , p $<$ .0001), Mia (df = 28, t = 2.66 , p $<$ .013), or Vincent models (df = 28, t = 3.24, p $<$ .003), but not different than the Annie model (df = 28, t = .52 , p = .65 ns) or the Indy model (df = 28, t = 1.98, p $<$ .057).

For *Pulp Fiction*, utterances generated using the Mia model (fifth row of Table 6) are significantly more similar to Mia than utterances generated from the Alvy (df = 28, t = 6.72 , p $<$ .0001), and Annie (df = 28, t = 3.24 , p $<$ .003) models, but not different than those using models for Indy (df = 28, t = 1.67, p = .11 ns), Marion (df = 28, t = 1.06 , p = .30 ns), and Vincent (df = 28, t = 1.58 , p = .13 ns). The fact that the model for the Mia character was trained on the fewest number of utterances (she has only 81 lines in the film) could contribute to the lack of perceivable differences. Utterances generated using the Vincent model (sixth row of Table 6) are significantly more similar to Vincent than utterances generated using Alvy (df = 28, t = 6.59 , $p < .0001$), Annie (df = 28, t = 3.54, $p < .0014$), Marion (df = 28, t = 2.57, $p < .02$), and Mia models (df = 28, t = 2.25, $p < .03$), but not different than the Indy model (df = 28, t = .86 , p = .18 ns).

5 Discussion

If deeply interactive stories are to feature dialog, we must move beyond a model of pure hand authoring. As stories vary in terms of the events that take place, the characters that are present, the dynamic states of relationships between characters, and so on, we must be able to dynamically generate dialogue that reflects and drives the state of the fictional world while expressing character in a manner controllable by an author. But asking authors to, for example, specify the parameter settings for a complex natural language generation engine is at odds with the skillsets and approaches of most authors, whether experts or beginners.

In this paper we have demonstrated the first step toward an alternative approach: developing models of character linguistic style from examples, specifically using character utterances in film scripts. Our results are encouraging, showing that utterances generated in a different domain (that of an outdoor role-playing game) recognizably display important subtext for character personality as well as style that is more similar to the modeled character than to others (though, perhaps unsurprisingly, characters from the same genre or film are often more similar to each other than to others).

After this initial step, much work remains to be done. For example, just as a character's plot actions in an interactive story must be related to the current state of the world and actions of other characters, so must linguistic actions take place in context. Our current model does not represent anything about the relation between dialogic utterances across speakers. The importance of such relations can be seen in Figure 1, in which paraphrastic and echoic aspects of the dialogue actually seem to be an interesting part of Mia's linguistic style — as well as an indication of her character's current stance toward Vincent. This points to another important area for future work, as we explore how character linguistic style varies across situations in order to help communicate emotional dynamics to the audience.

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Representing Dramatic Features of Stories through an Ontological Model

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Abstract. In this paper we present a novel ontology-based model for the representation of the dramatic features of narrative media (video, text, audio, etc.), focused on the notions of the character's motivated actions. We describe the theoretical background, composed of narratological theories and rational agent theories, that support the proposed ontological formalization. We sketch the ontology and an encoding example.

1 Introduction

In this paper, we describe an ontology of the dramatic narration, called *Drammar*, designed and implemented for the CADMOS Project (Character-based Annotation of Dramatic Media ObjectS). The goal of the CADMOS project is to establish a formal framework and a software platform for the creation of annotated corpora of narrative media objects. The working hypothesis is that the construction of reliable resources of annotated media objects can contribute to the research in storytelling by prompting the empirical studies and triggering the automatic acquisition of rules for generation and analysis purposes. In this sense, the use of the ontological encoding, as a shared formal representation, limits the arbitrariness of the annotation and improves the interoperability of annotated resources.

In CADMOS, ontologies are employed to encode both the entities and the events featured in a story (characters, objects, places, actions, natural phenomena, etc.), and the basic principles of the dramatic narration.

For encoding such principles, the ontology Drammar pivots on the notion of *motivated actions*, that is, the actions carried out by the characters in trying to achieve their goals. Actions are central in drama (from classical Greek "dran", to act), and their motivations, in terms of goals, moral values, and emotions, provide the basis for the characters' coherence on behalf of the audience.

The next section provides the theoretical background of Drammar, together with a description of the related work. The Section 3 sketches the structure of the ontology and illustrates an example. Conclusions end the paper.

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2 Theoretical Background and Related Work

The Drammar model builds upon three major knowledge backgrounds concerning, respectively, story models, rational agents and computational ontologies.

The notion of story is usually summarized as two orthogonal axes: *characters* and *plot* [19]. A story contains a series of incidents, made of characters' actions and unintentional, naturally occurring, events. *Drama*, as a "cultural object" developed along two millennia, is based upon the notion of action (drama as "imitation of praxis") [1], where *emotional characters* [7] engage in *conflicts* that necessarily arise from their deliberative processes [12]. So, actions are motivated by characters that are pursuing their goals. The most general and commonly acknowledged dramatic rule requires the actions to be deployed in such a way to put at stake values of increasing importance, until a climax of characters' struggling, after which conflicts tend towards a resolution [10]. For example, in *Romeo and Juliet*, the two lovers first must foul the parents to get secretly married; then, as the plot unrolls, they have to face homicide, exile and death.

In our ontology, in order to keep the annotation schema as much as possible of a descriptive nature and independent on specific accounts of the narrative structure, we did not include the knowledge about story models, such as Propp's functional roles [20], Egri's premises [8], or Polti's dramatic situations [18]. On the same line of research, there are the recent collections concerning genres and tropes (such as TV tropes[1]). The adoption of such approaches would bias the annotation toward empirical aspects; this will be possible on top of the core ontology we propose.

Character is a powerful instrument of identification, contributing to the emotional engagement of the audience [4] "in sympathy with the narrative character" [11]. The mechanism of identification [3] requires characters to exhibit both stability of behavior and dynamic changes (character as a general psychological and moral trait and as an individual person occupying a place in a narrative) [15]. So, while the plot forces the character to react to the events by adapting her/his behavior to the context, she/he must as well stick to her/his established long-term goals. For example, Romeo is confronted by his archenemy Tibaldo in one scene, but tends to avoid conflict because he does not forget the long term goal of being with Juliet. The mediation between the high–level stability of characters' behavior and the deployment of drama is achieved through organization of drama into a hierarchy of units. In Drammar, the annotation of characters' goals, values at stake, emotions and actions, are formally interconnected in a structural unit (*Unit* class).

The formal model employed in Drammar for the annotation of character's actions and motivations is the BDI (Belief, Desire, Intentions) model of rational agent [2,9]. In Drammar, the BDI model is augmented with emotions, and moral values: characters' feel emotions, associated with the achievement of their own goals and the appraisal of the actions of other characters and unintentional events

[1] `http://tvtropes.org`

(following [6,16]); characters' values are put at stake by others' actions or events, prompting the formation of new goals (see the model in [5]).

Finally, beside the inner consistency of characters' behavior, the notion of verisimilitude also requires the overall interplay of characters' actions to form a logical, believable sequential flow of facts. For the story to be consistent, the state of the world that holds after a certain unit must be consistent with the logical preconditions of what follows it in the narration, in order to account for the narratologists' claim that plot incidents must be causally connected to each other as a necessary condition for story construction [21]. The notion of horizontal development of the story is the *Dynamics* of the unit.

Given the background of narratology and AI studies sketched above, the instrument through which this knowledge is represented in CADMOS is given by the computational ontologies. This assumption is in line with other initiatives in multimedia annotation, especially in story–oriented media.

The EU-funded ANSWER project[2], aims at defining a formal language for script and scene annotation, with the goal of automatic pre-visualization. ANSWER does not address the narrative aspects, but rather the filmic language by which the narrative will be conveyed, and relies on the semantic layer provided by a Film Production ontology. This ontology constitutes the reference model for the Director notation, the input language for the pre-visualization services.

A media independent project is provided by the OntoMedia ontology [13], exploited across different projects (such as the Contextus Project [14]) to annotate the narrative content of different media objects, ranging from written literature to comics and tv fiction. The OntoMedia ontology mainly focuses on the representation of events and their organization into a timeline. In this sense, it lends itself to the comparison of cross-media versions of the same story, for example, a novel and its filmic adaptation, while it does not cover in a detailed way the role of the individual characters and the description of their behavior.

KIIDSOnto [17] is an ontology developed for the KIIDS (Knowledge-Intensive Interactive Digital Storytelling) system, that generates interactive stories with a case-based reasoning approach. KIIDSOnto incorporates Propp's model of tale [20] to deal with a repository of 49 Russian folk tales. KIIDSOnto is used to measure the semantic distance between different folk tales, considering the concept hierarchy and the heuristics of the system. Though it includes the notion of character, KIIDSOnto is limited to the mapping of the Proppian functions onto the story events and does not address the motivations that lead characters to perform certain actions.

The CADMOS project shares with these approaches the basic assumption that a media object can be segmented into meaningful units and, given some kind of formal description, the units can be accessed and navigated. However, it replaces the previous definition of units, respectively based on production (Answer), structuralist concepts (OntoMedia), or events (KIIDSOnto) with a character–based perspective.

[2] http://www.answer-project.org/

3 Drammar

The Drammar ontology has been designed for the annotation of the narratological features of units, i.e. segments of a dramatic narration, with the goal of building annotated corpora of audiovisual media objects. This resource can be used in many applicative scenarios such the retrieval, on a narrative base, of archive material, for the production of new videos and the acquisition of knowledge, in terms of dramatic rules, for use in analysis and generation of stories.

The top level of the presented ontology consists of four classes: `Entity`, `Dynamics`, `Unit` and `Relation`. `Entity` models the agents and objects of the dramatic narration. In particular, the agents' propositional attitudes, namely beliefs and deliberated goals, account for the participation of the character in the dramatic media objects.

The `Dynamics` of drama encompasses both the occurrence of incidents (actions and events) and their effects on the mental states of the characters. The `Incident` class models both the intentional actions performed by the characters and the naturally occurring events. Characters' motivations and emotional states are modeled by the `MentalState` class, further subdivided in `Belief`, `Goal`, `Emotion` and `Value`. Since all these properties are dynamic (i.e., Unit-dependent), they are not directly connected with the `Agent` class. Indeed, the connection between `Agent` and its properties is mediated by the `Relation` class.

`Unit` is the core of the annotation, since it models the partition of the story into logical segments. A unit is a chunk of the story that is motivated by (at least) one character's goal. Unit boundaries are defined by the achievement or failure of agents' goals. In the story progression, some units exhibit dramatic qualities: when a goal is in conflict with some other goal (either of the same character or of another agent) or with an event, it is defined a `DramaGoal`. If the unit encompasses a sequence of actions that show the dramatic qualities (such as the conflicting goals), it is defined as `DramaUnit` class.

The major subclass of `Relation` is `DramaRelationType`, that defines the relationships among agents and mental states in a specific Unit. This is needed because the relation between characters and mental states can vary from Unit to Unit. For example, in Romeo and Juliet (Act III, Scene 1), Romeo is fond of Tibaldo and later on he hates him because Tibaldo has killed Mercuzio. This information is modeled through the subclass `AgentInUnit` that permits to associate an instance of an `Agent` to a `Goal` and the unit in which the agent pursues the goal (`featuresGoal` property). Since goals are assumed to be achieved by action plans, the property `obtainedThrough` connects the `GoalOfAgentInUnit` class with the actions the agent performs.

As an example, consider the famous nunnery scene, in Hamlet, where Hamlet is confronted by Ophelia, while Claudius and Polonius observe them behind the curtains (already studied in [6]). Here, we describe only the first unit of the characters of the scene, where Hamlet and Ophelia meet, `DU1`. This `Unit` contains all the scene characters, through the `enactedBy` property.

```
<NamedIndividual rdf:about="&drammar;DU1">
  <drammar:enactedBy rdf:resource="&drammar;agentInUnit1Ophelia"/>
  <drammar:enactedBy rdf:resource="&drammar;agentInUnit1Hamlet"/>
```

The `Action` performed by Ophelia is to greet Hamlet (`greetingProcessSchema`):

```
<NamedIndividual rdf:about="&drammar;actionOpheliaDU.1">
  <rdf:type rdf:resource="&drammar;Action"/>
  <drammar:predicateIncident rdf:resource="&drammar;greetingProcessSchema"/> ...
```

Ophelia's goal is to meet Hamlet. This is a drama goal, since it is in conflict with Hamlet's goal, and it holds in Unit DU1 (an instance of `GoalOfAgentInUnit`). The predicate describing it (`predicatePropositionalAttitude`) is `meeting ProcessSchema`.

```
<NamedIndividual rdf:about="&drammar;goalOfAgentInUnitOpheliaDU1">
  <rdf:type rdf:resource="&drammar;goalOfAgentInUnit"/>
  <drammar:predicatePropositionalAttitude rdf:resource="&drammar;meetingProcessSchema"/> ...
```

This goal is linked to the agent by the featuresGoal property and conflicts with the goal that Hamlet holds in the same unit.

```
<drammar:featuresGoal rdf:resource="&drammar;dramaGoalOpheliaDU1"/>
<drammar:inConflictWith rdf:resource="&drammar;goalOfAgentInUnitHamletDU1"/>
```

Hamlet's goal in that scene is described by the predicate `avoidingProcess Schema`. The status of this goal is false, since it is not achieved in the unit: by the end of the unit, Hamlet fails to leave after Ophelia greets him.

Ophelia's goal originates from Ophelia's `belief` (`beliefOpheliaDU1`) that Polonius wants her to meet Hamlet (`goalPoloniusDU1`):

```
<NamedIndividual rdf:about="&drammar;beliefOpheliaDU1">
  <rdf:type rdf:resource="&drammar;Belief"/>
  <drammar:predicatePropositionalAttitude rdf:resource="&drammar:goalPoloniusDU1"/> ...
```

Since she owns the value of paternal authority, this belief puts such a value at stake, forcing her to assume the goal.

```
<NamedIndividual rdf:about="&drammar;OpheliaCharacterValue">
 <rdf:type rdf:resource="&drammar;CharacterValue"/>
 <drammar:valueContent rdf:resource="&drammar;valuePaternalAuthority"/> ...
```

Ophelia's emotional state is "hope" for the achievement of her goal:

```
<NamedIndividual rdf:about="&drammar;emotionOpheliaDU1">
  <rdf:type rdf:resource="&drammar;Emotion"/>
  <rdfs:label>emotionOpheliaDU1</rdfs:label>
  <drammar:emotionType>hope</drammar:emotionType>
  <drammar:cognitiveAppraisal rdf:resource="&dramamr;goalOpheliaDU1"/>
</NamedIndividual>
```

4 Conclusion

In this paper we presented a novel ontological model for representing dramatic features of a narrated story. This model relies on the dramatic concepts of "character" and "goal", and uses them to logically segment the story into narratively coherent units. The presented ontology can therefore be used for guiding a dramatic based annotation process or also supporting advanced retrieval and reasoning operations on the annotated data. We reported the motivations and the general assumptions that guided our work, providing also examples that highlight the functionalities of the ontological model for annotation purposes.

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Adaptive Storytelling and Story Repair in a Dynamic Environment

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Abstract. Most stories constructed by game designers are inherently linear in nature, with the result that player interactions have limited impact on the direction of the game narrative. Massively multiplayer online role-play games (MMORPGs) typically contain thousands of linearly scripted storylines, and stories generally do not adapt to player interactions or changes in the game-world state. However, there is some evidence that interactive storytelling techniques may have the potential to enhance narrative experience in these online worlds. An important challenge is the need for ongoing stories to be seamlessly adapted when story plans are invalidated by unforeseen events in the game world, such as the actions of player characters. In this paper we present novel techniques for repairing story plans while maintaining plot coherence and demonstrate their ability to enhance the robustness of adaptive storytelling in dynamic game worlds.

Keywords: multiplayer games, interactive storytelling, virtual worlds, hierarchical task networks, planning, story repair.

1 Introduction

There is a growing trend in recent computer games for more emphasis to be placed on story variability and providing more interesting ways for players to interact with the game narrative [1,2]. However, one genre where this trend is less apparent is Massively Multiplayer Online Role-Play Games (MMORPGs) [3]. This is partially due to the increased level of complexity that comes with allowing many players to interact simultaneously with the world state. To address this issue, contemporary MMORPGs typically provide limited state persistence (e.g., items/enemies are re-spawned to enable the state required for a particular story instance). As a result, player actions may have little or no persistent consequences [4]. In this context, it is difficult to see how dynamic storytelling can be effectively supported given that stories are, in essence, series of actions linked together by cause and effect.

In previous work [5], we presented an interactive storytelling system called MIST that allows all actions to have lasting effects on the world state, while ensuring that the world remains sufficiently stable for storytelling purposes. In this paper, we extend our storytelling approach in MIST to enable the generation, enactment, and repair of stories

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involving multiple characters. Contributions of the work presented include novel techniques for repairing story plans while maintaining plot coherence when the original story plan is invalidated by unforeseen events in the world (e.g., player interactions). In Section 2, we examine existing approaches to interactive storytelling in virtual environments. In Sections 3 and 4, we describe our approach to the generation, enactment, and repair of stories in MIST. In Section 5, we empirically evaluate our proposed approach to story repair in a virtual world in which ongoing stories are subjected to different levels of interference. Our conclusions are presented in Section 6.

2 Interactive Storytelling Systems

In this section, we examine existing approaches to interactive storytelling in virtual environments. The storytelling systems considered in the discussion illustrate some of the challenges of supporting player interaction while ensuring variability and robustness in the story generation process.

Opiate. In Opiate [6], the player interacts with non-player characters (NPCs) and game objects in a 3D virtual world. These interactions can potentially change the future ordering of plot elements during story compilation. The system uses case-based reasoning (CBR) for story selection and Propp's morphology [7] as its expert knowledge. A case consists of a set of abstract story functions (e.g., *villainy* or *departure*) that can be combined in multiple ways as long as they comply with Propp's structural definitions. When a list of suitable cases is retrieved, the system chooses one of them to be enacted in the world, assigning story roles to the most suitable characters based on heuristics. A limitation of the approach is that once a subplot has been selected, the player must follow it in a strictly linear fashion to continue. While Proppian structuring provides a reliable framework for story creation, it has been suggested that complying with Proppian plot rules makes it difficult to offer plot-affecting choices to the player during story execution [8].

Haunt 2. The characters in Haunt 2 [9], another 3D interactive storytelling game, are semi-autonomous in that they exhibit various behaviors while not currently assigned tasks by the *story director*. The story in Haunt 2 is represented by a set of partially ordered scenes, each with preconditions that must be true in the world state before they can be activated. The story director checks whether preconditions are satisfied and activates scenes as appropriate. It also has a mechanism whereby it will intervene when preconditions for the next scene have not been achieved within a specified time by assigning goals to NPCs to achieve the necessary preconditions. Goals assigned to NPCs by the story director can sometimes be achieved by NPCs in a number of different ways, thus adding to plot variability. Haunt 2, like some other interactive storytelling systems [10] uses a partially ordered story structure that increases author control over the narrative at the cost of variability in the initial plot structure. However, the approach provides variability in other important ways. For example, allowing the author to assign abstract goals to NPCs gives the system scope to decide how the NPCs achieve their goals depending on which strategy is best at a particular time. Also, partial ordering of the story script allows flexibility in the way that scenes occur while ensuring overall temporal coherence.

GADIN. GADIN [11] is an interactive text-based system that automatically generates narratives focusing on dilemma situations between characters. In these dilemma situations, players make decisions that affect the affiliation values of other characters towards them in negative or positive ways. For example, a *betrayal* dilemma gives the player the option to achieve personal gain at the cost of a friend losing out in some way, thus lowering the friend's opinion of the player. Dilemmas are presented to the user in GADIN as part of planned stories generated using the STRIPS-based planning algorithm *Graphplan* [12]. Before a story begins, GADIN selects a story goal out of all possible facts that are not currently true. The selected story goal is made known to the user from the outset and reiterated to them by NPCs throughout the game. The game allows the player a high degree of freedom and for the most part assumes that the player will act in a way that brings the game state closer to the goal. However, if the player's actions move too far away from the goal state, a new story goal is selected randomly and revealed to the player. Also in this situation, all further actions are carried out by NPCs. While goal reselection may be jarring for users when it occurs, the fact that they are given scope to maneuver plot trajectory increases story variability and local player agency.

Mimesis. Mimesis [13] provides intelligent narrative control over a 3D world space. At the start of the simulation, the narrative planner generates a plan that works towards satisfying a set of story goals from an initial state. This plan consists of a set of actions with partial ordering as well as causal links between their preconditions and effects. Mimesis also uses a module called the *mediator* to detect when the player is attempting to execute an action that will threaten the integrity of a story plan. If such an action is detected, the system will attempt to accommodate the player's action by incorporating it into the plan, thus contributing to plot variability. If the player's action cannot be accommodated in this way, the system will cause the action to fail, and the player will be given a pre-authored reason for its failure (e.g., a gun jamming prevents the player from killing a central character).

I-Storytelling. I-Storytelling [14] takes a character-based approach and uses *hierarchical task networks* (HTNs) to represent the story space on an individual character basis. These task networks represent individual character roles that define possible variations in behavior. Other factors that contribute to variability in I-Storytelling include random selection of character starting positions, autonomous NPCs, and player interventions. Users interact with the system by influencing characters through voice recognition or manipulating game-world objects. This can interfere with ongoing NPC plans and force characters to find alternative ways to achieve goals. The story is generated primarily from the lead character's task network, which contains methods for achieving the main story goal.

3 Multiplayer Interactive Story Telling (MIST)

The goal that motivates our research is to develop an approach to interactive storytelling for multiplayer game worlds that is capable of providing high levels of plot variability, robustness, and adaptability. As a first step towards this goal, we created an interactive storytelling system called MIST [5] in which some NPCs are assigned story roles according to their attributes while other NPCs are allowed to behave autonomously. MIST is based on a modularized architecture that consists of two main components. The first component is a virtual world populated by player characters and NPCs. Autonomous NPCs operate under a belief-desire-intention (BDI) framework [15], which helps to promote variability in NPC behavior. However, an environment in which all NPCs are autonomous is unlikely to provide enough dramatic interest for users and may result in stories with limited narrative potential. The second component of MIST, called the *story manager*, is responsible for generating stories to be enacted through NPC and player actions.

As in Opiate [6] and Haunt 2 [9], stories are generated from an abstract representation that enables them to be applied to the virtual world in a variety of ways depending on the world state. As discussed in Section 4, the use of hierarchical task network (HTN) planning [16] in our approach also contributes to plot variability, for example by enabling stories to be tailored to suit character attributes, item locations, and other features of the world state in a given instance of the game world.

The game engine controls the virtual world in MIST. Its tasks include updating game world objects, managing NPC state machines, and providing state information needed by the story manager for story generation. NPCs move around the world, perform actions (e.g., fishing, picking berries, selling wood), and visit locations (e.g., shops, lakes, forests). A notional currency exists which allows the semblance of a world economy. A thief, for example, will try to make money by stealing from other characters whereas a woodcutter will chop and sell wood. The varied activities of autonomous NPCs (e.g., woodcutters, thieves, berry pickers) provide the basis for a dynamic environment in which the world state is constantly being modified. NPCs acquire knowledge about the world from sensors. Internal sensors provide an NPC with knowledge about its possessions, affiliations to other NPCs, current desire, and current location. External sensors provide knowledge about other game world objects and their locations (e.g., shops, weapons).

Fig. 1 shows the MIST graphical interface with an executing story instance. The story script is shown with other information to the right of the main viewing pane. At the bottom left of the screen there is a miniature map with story NPCs highlighted in black.

4 Story Management in MIST

In Section 3, we described some of the ways in which plot variability is provided in our approach to storytelling in MIST. In this section, we show how variability is further increased by allowing outside influences (e.g., the actions of non-story NPCs/players) to modify the world state in ways that may affect the trajectory of a story while in progress. In Section 4.1, we describe how HTN planning is used to create story plans in MIST. In Section 4.2, we present the techniques we have developed for detecting plan failures that are likely to occur as a result of unforeseen events in the game world, and adapting the story plan to prevent such failures while maintaining overall plot coherence.

Fig. 1. MIST screenshot showing a story being executed in the virtual world. Story information is displayed to the right of the main viewing pane, and the event log is at the bottom of the screen.

4.1 Story Planning

Artificial intelligence planning has an important role to play in interactive storytelling systems because of the close relationship between stories and plans, both of which can be described as a series of actions/events linked together by cause and effect. Some storytelling systems, such as GADIN [11] and Mimesis [13], use STRIPS-based planning algorithms that chain together steps in the narrative to achieve story goals. Opiate [6] uses a CBR approach in which scenes are selected to match a specific structure. Other developers choose to implement a pre-authored, partially ordered story script that can be traversed in various ways [8]. We have chosen to use HTN planning [16] as the basis for story creation and management in MIST. In HTN planning, a task to be performed is given as input rather than a set of goals, and domain knowledge is provided in the form of methods for task decomposition rather than STRIPS [17] operators. The overall task is then broken down into smaller subtasks by the planner, and task decomposition continues until all that is left is a series of primitive actions that can be used as plan steps to perform the overall task.

The abstraction inherent in HTN planning helps to simplify the process of story authoring. For example, explicit declaration of subtask ordering in the approach enables the HTN author to guide planner choices based on implicit heuristic information [18]. In effect, the author uses her knowledge of the domain to ensure both the *validity* and *coherence* of stories generated from the task decomposition methods she defines. Thus HTN planning can help to avoid issues related to non-coherence of story plans such as those discussed by Riedl and Young [19] while also providing a high level of plot variability.

It is also worth noting an important difference in the use of HTN planning for story generation and its applications in practical real-world domains [20]. In a real-world application, an HTN planner has limited knowledge of the environment, typically obtained from sensors. However, in the context of story planning for a virtual environment, the entire state of the world at any time can be made available to the story manager. As we show in Section 4.2, an important benefit of the story manager's *omniscience* in this sense is the ability to seamlessly adapt to unforeseen events in the game world that would otherwise lead to plan failure.

Initial tasks from which stories are created in MIST are similar to *headlines* in a newspaper, and the basic steps in a story plan resemble the details that the journalist provides when telling the news story. For example, a possible headline for a kidnap story might be 'X is kidnapped by Y and rescued by Z'. Variables in a story headline represent roles that can be filled by characters that satisfy preconditions specified in the methods (i.e., task decompositions) defined by the author of the HTN from which the story is generated. Alternatively, variables may represent items or locations in the game world. The example story in the Fig. 1 screenshot is based on the story headline 'I is stolen from X by Y and recovered by Z'. The story roles X, Y, and Z are assigned in the example to NPCs called Jim, Bill, and Bob, and steps in the story plan include: 'Bill waits for Jim at Jim's house', 'Bill attacks Jim at Jim's house with axe', 'Bill steals magic wand from Jim'.

Starting with a given story headline (i.e., the overall task to be performed), the story manager in MIST uses an HTN planner together with an authored hierarchical network of story elements that can be pieced together in different ways to create a story plan. Each story element has a set of preconditions that determine whether or not it is valid for a particular game context. The current state of the game world is passed to the story manager periodically from the game engine to enable the story manager to check the preconditions of each story element. The use of HTN planning in this way enables the creation of many story variants based on the state of the world at a particular time. Other tasks performed by the story manager include assigning story roles to NPCs and giving them tasks to perform.

4.2 Story Repair

An effective approach to story repair is essential to ensure the robustness of interactive storytelling in a dynamic environment where unforeseen events (e.g., the actions of players or autonomous non-story NPCs) may interfere with an ongoing story. In the absence of such interference, a given story can be expected to succeed, as we assume that the HTN methods used to generate stories have been correctly authored to ensure the validity of story plans (i.e., the preconditions of each plan step are either true in the initial state or achieved by an earlier plan step). We also assume the coherence of plans generated from the HTN. In MIST, NPCs that have been assigned roles in a story plan are prevented from disrupting the story by being "locked" in the sense that they do not attempt to achieve their internal desires while the story is in progress.

The story manager in MIST attempts to repair an ongoing story when it detects an invalid plan step (resulting from the actions of non-story characters) in the story plan. In our approach to story repair, the repaired plan is required to be *consistent* with the steps that have already been completed in the original plan.

Definition 1. *A plan step S_2 is invalid if one of its preconditions is not satisfied in the current world state and is not achieved by another plan step S_1 that has still to be performed before S_2.*

Definition 2. *An alternative plan P_2 is consistent with an executing plan P_1 in which k steps have been completed if P_2 begins with the same k steps as P_1.*

We consider two alternative approaches to detecting invalid plan steps while a story is in progress. The first is simply to look one step ahead to check that the preconditions of the next plan step are satisfied. We will refer to this as *point-of-failure* (POF) detection. However, an important limitation is that because of commitments made by story characters close to the point of (potential) failure, a consistent plan repair may not be possible. For example, suppose an NPC goes to location X to pick up a sword, only to discover that the sword is no longer there. In this situation, an alternative plan is unlikely to involve going to location X unless another weapon (e.g., an axe) is available at that location.

In our second approach to detecting invalid plan steps, the story manager uses its omniscience (Section 4.1) to continuously check the preconditions of *all* future plan steps. We will refer to this as *preemptive* (PRE) detection. As Fig. 2 illustrates, PRE detection increases the chance of finding a consistent plan repair because it enables the story manager to avoid commitments being made by story characters close to the point of failure, such as going to a location to collect an item that is no longer there. By avoiding such commitments, it is more likely to find a consistent plan repair that bypasses the invalid plan step.

Our current approach to story repair applies only to situations where a plan step is made invalid by the deletion of a precondition that was true in the initial state from which the story was generated. It does not apply to situations where a plan step is made invalid by the deletion of a precondition achieved by an earlier plan step. However, our empirical results (Section 5) suggest that deletions of this type may account for a minority of story failures in practice.

Repair Method. When the story manager detects an invalid plan step in an ongoing story, it attempts to repair the story plan using the following information:

- Initial state from which the story was generated
- Unsatisfied precondition in the invalid plan step
- List of steps already completed before the invalid plan step was detected

It removes the unsatisfied precondition from the initial state and uses the HTN planner to search for an alternative story plan that begins with the same steps as the original plan, up to and including the most recent step that has already been completed. The new story plan is both consistent with the original plan and generated from the same (correctly authored) HTN, thus ensuring that plot coherence is maintained.

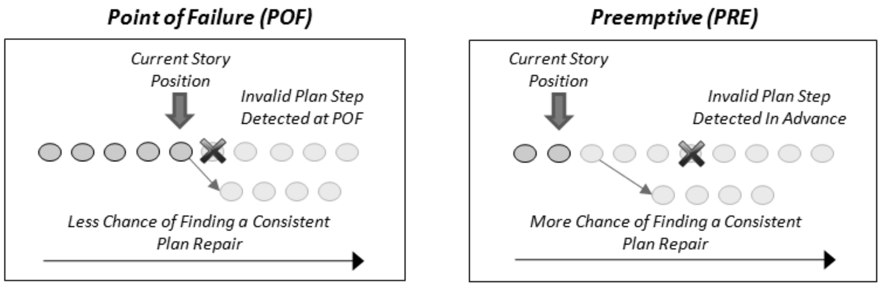

Fig. 2. Preemptive detection of invalid plan steps avoids commitments close to the point of failure, thus increasing the chance of finding a consistent plan repair

Table 1 shows a story repair example in which an invalid plan step is detected at an early stage and a consistent plan repair is found in which three steps are replaced in the initial plan. In general, the repaired plan need not be equal in length to the original plan as in this example. It is also worth noting that more than a single repair may be required to enable a story plan to be successfully completed.

Table 1. Story repair example in which an invalid plan step is detected at an early stage and a consistent plan repair is found in which three steps are replaced in the initial plan

	Initial Plan	
1	mary walks from house6 to lake1	
2	**mary picks up b&a at lake1**	*Invalid plan step (Step 15) detected at this point: there is no longer a bow and arrow (b&a) at cave1*
3	mary walks from lake1 to sams house	*Steps 1-13 in the repaired plan are the same as in the initial plan* *Steps 14-16 in the repaired plan are shown below*
4	mary waits for sam at sams house	
5	sam walks from house7 to sams house	
6	mary walks up to sam at sams house	
7	mary attacks sam at sams house with b&a	
8	mary steals gold staff from sam	
9	mary walks from sams house to foxcliff castle	
10	sam walks from sams house to house4	
11	sam walks up to bob at house4	
12	sam asks bob: will you help me get my gold staff back?	
13	bob says to sam: yes I will help you	
14	bob walks from house4 to cave1	bob walks from house4 to shop1
15	**bob picks up b&a at cave1**	bob buys b&a from shop1
16	bob walks from cave1 to foxcliff castle	bob walks from shop1 to foxcliff castle
17	bob walks up to mary at foxcliff castle	*Steps 17-24 of the repaired plan are the same as in the initial plan*
18	bob attacks mary at foxcliff castle with b&a	
19	bob takes gold staff from mary	
20	bob walks from foxcliff castle to house4	
21	bob walks up to sam at house4	
22	bob gives gold staff to sam	
23	sam says to bob: have this as a reward	
24	sam gives fishing rod to bob	

5 Experimental Results

In this section, we present the results of an experiment to compare the effectiveness of our story repair mechanism with preemptive (PRE) and point-of-failure (POF) detection of invalid plan steps. We are also interested in assessing the robustness of the stories generated by MIST when the virtual world is subjected to varying levels of interference caused by the actions of non-story NPCs.

A baseline for the evaluation is provided by observing the percentage of successful stories when no attempt is made to detect invalid plan steps or repair story plans when they occur. We control the level of interference in the experiment by first creating a virtual world in which no interference can occur and then introducing one or more NPCs that we refer to as *malicious* NPCs (M-NPCs). These M-NPCs are allowed to influence the world state in ways that may interfere with an ongoing story, such as moving items to new locations or taking items from other NPCs. The interference they cause is designed to be at least as disruptive as might be expected when equal numbers of human players are present in the world. We achieve this by assigning all M-NPCs to the thief class and ensuring that their *make money* desire is constantly active during story execution. This causes them to perform tasks like stealing items and selling them.

The story headline used to create stories in our experiment is ‘I is stolen from X by Y and recovered by Z’. In each run, the size of the world and number of items are fixed at a moderate level. The number of “normal” NPCs is fixed at 3 (i.e., the number of roles in our test story). Both item and NPC locations are randomized in each run to ensure variability of the stories generated by MIST. We test each repair strategy using the same set of 100 randomized worlds (and initially generated stories) for each interference level (0, 1, 2, or 3 M-NPCs) to ensure that the results for the different strategies are comparable. For each repair strategy (None, POF, PRE) we record the number of stories that are ultimately successful, and the number of repairs attempted (if any) for each story. For each plan repair attempted in the PRE detection strategy, we also note the distance (i.e., number of plan steps) from the current plan step to the invalid plan step that triggered the story repair process.

Fig. 3 shows the percentage of story plans that were successful (with or without repair) in None, POF, and PRE for increasing numbers of M-NPCs. With no plan repair, story success rate decreases rapidly to a minimum of 29% for the highest level of interference (3 M-NPCs). Plan repair based on POF detection is reasonably effective for the lower levels of interference, for example with an overall story success rate of 45% with two M-NPCs. However, plan repair based on PRE detection is much more effective in preventing plan failures, for example with a story success rate of 75% for two M-NPCs compared to 45% for POF and 31% for no plan repair.

Table 2 shows the numbers of stories for which 1, 2, 3, or 4 plan repairs were attempted in PRE and POF. The number of stories successfully completed in each case is also shown. Plan repair based on PRE detection has a success rate of 62% for stories in which a single repair was attempted, and 57% for stories in which more than a single repair was attempted. The corresponding results for POF are 18% and 10%.

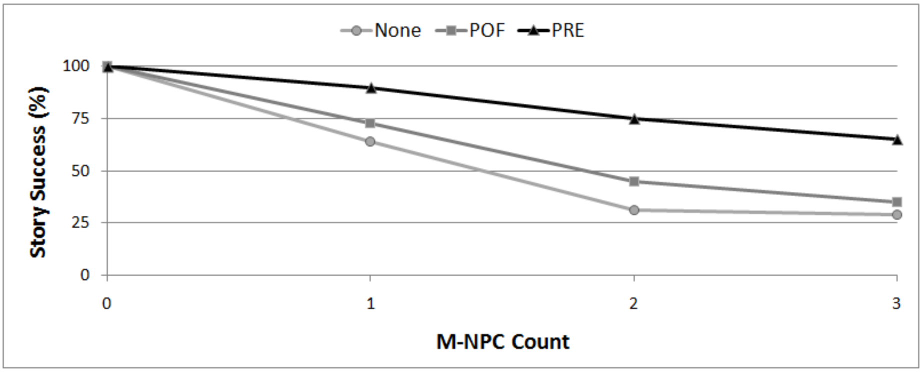

Fig. 3. Story success rates for three plan repair strategies in a virtual world subjected to increasing levels of interference from M-NPCs

Fig. 4 shows the relative frequencies, as percentages, of distances from the current plan step to the invalid plan step over all plan repair attempts in the PRE strategy. The proportion of successful repairs for each distance value can be seen from the lower (darker shaded) section of each column in the graph. For example, less than a quarter of attempted repairs were successful in cases where an invalid plan step was detected at a distance of one from the current plan step. However, attempted repairs were invariably successful in the experiment for distances greater than 4.

Table 2. Story completion counts for stories in which 1, 2, 3, or 4 plan repairs were attempted in the PRE and POF detection strategies

Repair Attempts	PRE		POF	
	Story Count	Completed Stories	Story Count	Completed Stories
1	116	72	136	25
2	46	30	38	4
3	11	4	2	0
4	3	0	0	0

As discussed in Section 4, our current approach to story repair is applicable only in situations where a plan step is made invalid by the deletion of a precondition that was true in the initial state from which the story was generated. In spite of this limitation, its effectiveness in combination with preemptive detection of invalid plan steps can be seen from our results. Our plan repair algorithm was found to be applicable to 86% of invalid plan steps detected in the experiment, indicating that it provides good coverage of problems caused by unforeseen events that occur while a story is in progress. Extending the algorithm's coverage to situations where a plan step is made invalid by the deletion of a precondition achieved by an earlier plan step is one of the issues we hope to address in future research.

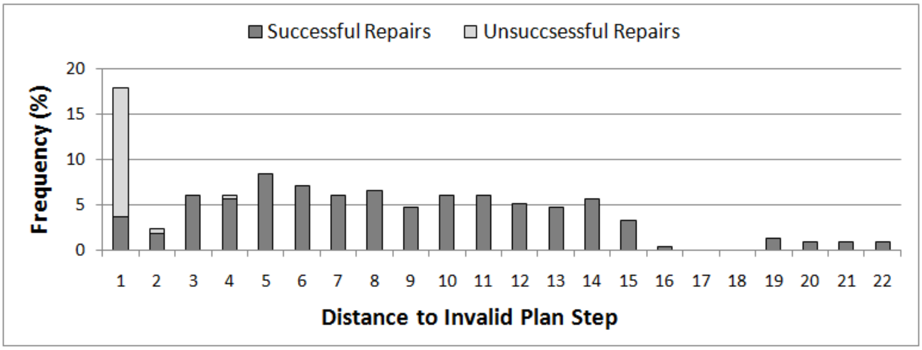

Fig. 4. Relative frequencies, as percentages, of distances from the current plan step to an invalid plan step in the PRE detection strategy

6 Conclusions

Persistence of the shared state space is essential to enable dynamic storytelling to be more effectively supported in large-scale multiplayer worlds. However, along with the benefits of allowing the actions of non-story characters to have persistent effects comes the challenge of telling stories that may be invalidated by unforeseen events in these complex environments. In this paper, we presented an approach to story repair that looks forward in time to check for invalid plan steps and attempts to repair the story plan, while maintaining plot coherence, before it reaches an invalid plan step. Our approach ensures the consistency of the repaired plan, if any, with steps that have already been completed in the original story. We empirically demonstrated the effectiveness of our approach to story repair for stories involving multiple NPCs in a virtual world in which ongoing stories were subjected to increasing levels of interference by non-story NPCs. The interference caused by non-story NPCs was designed to be at least as disruptive as might be expected when equal numbers of human players are present in the world. Preemptive detection of invalid plan steps consistently outperformed point-of-failure detection across a range of interference levels in our study. Our future work will include further investigation of techniques for increasing the variability and robustness of adaptive storytelling in multiplayer environments.

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Director Agent Intervention Strategies for Interactive Narrative Environments

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Abstract. Interactive narrative environments offer significant potential for creating engaging narrative experiences. Increasingly, applications in education, training, and entertainment are leveraging narrative to create rich interactive experiences in virtual storyworlds. A key challenge posed by these environments is building an effective model of the intervention strategies of *director agents* that craft customized story experiences for users. Identifying factors that contribute to determining when the next director agent decision should occur is critically important in optimizing narrative experiences. In this work, a dynamic Bayesian network framework was designed to model director agent intervention strategies. To create empirically informed models of director agent intervention decisions, we conducted a Wizard-of-Oz (WOZ) data collection with an interactive narrative-centered learning environment. Using the collected data, dynamic Bayesian network and naïve Bayes models were learned and compared. The performance of the resulting models was evaluated with respect to classification accuracy and produced promising results.

Keywords: Interactive Narrative, Narrative-Centered Learning Environments, Director Agent, Dynamic Bayesian Network.

1 Introduction

Recent years have witnessed significant growth in research on interactive narrative environments that create engaging narrative experiences for education, training, and entertainment applications [1,2,3,4]. Utilizing the inherent structure of narrative, interactive narrative planning [5,6,7] offers significant potential for creating engaging and effective narrative experiences. A broad range of computational models of interactive narrative planning has been investigated to build coherent narrative structures while integrating users' interactions in real-time [8,9,10,11]. A common metaphor these models share is employing a *director agent* or drama manager that works behind the scenes to direct a cast of non-player characters and storyworld events for the unfolding narrative [12,13]. Through their narrative actions, director agents subtly guide users through an intended narrative experience.

Throughout an interactive narrative, director agents actively observe the unfolding storyworld events and determine when it is most appropriate to intervene with the next director agent action to perform in service of guiding users' experiences.

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Through this process, director agents manage the overall story structure and plot coherence. Prior work on interactive narrative has focused on developing models that determine the next director action to take [7,9], but little work has explicitly explored intervention strategies for director agents. A promising approach to building an effective intervention strategies model for interactive narrative is adopting an empirically driven method. By utilizing a corpus of collected human interactions within a narrative environment, models of intervention strategies can be learned from data.

This paper presents a dynamic Bayesian network (DBN) approach to modeling a data-driven director agent's intervention strategies. By utilizing multiple sources of observable evidence that affect narrative decisions from a corpus, a model of director agent intervention strategies was learned. A corpus collection was conducted using a Wizard-of-Oz methodology with thirty-three participants interacting within a narrative-centered learning environment. In the corpus collection, users assumed the role of a medical detective solving a science mystery while a wizard provided director agent functionalities for the system. Throughout the corpus collection, detailed trace data was collected for all wizard decision making and all user navigation and manipulation activities within the virtual environment. Analyses reveal that using a dynamic Bayesian network for director agent intervention strategies is promising.

This paper is structured as follows. Section 2 provides background and related work on interactive narrative. Section 3 presents the dynamic Bayesian network models for director agent intervention. The CRYSTAL ISLAND Learning Environment and the extensions to it that support Wizard-of-Oz functionalities are described in Section 4, and the data collection design and procedure are presented in Section 5. Section 6 discusses the findings and associated design implications, and Section 7 offers concluding remarks and suggests directions for future work.

2 Background

Narrative experiences are both compelling and pervasive. Cognitive scientists have long recognized narrative's foundational role in problem solving [14], and narrative plays a central role in models of reading comprehension [15] and film theory [16]. Increasingly, interactive applications in entertainment [3], education [1,4,17,18], and training [2] are leveraging narrative to create engaging experiences in rich virtual storyworlds. There has also been a long tradition of using scripted sequences of activities to create interactive narrative for education and entertainment applications. In these scripted environments, events are either completely linear or ordered in a pre-determined branching structure [19], but the tree-like representations of interactive narrative limits the level of interactivity and tailoring provided by the system to individual users.

A promising alternative to pre-defined branching structures is interactive narrative planning in which stories are dynamically crafted in response to users' actions. Interactive narrative planning has been the subject of increasing interest, and recent work in the narrative technologies community has explored a wide range of issues for interactive storytelling. Techniques have been developed for tightly coupling plot creation and character behavior in dialogue-oriented interactive stories [3], for monitoring users' actions to determine if they are threatening the plot and, if so, either accommodating the new development or intervening [8,20]. Search-based approaches utilize an evaluation function encoding author aesthetics to guide narrative planning [7,13], while reinforcement learning has been used to learn policies to guide narrative action selection [10], and Targeted Trajectory Distribution Markov Decision Processes (TTD-MDP) have been employed to enhance replayability [11,21]. Other narrative planners have taken decision-theoretic approaches [9,22].

3 Director Agent Intervention Strategies Model

Interactive narrative is a time-dependent phenomenon. Director agents utilize numerous storyworld observations that change over time to accurately determine the most appropriate time to intervene in the unfolding story. Dynamic Bayesian networks (DBNs) explicitly characterize models' belief state over time. DBNs provide a natural representation for describing worlds that change dynamically [23]. A DBN is a directed acyclic graph that incorporates *time slices*, where each time slice contains its own state variables. By utilizing time slices, DBNs support probabilistic inference for events that change over time.

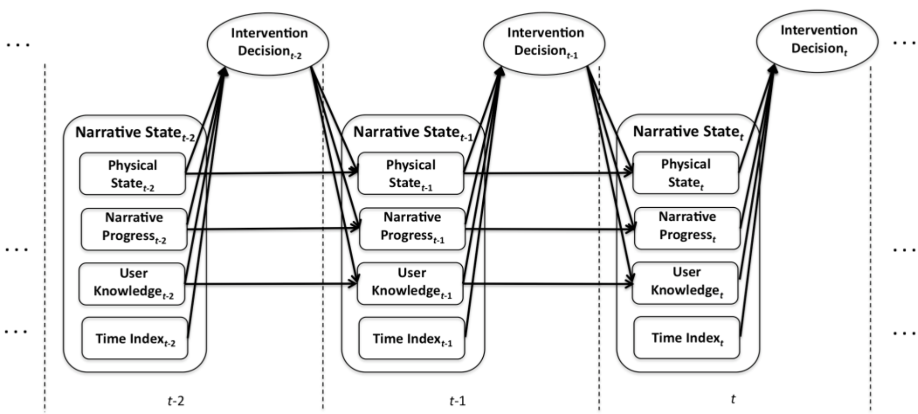

Fig. 1. Dynamic Bayesian network model for director agent intervention strategies

The high-level structure of the dynamic Bayesian network model created for director agent intervention strategies is shown in Figure 1. Three time-slices are illustrated in the figure with the intervention decision from the previous time slice, *intervention decision*$_{t-1}$, influencing the current intervention decision, *intervention decision*$_t$. Within each time slice, observations from the story world, *narrative state*$_t$, also influence the intervention decision. These observations include items such as the physical state of the storyworld, progression of the narrative, user knowledge of the story, and the overall story timeline. Each time slice encodes a probabilistic representation of the director agent's belief about the overall state of the narrative.

The DBN model consists of the following elements:

- *Intervention Decision*: Models the director agent intervention decision. The intervention decision is a binary variable taking on the values of either *action* or *no-action*. *Action* indicates that a director action should be taken to intervene in the story while *no-action* indicates that the director agent should remain inactive. In the network, the beliefs about *intervention decision*$_{t-1}$ in time slice *t-1* are influenced by *physical state*$_{t-1}$, *narrative progress*$_{t-1}$, *user knowledge*$_{t-1}$, and *time index*$_{t-1}$. The *intervention decision*$_{t-1}$ influences *physical state*$_t$, *narrative progress*$_t$, and *user knowledge*$_t$ which in-turn influence *intervention decision*$_t$ in time slice *t*.
- *Physical State*: Models the current location of the characters in the storyworld's virtual environment. In the network, the current beliefs about *physical state*$_t$ in time slice *t* are influenced by the *physical state*$_{t-1}$ and *intervention decision*$_{t-1}$ in time slice *t-1* and influences the *intervention decision*$_t$ in time slice *t*.
- *Narrative Progress*: Models the storyworld's narrative structure. To characterize the progress of the narrative, we analyzed the story structure utilizing a narrative arc framework. Utilizing the current phase of the narrative arc as an observation provides the model with evidence about the high level structure of the unfolding narrative [24]. In the network, the current beliefs about *narrative progress*$_t$ in time slice *t* are influenced by the *narrative progress*$_{t-1}$ and *intervention decision*$_{t-1}$ in time slice *t-1* and influences the *intervention decision*$_t$ in time slice *t*.
- *User Knowledge*: Models the user's beliefs about the salient facts of the story learned through interactions with the environment and other characters. Within the CRYSTAL ISLAND environment users complete a *diagnosis worksheet* while solving the science mystery [25]; the diagnosis worksheet provides details regarding users' current beliefs about the story. In the network, the current beliefs about *user knowledge*$_t$ in time slice *t* are influenced by the *user knowledge*$_{t-1}$ and *intervention decision*$_{t-1}$ in time slice *t-1* and influences the *intervention decision*$_t$.
- *Time Index*: Models the overall timeline of the storyworld to provide the temporal-based evidence for the intervention decision. In the network, *time index*$_t$ influences the current *intervention decision*$_t$. It is not influenced by other observable variables since it is a deterministic monotonically increasing sequence.

During runtime, as new observations become available, such as user and wizard locations, the corresponding nodes in the network are updated with their observed values. Influences are then propagated throughout the network, allowing inferences to be made regarding the most probable *intervention decision*$_t$ at time slice *t*.

4 Example Domain

To investigate director agent intervention strategies, a Wizard-of-Oz data collection was conducted with a customized version of the CRYSTAL ISLAND narrative-centered learning environment [24]. After introducing CRYSTAL ISLAND, we describe the custom episode created for this data collection along with the Wizard-of-Oz functionalities introduced into the environment.

4.1 Crystal Island

CRYSTAL ISLAND is a narrative-centered learning environment developed for middle school students for the domain of eighth-grade microbiology [4]. It is built with Valve Corporation's Source™ engine, the technology behind Half-Life® 2. CRYSTAL ISLAND features a science mystery set on a recently discovered tropical island where a research station has been established to study the island's unique flora and fauna. Within the story, the user plays the role of the protagonist attempting to discover the identity and source of an infectious disease plaguing the research station. Throughout the mystery, the user is free to explore the world and interact with other characters while forming questions, generating hypotheses, collecting data, and testing hypotheses. The user can pick up and manipulate objects, view posters, operate lab equipment, and talk with non-player characters to gather clues about the source of the disease. During the course of solving the mystery, the user completes an in-game diagnosis worksheet to organize her thoughts regarding the patients' symptoms, the likelihood of potential diseases (based on their expected symptoms, incubation period, and transmission source), and her final diagnosis. Upon completing the diagnosis worksheet, the user verifies its contents with the camp nurse and develops a treatment plan for the sickened CRYSTAL ISLAND researchers.

4.2 CRYSTAL ISLAND: Wizard-of-Oz Version

For the corpus collection, a custom episode of CRYSTAL ISLAND (Figure 2) was created featuring a companion agent who assists the user in solving the mystery. This episode features six characters Alyx Reid (player), Kim Lee (camp nurse and companion agent), Bryce Reid (lead scientist), Ford Patterson (zoologist), Audrey Newsome (botanist), Quentin Nash (camp cook), and Al Cunningham (camp foreman). The user plays the role of Alyx Reid visiting her father, Bryce, who serves as the research station's lead scientist.

Alyx has arrived at CRYSTAL ISLAND to visit her father whom she has not seen for a while. As she approaches the dock, she hears news that her father has fallen ill from Al, the camp foreman. Al tells her that Audrey, Ford, and her father were out on an expedition gathering specimens. Their expedition was scheduled to last for two days; however, they failed to return to the camp on time. Al found this very unusual since they were known to adhere closely to schedule. Fearful for their safety, Al led a search team to locate them. After two days of searching, the research team discovered that the expedition team had fallen ill on the south side of the island. It appears the group lost their way, became ill, and could not make it back to the camp. They are in the infirmary and are being attended to by the camp's nurse. Upon hearing the news, Alyx goes to the infirmary to see her father and his colleagues. Kim, the camp's nurse, informs her that their condition is not good. Her father seems to be much worse than the others. Kim is baffled by the illness and does not know what could have caused it. She asks Alyx to help her identify the disease and its source.

Fig. 2. WOZ-enabled CRYSTAL ISLAND

In this episode, the user takes control of her character upon arriving at the camp's infirmary, which is housed in the same building as the laboratory. All of the user's interactions, as she works with the camp nurse, occur within the confines of the infirmary and laboratory. A typical scenario has the user learning about the scientific method, examining patients to learn about their symptoms, learning about infectious diseases by reading books, testing food items to find out which ones are contaminated, convincing the camp nurse of a diagnosis, and finally treating the sickened research team members for their illness.

4.3 Wizard-of-Oz Functionalities

To investigate director agent intervention strategies, CRYSTAL ISLAND was extended to include Wizard-of-Oz functionalities. In this WOZ-enabled version of CRYSTAL ISLAND, a wizard provides the narrative planning functionalities, including spoken natural language dialogue for the character of the camp nurse. Playing the role of the camp nurse, the wizard works collaboratively with the user to solve the science mystery. Together in the virtual environment they carry on rich conversations using voice chat and observe one another's actions while engaging in problem-solving activities. In addition to directing the navigation, spoken communication, and manipulation behaviors of the nurse's character in the virtual environment, the wizard guides the user's inquiry activities and controls the progression of the story. To support these activities, the wizard's display includes detailed information regarding the user's activities in the environment (e.g., reading books, testing objects, updating the diagnosis worksheet) as well as access to a narrative dashboard. The *narrative dashboard* allows the wizard to initiate key narrative decisions in the environment (e.g., introducing new patient symptoms, having a non-player character bring in additional items for testing) analogous to a director agent.

In addition to the wizard functionalities, the narrative environment was modified to focus on the rich interactions between the user and wizard as well as to reduce the time spent navigating the environment. This was accomplished by confining the scenario to a single building housing both the camp's infirmary and laboratory. Within this environment the user and wizard gain access to all of the materials needed to solve the science mystery (e.g., sickened researchers, background books and posters, potential sources of the disease, lab equipment). The scenario, user and wizard controls, and wizard display were refined throughout a series of pilot studies with college students prior to the corpus collection described in this paper.

4.4 Example Scenario

To illustrate the behavior of the WOZ-enabled CRYSTAL ISLAND environment, consider the following scenario. A user has been collaborating with the nurse character, whose behaviors are planned and executed by the wizard. The user has learned that an infectious disease is an illness that can be transmitted from one organism to another, often through food or water. Under guidance of the nurse, the user has examined the patients' symptoms and run lab tests on food items. Through this exploration, the user has come to believe that the source of the illness is a waterborne disease and that it is likely cholera or shigellosis. Although she believes cholera is more likely, she is unable to arrive at a final diagnosis. Through her conversation with the nurse character, "Yeah, hmm, well, they both can come from water, but cholera is mostly water, I believe," the wizard determines that the user is having difficulty ruling out shigellosis and decides that this is an opportune moment to provide a hint. The wizard uses the narrative dashboard and enables the *Observe Leg Cramp Symptom* plot point, which results in one of the patients moaning loudly in the infirmary. The user examines the patient and informs the wizard, "He has leg cramps. That means it is cholera." The wizard asks the user to update her diagnosis worksheet with her new hypothesis and explain why she believes this. The user then provides a detailed explanation justifying her diagnosis, and the story concludes with the nurse treating the patients for cholera.

5 Data Collection

In the data collection, more than twenty hours of trace data were collected using the WOZ-enabled CRYSTAL ISLAND environment. The trace data includes detailed logs of all the user and wizard actions (e.g., navigation, manipulation, and decision making) within the environment, as well as audio and video recordings of their conversation.

5.1 Participants

The participants were 33 eighth-grade students (15 males and 18 females) from a public school in North Carolina ranging in age from 13 to 15 (M = 13.79, SD = 0.65).

Two wizards assisted with the corpus collection, one male and one female. Each session involved a single wizard and a single student. The student and wizard were physically located in different rooms throughout the session.

5.2 Participant Procedure

When users arrived at the data collection room, they were greeted by a researcher and instructed to review a set of CRYSTAL ISLAND handouts, including information on the CRYSTAL ISLAND back-story, task description, characters, and controls. Upon completing their review of the handouts, the researcher provided further direction to the users on the use of the keyboard and mouse controls. The researcher then informed the users that they would be collaborating with another human-controlled character, the camp nurse, in the environment to solve the science mystery. Users were asked to communicate with the camp nurse throughout their sessions. Finally, the researcher answered any questions from the users, informed them that the sessions were being videotaped, instructed them to put on their headsets and position their microphones, and asked them to direct all future communication to the camp nurse. The researcher remained in the room with the user for the duration of their session. The CRYSTAL ISLAND session concluded once the user and wizard arrived at a treatment plan for the sickened researcher. The users' sessions lasted no more than sixty minutes ($M = 38$, $SD = 5.15$). During model evaluation one of the participants was eliminated as an outlier—the data were more than three standard deviations from the mean—leaving thirty-two usable trace data logs.

5.3 Wizard Protocol

To improve the consistency of the wizards' tutorial planning, narrative planning, and natural language dialogue activities, a protocol was iteratively developed and refined through a series of pilot studies. The resulting protocol included a high-level procedure for the wizard to follow (e.g., introduce yourself as the camp nurse, describe the patient situation to the student, review the scientific method with the student), a set of interaction guidelines (e.g., collaboratively work with the student to solve the mystery, organize the student's activities around the scientific method, act as a senior peer to the student, encourage the student to explain her conclusions and ensure they are logical and consistent with the available data, engage the student in constant face-to-face inquiry dialogue), and a set of narrative guidelines (e.g., overall story structure, appropriate contexts for narrative decisions, ordering constrains, be cognizant of the elapsed time to ensure the session completes in a timely manner).

Prior to the corpus collection with the eighth grade students, each wizard was trained on the CRYSTAL ISLAND microbiology curriculum and the materials that would be provided to students during the corpus collection. The wizard training also included information on key concepts from the CRYSTAL ISLAND curriculum and the protocol to follow. After carefully reviewing the materials over the course of a week and having any of their questions answered, the wizards participated in at least three training sessions with college students. After each training session, a researcher performed an "after action review" with the wizard to discuss his or her interactions with the students and adherence to the wizard protocol.

6 Findings and Discussion

For the DBN model, there are a total of 84 time slices, 420 nodes, and more than 5200 conditional probabilities present in the director agent intervention decision-making network. The number of slices was determined based on the smallest time interval between narrative interventions found in the collected corpus. The model was implemented with the GeNIe/SMILE Bayesian modeling and inference library developed at the University of Pittsburgh's Decision System Laboratory [26]. Given the network structure of the DBN, the probabilities of each node in the network were learned by performing parameter learning for the conditional probability tables (CPTs). The Expectation-Maximization algorithm from the SMILearn library was used to learn the CPT parameters. After CPT parameters were learned, the resulting network was used to make inferences about the director agent intervention decision nodes in the model.

6.1 Results

An analysis was conducted to assess using dynamic Bayesian networks for modeling director agent intervention strategies. To compare the effectiveness of the DBN model, a naïve Bayes model was developed as a baseline in which all observable variables are assumed to be independent of one another. Both of the models were learned using trace data collected from thirty-two interactive CRYSTAL ISLAND sessions. A leave-one-out cross validation method was employed to ensure the learned models were not over-fitted. Recall, precision, and accuracy were computed using an aggregated confusion matrix for each model.

Table 1. Classification results of director agent intevention models

Narrative Intervention Model	Recall	Precision	Accuracy
Naïve Bayes	39.3%	31.9%	75.5%
DBN	73.3%	82.0%	92.8%

Table 1 shows the results of classification measurements for the naïve Bayes and DBN models. It was found that the DBN model outperformed the baseline model naïve Bayes model in all categories. There are significant improvements exhibited by the DBN model. The DBN model achieved prediction accuracy of 92.8% and the baseline achieved 75.5%. The DBN model exhibited a more than 16% accuracy improvement over the baseline. Also, the DBN model provides significant gains both on recall and precision, 34% and 50% respectively, as compared to the baseline.

6.2 Discussion and Design Implications

The evaluation indicates that using empirically informed dynamic Bayesian network models for director agent intervention strategies are promising. It was found that the

DBN model significantly outperformed the baseline model in all classification analysis. The results suggest that in interactive narrative environments the independence assumption underlying naïve Bayes models may not hold. It appears that providing evidence regarding narrative structure, physical locations, the user's beliefs, overall story timeline, intervention decision history, and their dependent relationships can significantly improve director agent intervention decision predictions.

To further improve the prediction of the director agent intervention strategies, in addition to the observations used in the DBN model, we can utilize the *user actions* from the storyworld. The user actions indicate the user activities where they are specified by user character's interactions with objects and characters in the storyworld. User actions as an observable variable in the DBN model can influence the director agent intervention decision predictions.

It should be noted that the particular conditional probabilities learned as the parameters for the model are specific to the story arc, characters, and virtual environment of CRYSTAL ISLAND. However, it appears that the methodology itself is generalizable and applies across other narrative spaces and virtual environments. To learn the parameters for a new model, a model can be trained using the Wizard-of-Oz methodology for a new narrative space and environment, the resulting model can be used to make intervention strategies for that narrative space and virtual environment.

The results suggest design implications for modeling director agent intervention strategies. Director agents should carefully consider the state of the narrative and its emergent direction. They should also be able to reason about activities from a spatial perspective, and they must be able to utilize a model of the users' goals and beliefs so that they can properly scaffold their activities in the environment while making their intervention decisions. Furthermore, director agents should carefully leverage the conditional relationships inherit amongst the many elements of the narrative state to effectively make intervention decisions.

7 Conclusions and Future Work

Interactive narrative environments offer significant potential for crafting engaging story-based experiences that are tailored to individual users. Devising accurate models of director agent intervention strategies is critically important for creating optimal narrative experiences for users. Although previous investigations have explored techniques for modeling director agents in interactive narrative, little work has resulted in the design of director agent intervention strategies. We have presented an empirically driven model of director agents' intervention strategies for interactive narrative-centered learning environments. A corpus collection was conducted using a Wizard-of-Oz methodology with users interacting with a WOZ-enabled version of an interactive narrative-centered learning environment. The results indicate that using empirically derived dynamic Bayesian networks for director agent intervention strategies can make accurate narrative intervention decisions.

Several directions for future work are promising. First, an important area for future work is incorporating the DBN intervention strategies model into a runtime interactive narrative system. Second, during the data collection, wizards used natural language dialogue to guide users when unexpected behaviors were encountered. Imbuing characters with sophisticated natural language dialogue capabilities offers a means for guiding users through stories, so devising adaptive models of narrative-centered interactive dialogue is a promising line of investigation. A third potentially fruitful direction is developing more effective models of affect understanding and affect generation for interactive narrative systems. Equipping narrative planners with the ability to reason about users' affective states could yield more intervention strategies that are sensitive to users' affective states that change dynamically in response to evolving narratives.

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"I'm Sure I Made the Right Choice!" - Towards an Architecture to Influence Player's Behaviors in Interactive Stories

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Abstract. In this paper we present an architecture for Interactive Storytelling systems that dynamically selects persuasive manipulations to increase the likelihood of the users experiencing the story as intended by an author. We also describe a study using a text-based interactive storytelling system where the architecture was applied.

Keywords: Interactive Storytelling, Persuasion, Interactive Narrative.

1 Introduction

In every interactive storytelling system the user is an active element in the development of the story. And as such will experience *Agency* [9], if he can feel that his actions have consequences on how the plot unfolds. Unfortunately, it is very difficult for an author to create content to accommodate every possible user action, especially because if the user was truly able to wander freely in a virtual story world, most of his actions might not be related to the story. This fine balance between user interactivity and story coherence is often described as the *boundary problem* [7].

Ideally the user should have freedom, however only in the confines of what is reasonable in the context of the story that is taking place in the virtual story world. Several approaches have been taken to deal with this problem. Most of them explicitly limit what the user can perform or use coercive techniques to guarantee the development of the story [8] [13] [6] [1] [3].

However, would it not be nice if we could author an interactive story and then describe which parts were important, so that the system could make those more likely to be experienced by the users? Especially if the system could do so in real time without using coercive techniques that make the user feel trapped and without real choice.

There is research that supports the idea that we can use results from the area of persuasion to achieve that goal. In some circumstances people display the same patterns of behavior between themselves and between a computer [10,5](e.g. reciprocating towards a computer program). So, it should be possible to use the concepts from the area of persuasion in social psychology to elicit these

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circumstances where the system is able to increase the likelihood of the user acting in ways that are seen as desirable to the author.

In this paper we describe an architecture, which we have named *Persu*, that is able to take an encoding of what are desirable experiences and translate it into non-coercive interventions during an interactive story, and as such, increase the likelihood of the user having a particular desirable experience.

2 Using Persuasion to Influence Choices

The area of persuasion in social psychology is directed to the creation of stimuli(e.g. visual, textual, etc) that are able to affect an individual's behavior [11]. This is usually done by creating messages that are able to change an individual's attitude towards a particular subject. Additionally to the creation of persuasive messages that produce attitude change, and consequently might lead to changes in behavior [4], there are other manipulations that have been proven successful in influencing behavior and which rely on more instinctual features, and which have even been used in an interactive storytelling context [12]. For example, reciprocity, which can be described as the sense of obligation to return a favor every time someone does us one. It has been shown to manifest itself in human-computer interactions [5].

Commitment is also a popular technique, and the one we decided to test in the study we describe in this paper. The idea behind making people commit is that it leads to a self-reflection which changes the perception of the true merits that were at stake at the time of the commitment. For example, at the race tracks, people feel much more confident that their horse will win after they have placed their bet in it [2].

3 Persu - An Architecture to Influence Player'S Behaviors in Interactive Stories

Persu is an architecture for Interactive Storytelling (IS) systems whose goal is to influence the user in order to shape his/her experience. The experience of the user is guided by a policy, defined by an author, that encodes desirable attributes for the experience. *Persu* is composed of four modules(Figure 1): the Story Facilitator agent, the persuasive context, the persuasive manipulations' container and the realization engine.

This architecture is intended to be general enough so that it can be integrated with an Interactive Storytelling (IS) system. Yet, for that to be possible the system must verify two requirements. First, it is necessary that the effects of the actions in the virtual world can be determined. This is necessary so that it is possible to compute if an action satisfies or hinders the policy, and have the *Persu* act accordingly in each case. Secondly, it is necessary that the IS system is able to inform *Persu* of when an user's action becomes performable, so that *Persu* can take action before the user actually performs it.

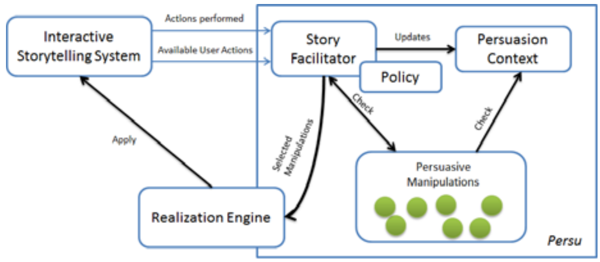

Fig. 1. Persu Architecture schema

Whenever an action is performed the IS system should inform the *Story Facilitator* (SF) agent. This agent contains the logic necessary to update all the persuasion system's modules and to decide when and how to influence the user's choices. This process is guided by the policy, which is comprised of goals defined by the author. These goals contain a description of the virtual world that can be satisfied by the user's actions.

As soon as the SF agent is informed of an action that is performed in the virtual world, it updates the persuasion context with a description of that action's effects. The persuasion context contains the information necessary for the SF agent to decide if a particular manipulation can be applied. For example, a manipulation whose goal is to persuade the user using an expert source has to be applied in a situation where a character that can be seen as an expert has entered the scene.

The persuasive manipulations are composed by a set of parameters that the SF agent can use to decide when to apply them. A manipulation contains a target, which defines a set of actions that it can affect (e.g. harming a particular character), a valence which states if the manipulation is in favor or in opposition to the actions it targets, and a set of preconditions that are matched against the persuasion context so that the SF agent can decide if the manipulation is applicable.

Finally, there is the *Realization Engine* which is a container for the realizations of the manipulations. Because we want to use *Persu* in different environments, both text-based as well as non-text based (e.g. 2D or 3D) IS systems we have developed the concept of a realization of a manipulation, which is an implementation specific way of achieving a manipulation in the particular IS system that is being used.

4 Study

To perform the study we developed a simple interactive text-based application where the user is presented with a description of the events that occur in a fictional environment followed by a set of options the describe his character's actions. The user progresses through the story by choosing an option that will lead to another part of the story, eventually reaching an ending.

To integrate this simple interactive storytelling system with *Persu* we annotated each part of the story with the characters' actions and their effects, and we also annotated the user's actions with their effects. Each time the user performs an action (by choosing one of the available options), the effects of that action are sent to the *StoryFacilitator* agent together with the effects of the characters' actions contained in the part of the story that follows the user's choice, and also the set of actions (options) that the user can perform in this new part of the story.

We wanted to test if it would be possible, using our architecture, to introduce a situation in a story where the user would be led to committing into helping (or not) a group of characters. So that later on in the story we could introduce another situation where we could explore the consistency with the initial commitment. The rationale for making the user commit and then present him a related situation where he can choose to be consistent with the early commitment is that there is evidence [2] that people tend to be consistent in these situations.

In the story the user is an adventurer that has to save a village from a tyrant. And to do so, he must enter a dungeon where he encounters another group of adventurers. Later on in the story, depending on how the user plays he can become a prisoner and be saved by the adventurers who then go as a group to face the tyrant, or he can escape being made a prisoner and kill the tyrant on his own.

To test the architecture we created a policy that included the goal of the user becoming a prisoner (arbitrary desired experience by the author) and that the user should be committed into helping (or not) the adventurers. When the user encounters the adventurers at the beginning of the story one of their available options is to ask the user for help (although this is not an action that the user can perform we can make a manipulation in *Persu* to target it, since conceptually there is no difference between an action performed by the user or by the characters). Later in the story there is a situation where the user re-encounters the adventurers, which will ask the user for one of his items. If the user accepts, the lack of that item will eventually lead him to become a prisoner, whereas if he rejects he will be able to complete the story without becoming trapped.

We created a manipulation that targets the action of the adventurers asking the user for help. That manipulation will be chosen because it targets an action that satisfies the policy goal of making the user commit. The (text) realization for the manipulation involves a description of the adventurers asking the user for help and the options for the user to accept or reject.

The other manipulation we created targets the action of the user giving the item to the adventurers. The manipulation will be chosen when the user is in a situation where he can perform the action, because it has the effect of the user becoming a prisoner, which satisfies one of the policy goals. The realization of this manipulation changes the way the adventurers approach the user (i.e. a reference is made regarding the user previously helping or not the characters). It also changes the story so that, if the user is consistent with his previous choice he/she will ultimately become a prisoner. This way causing the desired ending to be achieved through the most probable action and without coercing the user to take it.

In the control version the manipulations are not applied and therefore, the adventurers do not approach the user to create a situation where the user has to commit. Later on in the story, when the user is approached by the adventurers once again, if he chooses to help the characters by giving the item he/she eventually becomes a prisoner, and if he/she chooses not to do so the alternative ending is achieved.

4.1 Results

We conducted a between subjects experiment with 15 participants with mean age 23. The subjects were divided in a control group (6 male, 1 female) that played a version with no manipulations and a test group (4 male, 4 female) that played a version with manipulations. The system recorded each of their particular choices and the time they spent on each of them. Both versions ran on a web based choose your own adventure application(Figure 2), one with *Persu* enabled and one without *Persu*.

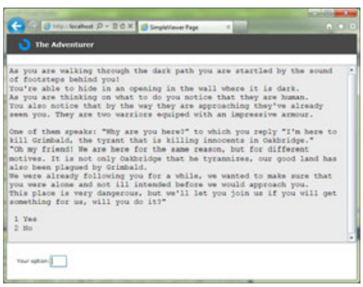

Fig. 2. Web version of a choose your own adventure story

In the control version 3 subjects (~50%) decided to help the characters (which led to the preferred ending), 3 decided not to help (~50%), and one did not finish the story.

In the version that used the Persu architecture with the commitment manipulation, 5 subjects decided to help the characters and were then consistent with that choice at the end(~83%), one decided to help the characters and later was not consistent with this choice (~17%) and 2 did not play the story until the end.

Although limited, the results are encouraging. The preferred ending was chosen by all individuals except one in the manipulated version in contrast with the control version where half chose each of the endings.

5 Conclusions

In this paper we have described the *Persu* architecture, and some of its supporting concepts from the area of Persuasion. The architecture allows an author to define a policy which will allow the system to dynamically select the right manipulations and apply them at the appropriate times in order to non-coercively increase the likelihood of the the user acting in way that satisfies the policy.

We describe a study where we implemented a text-based interactive story that feeds the characters and user's actions into our persuasion architecture (simulating a multi-agent environment) which in turn responds with the appropriate manipulations that are realized through a text realization engine.

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A Computational Model for Finding the Tilt in an Improvised Scene

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Abstract. Improvisational theatre (improv) is a real world example of an interactive narrative environment that has a strong focus on the collaborative construction of narrative as a joint activity. Although improv has been used as an inspiration for computational approaches to interactive narrative in the past, those approaches have generally relied on shallow understandings of how theatrical improvisation works in terms of the processes and knowledge involved. This paper presents a computational model for finding the tilt in a narrative environment with no pre-authored story structures, based on our own cognitively-based empirical studies of real world improvisers.

Keywords: autonomous improv agents, interactive narratives.

1 Introduction

The use of improv as a motivation for Interactive Narrative (IN) is not wholly novel [1],[2],[3]; however, these systems have relied on shallow understandings of common practices and / or teachings in improvisation. In the Digital Improv Project [4] we use the study of real world improvisers as a data source for the empirical analysis of the cognitive processes involved in story creation [5],[6].

Inspite their intrinsic unpredictability, improv presentations tend to fall into a three *beat* storytelling sequence: *establishment of a routine; breaking routine; resolve discrepancies* [7]. In the first beat, players are concerned about building a shared understanding about the story *platform* [8], by introducing the elements that define *where* a story is happening, *who* participates in it and *what* are they doing, e.g. a woman (who?), sitting alone in her apartment (where?), reading about a burglar that is entering a victim's house through the window (what?).

Although the creation of a routine within a balanced platform defines a story starting point it does not provide a direction for the action to follow. Actors must break the initial balance. The platform transition from a balanced to an unbalanced state that moves the story forward is called the *tilt* of the scene and is considered a core function of improvised scene work [7]. Continuing our example, a tilt could happen when the woman raises her eyes to find that the burglar from the book she is reading is actually in front of her. The improvisers now have to adapt to the

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fundamental change in the story world that exists in this new "tilted platform." We call an actor's response to this new platform *tilt riding* [6], a metaphor for actors remaining steady on new "tilted" ground.

Beat three occurs when the improvisers find the need to connect the story elements and present a conclusion to the audience. Going back to our example, after the improvisers are done exploring the tilted platform, the woman picks up a pen and starts to erase the burglar from the book. The burglar vanishes, the woman seats back in her chair and reading a new book. The story platform is therefore returned to a balanced state.

Tilt and tilt riding are real life examples of reasoning over story development without prior knowledge about the story structures, which can helps to define the implementation of more dynamic IN systems. The focus of this work is to contribute to the creation of computational models of tilt and tilt riding.

2 Data Analysis

The creation of computational models for these functions requires the identification of which story elements they use and how they use them. During a performance, improv players develop individual models of a story (*story frames*) that are used to create to create common understanding over story development *(dramatic frame)* in a process called *cooperative emergence* [8]. Cooperative emergence is a turn-by-turn process in which players propose new story elements (*offers*) and confirm or reject previous offers (*response*). Story elements included in an offer are kept in the individual *story frame* of each player and do not take parte in the dramatic frame. Only confirmed story elements may take part in the dramatic frame.

In order to identify the story elements used in a tilt, we defined a coding scheme for real improv performance analysis based on cooperative emergence (Table 1).

Table 1. Coding Scheme

Code	Description
P (Proposed)	When any variable is presented to a scene, it is labeled with P on the frame of the player who proposes it.
R (Received)	When an agent proposes a variable, the other agents interpret it and register the result of this interpretation with the value R.
A (Altered)	If the scene development leads into a state in which the value of an R variable is no longer consistent, the agent modifies its value into a possibly consistent value and marks it as A.
C (Confirmed)	When a variable is addressed by another than the one that originally proposed it, the variable is marked as C.

The story elements annotated are organized according to the platform elements of *who*? (characters name, occupation, habits, physical attributes, relations affinity and status) *what?* (activities subjects, targets, props) and *where?* (variables that define the scenario location). At each relevant story turn we are able to annotate which elements compose each individual story frame and also which of those elements take part in the shared dramatic frame. One should note that the assessment of each variable state in each story frame is only possible because our data includes not only videos of improv performances, but also videos of individual and collective post-performances interviews where the players comment their own performances [4].

Table 2. Strong tilt examples from two scenes with different actors

	Tilt Example (scene A)	Tilt Example (scene B)
Buildup	Two players (1 and 2) emphasize how 1 is saving the world reselling Fair Trade products. Player 3 enters as F.T. worker.	Three players (4, 5 and 6) Player 6 acts as “serious no fun guy” that teaches his friends how to behave in public places.
Tilt	Player 3 – Please feed me! Player 1 - <fails to explain himself>	Player 5 – <towards player 6> Does she (player 6’s wife) hit you?
Effect	Player 2 - <shocked at player 1>	Player 6 – I don’t want to talk about it guys… <avoids eye contact>
Info	Total length 3m20s; 3 actors; 65 actor turns; 2 weak tilts; 3 strong tilts; avg. number of variables/story frame 68	Total length 4m; 3 actors; 76 actor turns; 1 weak tilt; 1 strong tilt; avg. number of variables/story frame 76

Two scenes with the best tilt examples from our data were analyzed (Table 2). In both a group of three improvisers was asked to improvise a three-minute scene. In scene A no additional constraints were given, while in scene B the improvisers received an initial setup of “three college friend at the zoo”.

3 Results

In scene A, we found evidence of a tilt that occurred when two actors (D1 and D2) had different values for “Location” in their individual story frames. This divergence was a result of D2’s misinterpretation od D1’s initial activity.

Table 3. Players Frames at Turn 2. D2 received (R) D1’s activity as maintenance and proposes (P) Coffee Shop for location. D1 is forced to alter (A) his previous proposed value for location.

	D1 Frame	D2 Frame
Activity	D1 Mopping (A) (Breaking Leaves (P))	D1 Maintenance (R)
Location	Inside (A) (Outside(P))	Inside(P) Coffee Shop(P)
Props	Mop(A) (Rake(P))	

In both examples analyzed, relations and roles were clearly defined whenever a tilt occurred; furthermore there is evidence in both cases of shifts in the relations’ properties annotated. In example A the main shift was in player 2’s affinity towards player 1, and in example B there was a clear status shift for player 6. Also, in both cases we detected the introduction of new story elements that oppose properties that are strongly associated with the characters on scene, which will be explored in the next section.

3.1 Tilt Strategies Analysis

A tilt is a process that operates over a previously defined story platform, unbalancing it and providing story elements to explore in order to move the story forward. This is why, the creation of a tilt function depends of the platform implementation.

Platform Representation

Following our working definition, a platform is a collection of elements that establishes the characters (who?), activities (what?) and location (where?) of a scene. In our data analysis we observed that in some cases where? is not commonly established. This observation suggests that this element contributes to a platform definition but is not essential for the tilt process. We argue that location's contribution to story development is similar to props (objects that exist on a scene) contribution, which is to add more associations to the story elements, in order to feed the players process of adding elements to a scene. Based on this, we propose that the knowledge structure used by improv agent to represent a platform should include four elements: who?, what?, where?, and props.

Each specific platform is a unique combination of different instantiations of platform elements. Like in improv, there are no restrictions to the possible combinations of these elements in a platform. Nevertheless, there are some combinations of platform elements that are more likely to occur in the same platform (co-occur),.Two platform elements that are very likely to co-occur have a strong value associated to their relation, while platform elements that are very unlikely to co-occur have weak values associated to their relation. In order to express this particular aspect, we propose to include in each relation a Degree of Association (DoA), representing a strength of the association between two elements. We consider that the strength of the associations between platform elements is directional, e.g. coffee shop -> drink coffee might be a stronger association than drink coffee -> coffee shop (Fig.1).

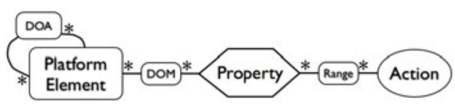

Fig. 1. Structure for Platform Elements Representation

The hierarchical structure of platform elements (Fig. 1) is an adaptation of the character prototype structure used in the Digital Improv Project's Party Quirks system [9], where each element is characterized by a set or properties, e.g. a stadium can be characterized by being crowded. The strength of the relationship between the elements and the attributes is represented by a DOM (i.e. the non-Boolean degree of membership of an element belonging in a given set). The main purpose for DOM in our case is to provide a value for the importance of a variable in the definition of an element. For each property there is a set of actions portraying it. The relationship between a property and each of the actions that portray it includes a range, which is a probabilistic distribution of how much an action portrays the corresponding property. This value should be used for providing more variability when selecting an action to portray a property. Relations between elements' properties include a value for consistency, which represents the strength of how much the semantic value of a property conflicts with another. The need for this representation is related with the recurrent improv technique of creating conflict and it will be detailed further ahead.

Tilt Strategy: Property Inconsistency

In a minor tilt from scene B player A endows himself with the prototype of a zoologist. Following our knowledge structure approach this means that the zoologist (who?) is associated to player A. Supposing that in the knowledge base a zoologist has the property of respecting animals with a high DOM associated, which can not be added to the platform, because it has not been addressed. Further on, player A endows himself the attribute of "not respecting animals", by saying "*animals are lesser than humans,"* Such property has a negative value for consistency with "respects animals", which is an attribute with a very strong DOM associated to the zoologist prototype enacted by player A. Now there is a tilt variable that breaks the normal "routine" of a zoologist, which can be explored. In this case a tilt agent using our knowledge structure would create a tilt by endowing a character with a property which is inconsistent with a "who?" element of the target character. The impact of this strategy should be related with the DOM between the character "who?" and the property that is placed under inconsistency. We could say that an agent performing this technique would follow two steps: 1- Select a property of an active *who?* element with a high DOM value that has not been addressed. 2 - Select an action that endows the character playing the *who?* with a property that is not consistent with the property addressed in the firs step.

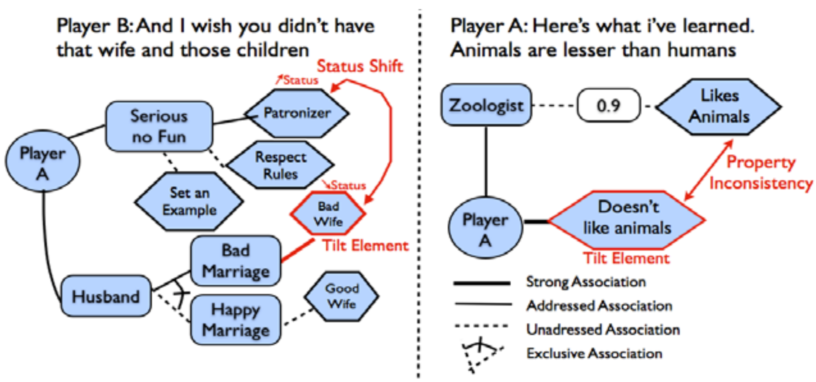

Fig. 2. Tilt Strategies

Tilt Strategy: Status Shift

This example occurs in scene B where player A is portraying a "serious no fun guy". We could consider "serious no fun guy" as a character prototype that has propertiy "patronizer" and also consider that portraying this property raises the status of the character. This should result in a story platform where player A is associated with "serious no fun" where, after portraying "patronizer" player A has a high status.

When player B wishes player A did not have that wife, he adds "friends don't like her" attribute to A's wife. This new attribute is strongly associated to a "Bad Wife" prototype, i.e. player B is establishing a connection between player A's "husband" attribute and a "Bad Wife." Furthermore, if we consider that the actions that portray "friends don't like her" lower the status of the "husband" associated with "bad wife", player A status drops provoking a status shift from a high value to a low value.

Based on this we consider that a tilt agent using a status shift technique could follow these steps: 1 - Detect if a particular character is gaining relatively more status than the others. Define that character as a target. 2 - Select an action that endows the targeted character with a property that affects status negatively.

4 Conclusions

In this paper we present a proposal for the creation of autonomous actors by relying on an empirical study of improv, where tilt is the nuclear function that moves the cooperative story creation process.

Although preliminary, the results presented in this paper contribute to the formalization of tilt and tilt riding, by eliciting story elements that can be used in a tilt process as well as strategies that can be used to tilt a platform.

In the future we expect to collect more data and contribute to the development of computational agents that reason about story development without using pre-authored story knowledge, the same way improv actors do. The creation of such agents would contribute to an extreme reduction of the creative constraints that IN systems present their users, specially the limititations imposed by pre-authored content.

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Extending CRPGs as an Interactive Storytelling Form

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Abstract. Computer role-playing games (CRPGs) have strong narratives, but in general lack a density of interesting and meaningful choices for the player within the story. We have identified two main components of player interaction within the story—quests and character interaction—to address in a new playable experience, Mismanor. In this paper we focus on the character interaction aspect. In particular, it describes how we use the Comme il Faut system to support emergent social interactions between the player and the game characters based on player's traits and the social state of the game world. We discuss the design and creation of the game as well as the modifications to the systems required to support this new CRPG experience.

Keywords: character interaction, game design, role-playing games, storytelling.

1 Introduction

Computer Role-Playing Games (CRPGs) are known for their strong narrative structure, often involving carefully crafted stories for the player to experience. These games also often have complex character creation systems, giving the player hundreds of options for the type of character they want to play, and the way they look. However, this personalization has little to no effect on the story in the game beyond a few word replacements. Additionally, the narrative is often on a pre-set path; the player moves through the experience, fulfilling checkpoints to advance the story. The player may have some choices along the way during pre-determined branch points within the narrative; however these choices generally have localized impact, with the overall story arc remaining the same—or at most leading to alternate endings.

CRPG combat systems, however, are often complex and robust, allowing for many interesting and meaningful choices through player-crafted strategies. The personalization of the character has strong implications in what actions are available within combat. For instance, a rogue can stealth and backstab, while a mage can cast spells. This imbalance is in large part due to highly formalized and structured combat models found in table-top role-playing games, the predecessor to CRPGs. However, story flexibility is created by a human game master (GM) adapting and responding to each player's actions, with no formalized system to govern the adaptations.

While combat systems have become core elements in many CRPGs, we are interested in extending the genre to introduce playable story structures, which can

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begin capturing the complex player-influenced narrative available in table-top counterparts. Our work examines the two primary methods for offering players RPG stories: character interaction and quests–this paper focuses on the former.

Interaction with game characters in many CRPGs is limited to the player choosing a line of dialog from a list to speak to the non-player character (NPC). Some games such as *Dragon Age 2* [1] introduce the ability for the player to choose the emotion they want to convey during dialog, which gives the player additional expressivity. However, this is still an indirect form of choosing a line of dialog from a limited list (which is itself part of a directed graph). These dialog options may have an effect on the story, though they usually have localized effects with no lasting impact on story.

To address these issues and learn from the design of a particular alternative, we are creating a playable experience entitled *Mismanor*, a non-combat CRPG with a focus on emergent character interactions and dynamic quest selection. The available actions within the social space are dependent on the player character's traits, a player's past actions, and the current social state. We present *Mismanor* as a step towards an experience that supports playable character interactions, giving the player the ability to create their own narrative path through the socially-oriented game world. In the rest of this paper, we will present details about *Mismanor* and the underlying system created to support this new style of play.

2 Related Works

There are many systems of social simulation. However, we know of only a few fully playable games that have been created with similar goals to those of *Mismanor*. *Prom Week* [5] was created as an example of the capabilities of the Comme il Faut (CiF) system. The game features the week leading up to a high school prom, where the player controls the relationships and interactions between the various characters. *Prom Week* does not have a specific player character; rather the game allows the player to choose which characters interact with each other. There are a set of author-specified goals for the player to achieve, which present an overarching narrative. While we are also interested in exploring the space of complex social interactions, we are interested in how a player character—personalized based on the user's preferences—can influence and interact with an integrated social simulation, along with dynamic quest selection.

Pataphysic Institute (PI) [6] is a multiplayer role-playing game that deeply connects a player's character with the game world. The player's traits and abilities are based on their personality and state of mind, tracked by the *Mind Module* [7]. A player can create new enemies to defeat based on their actions within the game. Similarly, we also have an interest in deeply tying the player's character and choices to the story and available actions. However, in *Mismanor* we are focused on non-combat interactions, and the narrative built through the quest structure.

Façade [8] was created to demonstrate an open-ended dramatic scene between the player and two game-controlled characters. The player interacts by using natural language to type lines of dialog, and by interacting with items around the room. The player is able to direct the discussion and the outcome, creating a deeply interactive drama. While this system is very robust, the player does not have the ability to personalize their own character in any way other than their name. In *Mismanor,* we are interested in giving the player the ability to create a custom character that is deeply represented, dynamic, and has noticeable effects on the game world.

3 Design of *Mismanor*

Creating *Mismanor* was partially motivated by extending the storytelling capabilities of CRPGs through social interactions with the game characters. Many CRPGs use character interaction as a method of delivering story, but the options given to the player as to how they interact, or who they interact with, are very limited. We are interested in giving the player more interesting and meaningful choices in the way they can interact with the other characters. For the choices to be interesting to the player, there must be a way for the player to strategize about them. Similarly, for choices to be meaningful, they must deeply affect the game and its progression.

To highlight the importance of the interactions with the other characters, we chose to create a game with no fighting mechanics. To give the player a number of choices, we needed to design a situation that would have room for a lot of interesting social interactions. When brainstorming ideas, we realized that it was also important that the social interactions involve situations that the player would be able to logically predict in order to fit with our model of interesting choices. Because of this, we veered away from stories that involved psychosis or psychological impairment. While these make for very interesting characters, unpredictable responses to a new style of mechanic can quickly lead to player frustration.

Instead, we chose a historical fantasy setting; it is the 1930s, and the player character (PC) has been invited to a manor in the English countryside. The invitation comes from Violet—the daughter of the family—whom the PC knows only on a superficial level. Through playing the game, the player can find out about the strained relationship between the Colonel and the rest of his family, the secret relationship between Violet and the stable boy, James, and the strange tension between James and the Colonel. As the game progresses, the player learns of the cult (which is known to only a subset of the characters), and their future role in the evening's ritual. Depending on the PC's actions throughout the game, relationships with the different characters will change and lead to different storylines and endings.

4 Social Actions

With the design of *Mismanor* focused so heavily on social interactions, it was important for us to have a system that could richly simulate the social landscape of our game. We chose to use the Comme il Faut (CiF) system as our starting point. We heavily modified and expanded the system to create a new social framework.

CiF includes first-class models of multi-character social interactions—modeling relationships, traits, statuses, social history (in the social facts database, or SFDB), and culture, along with a library of social interactions or moves. The rules about how these models affect social interactions are represented as *micro-theories*. The micro-theories represent social knowledge outside of the context of specific social moves, supporting their reuse. The micro-theories are used to modify the saliency of each social action—adding a positive or negative weight to whether a character is likely to want to engage in a specific social action.

For our use, one of the most important aspects of CiF is the character representation. Each character within CiF is described by a set of traits and statuses. Traits are static character descriptors such as “sentimental,” “unforgiving,” or “defensive.” Statuses are transitory, representing temporary character states such as “AngryAt,” “depressed,” or “heartbroken.”

Another key component to our design is CiF’s model of relationships. CiF maintains multiple dynamic relationship spectrums between characters which are bi-directional, but not necessarily reciprocal; that is, while Jane and Bob both have a value representing their level of friendship with one another, Bob may have stronger feelings of friendship for Jane than vice versa. Since inter-personal feelings are multi-dimensional, CiF supports a number of different relationships such as friendship and romance. Traits, statuses, and relationships all have an impact on what social actions are available to the player or game characters in a given situation.

4.1 Player Interaction

CiF was originally intended for a simulation game, and a number of modifications and extensions were required for the system to work with *Mismanor,* which we describe in more detail in this section.

Instead of a simulation in which the player can directly choose any two characters to interact with one another, the player instead controls their own avatar (the PC) and interacts with game characters through that avatar.

A key aspect of the gameplay within *Mismanor* is that the player needs to actively strategize to mold their character and the social situation to manipulate what actions are available. Because the set of interactions available to the player need to be from the player character’s perspective, this meant we needed some way to model the PC such that we could calculate the current weight for each action, based on which social action the player would likely perform given their character makeup. We chose to model the player the same way NPCs are modeled, so that we could use the strengths of the CiF system. Using the player model and social state of the world, we can then calculate the most salient moves for the player to choose from.

When choosing the moves available to the player, the traits of the player’s character have a large impact on the weighting of each move, which in turn impacts the development of the story. We therefore want to give players control over their traits during character creation. We use a character creation process similar to Hero System [9] and GURPS table-top role-playing systems [10]. These systems support creating complex characters by choosing from a large set of abilities and traits, as opposed to assigning strengths to a small list of attributes (e.g., *strength, charisma*). In *Mismanor,* we have a large set of traits from which the player can choose. The player starts out with 100 points, and each trait costs between 10 and 50 points. Traits that are considered negative (e.g. *selfish*, *unforgiving*) add points to the player’s pool instead of subtracting from it. This adds an incentive for the player to create an interesting character with both strengths and flaws. Some traits are mutually exclusive, such that the player cannot have them both (e.g. *forgiving* and *unforgiving*).

Initial statuses and relationships are set according to the author's wishes. For *Mismanor* the player starts with no statuses set, and their starting relationships depend on the gender of the character and the back story. Once the game begins, the relationships and statuses change based on player social actions, and whether the characters choose to accept or reject the chosen action.

Additionally, characters respond to the player by initiating actions of their own. After the player's chosen social action is resolved, any NPC in the same room as the player may then initiate a responding action, with the player getting a chance to accept or reject. The responding action is chosen based on the highest positively weighted social action for any NPC in the room, with the player as the recipient.

The weighting takes into account keeping the same context as the previous move by the player as well as character urges. To keep the same context, if a move is tagged with a specific item or piece of knowledge, a reacting move that also involves the knowledge or item is weighted much higher. Character urges are used to encode game character moves that have stronger weighting over time. This allows a character to interrupt with important information or offer a quest if the player has not spoken to them in some time.

4.2 Knowledge Representation

In addition to altering the function of CiF characters, it was necessary to add two new game object representations to the system: Items and Knowledge.

Items are game objects that can be interacted with similar to game characters, but cannot autonomously choose reactions in our story, although we left the system flexible to having magical items that are able to react to the player. Knowledge can only be referenced in social moves by the player and other characters. Like characters, items and knowledge have a set of traits and statuses associated with them, and new and existing social moves were created and modified to work with these new objects.

Having traits and statuses on all game objects gives the system the ability to reason about social moves in a flexible way. For instance, if the player picks up a dagger which has the *cult item* trait, any game character that is in the cult will have a high weight to talk to the player about that item.

We use the knowledge object to encode the plot points in the story. Each knowledge object has a set of traits which lets the system know which storyline it is a part of and whether it is necessary for game completion. Additionally, some of the plot points can become false based on which actions the player takes – truth or falsehood is stored as a status. Unlike CiF, which assumes that all characters know all facts, *Mismanor* does not assume universal knowledge by storing fact knowers as statuses. These traits and statuses are also useful for story construction, though this is beyond the scope of this paper.

5 Conclusion

We have discussed the character-focused steps we have taken in creating a new type of role-playing game which emphasizes giving the player interesting and meaningful choices within social interactions. To accomplish this, we began with the *Comme il*

Faut (CiF) system and extended it to become a new framework for our game, *Mismanor*. We first modified the system to work with a player character, allowing the player to create their own character as well as adding some autonomy to the game characters. Additionally, we added support for two new game objects, items and knowledge, expanding the system to be able to represent and reason about these objects as deeply as it could initially reason about characters. This ontological work supports the creation of role-playing games with deep and interesting social actions.

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Framing Storytelling with Games

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Abstract. The purpose of this article is to aid the design of support tools for storytelling games, and to ease the analysis and understanding of storytelling games by expanding the hitherto available framing. Based on interviews with players, it outlines frames in storytelling games, expands the concept and suggests how this can be used in designs with examples from current and future storytelling support tools.

Keywords: Storytelling, storytelling games, interactive storytelling, role-playing, mediated communication, storytelling support systems.

1 Introduction

Storytelling has always been an important activity in human society, as has games, and it is no wonder that we nowadays see the two together. There is storytelling *in* games, and storytelling *with* games. The former consist of games that tell a pre-written story or even an "interactive" story where the players get to chose between pre-established paths. The latter uses games to help people co-create stories as they are being played, leading to such complex forms of storytelling as the interactive co-creation of narrative in games such as *Universalis* [14], or tabletop role-playing games such as *Wild Talents* [8] or *Dungeons and Dragons* [12].

This second type of storytelling is highly complex, since so much of the communication is utterly context-dependent. The players shift between play modes constantly [10], and many different activities can occur in the same game. What someone is saying can be part of the activity, part of the formal system that regulates the activity, outside the activity, or a combination. If there are personal characters, the emphasis of being "in character"[1] creates additional difficulty – one must also be able to differentiate what is being said in character and out of character! One also needs to know if something is part of the diegesis[2] of the story or not. When mistakes are made it leads to confusion at best and serious disruption at worst, leading to a loss of immersion [22] and/or flow [7].

[1] To quote Fergusson in his introduction to Aristotle's *Poetics*: "…the actor's art consists in 'taking the mold' of the character portrayed, and then responding to the situations of the play as they appear to that character." (p. 31) [9]

[2] The "diegesis" of a story consists of whatever is true *in that story*. Diegetic elements are "in the story"; non-diegetic elements are not.

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Unsurprisingly, both storytelling and games have moved into the digital domain, which also has storytelling *with* games as players seek new possibilities and attempt to mitigate or remove the obstacles of old methods. They might for example be looking to overcome spatial and temporal limitations through *play by e-mail* (PBEM) [20] or *Multi-User Dungeons* (MUD) [1], problems with representation through technologically assisted live action role-play (LARP) [29] or available affordances in computer games with a tool such as Sleep is Death [26].

Unfortunately, the highly complex and social nature of storytelling makes it difficult to design adequate support systems for the activity; the limitations of technology might even exacerbate the problems. The slow(er) return time of PBEM communication makes it difficult to clear up confusion, MUD/MUSHs are real-time but lack face-to-face interaction, excluding non-verbal indications of a play mode shift, LARP is face to face, but has problems with representations beyond the diegetic. Sleep is Death is dependent on pre-constructed building blocks and limited to two players. While there are tentative attempts at creating digital support tools for tabletop role-playing (e.g. [27]), these are still not widely used.

This article uses interview data from player respondents in order to describe the activity of storytelling with games as multiple potentially overlapping activities. This in order to support the creation of games and tools to facilitate the activity; with examples of how this can be used in designs. It does not focus on how to create a good story or a good game, but rather attempts to understand the storytelling activity.

2 Background

There are many different genres of games, some of which allow storytelling with games – presented here are some notable examples.

Joint storytelling games allow multiple participants to narrate a story together. There is usually a mutual before-hand agreement on some of the story's boundaries, such as theme and/or setting, but beyond this the story develops as it is told. *Universalis* [14] is such a game, and there are many examples of technological applications, see e.g. [2, 13, 35]. Some of these are more like games than others, but all have some sort of playful interaction in common.

Tabletop role-playing usually means that each participant has his or her own character, with exception of the GM[3], if there is one (see e.g. *Shock: Social Science Fiction* [23] for a rare exception where there is none). Diegetic control is usually strictly regulated – player-participants control their character and its actions, the GM most of everything else. *RPTools* [27] is an attempt at providing technological support (such as maps) for role-playing games, as is *Undercurrents* [3] which focuses on providing additional communication channels, and an area for asynchronous contributions to the storytelling process. Note that there is a huge difference between computer role-playing games such as *Baldur's Gate* [24] and tabletop role-playing in a digital setting.

[3] "Game Master", "Game Moderator" has also occurred recently, presumably since everyone doesn't approve of the implied "mastery", see[8]. Many games have their own term for the same role; e.g. "Storyteller" in [5].

An early example is *play-by-(e)mail* [20]. Many different games, including storytelling games can be played over PBM, and it enables players to participate in a game although they are spatially separated, albeit not in real time. *DeProfundis* [25] is an example of a commercial storytelling game played entirely over mail or email.

Another example is *MUD/MUSHs* [1]; online text-based platforms for role-playing and/or gaming (the amount of actual role-playing varies, see [34]). These have both different channels for communication and a convention of tagging entries to ease understanding. In *SMAUG MUSH* [28], players can for example type "emote" in front of an entry to have it edited automatically to reflect a specific stance or use a client which color-codes text from different sources.

Live Action Role-Playing, is a form of storytelling used to create stories with sometimes hundreds of participants [29]. Owing to the emphasis on a so called "360° illusion" [17], it is perhaps as close as one can currently get to Murray's "holodeck" [22] storytelling. It has trouble with representation – more fantastic elements such as magic or fictitious technology can be difficult to include. *Interference* [4] is one example of how a live-action game was enhanced with digital technology to provide a seamless experience of magic and advanced technology.

A computer game example is the digital storytelling game *Sleep is Death* [26] in which two players takes the roles of player and game master. The player explores the world and interacts with its objects and characters, while the game master controls everything else "behind the curtain", much like a traditional tabletop role-playing game.

3 Related Theory

In order to structure the activity of storytelling we turn to Goffman [11], who studied human interaction and uses play and games as an example. According to his *frame theory*, something can only be understood if you understand the frame (context) in which it resides; if you misunderstand the frame, you will misunderstand what is going on. A parent who hears his children cry "I'm going to kill you dead!" from the living room is probably much less concerned if he interprets it in a "computer game frame" than a "playing with knives" frame. The frame theory is highly applicable to the complex nature of storytelling games, and with it we can structure the many context and play modes of storytelling games into specific frames. Games are already somewhat formalised through their rules and are suitable for frame analysis; other scholars have done just that and applied frame theory to explain the frames of particular games:

One such scholar is Linderoth [19] who explores how children create meaning while playing computer games in his 2004 thesis *Datorspelandets Mening* (Eng. "The meaning of gaming"). He has analyzed video material of children interacting while playing computer games, and argues that their utterances only can be understood in context. He divides the children's speech into frameworks to better understand how meaning is created in games; *rules-oriented* frameworks, *theme-oriented* frameworks and *aesthetically* oriented frameworks. Each frame carries with it its own understanding of how a particular piece of communication is to be understood in the overall narrative.

Fine [10] looks at the activity of role-playing and structures it into three “levels of meaning”. The first is described as the “real world”, the “commonsense understanding that people have” (p. 186); the second is the “game context” and the third is the world of the characters. He also mentions frame confusion occurring during the games that he has studied, such as in an example regarding the source of a greeting (p. 201).

Mackay [21] divides the activity of “fantasy role-playing” into frames very similar to Fine’s, but subdivides the game-world frame into three – the “performative” (or “character”), the “constantive” (or “addresser”) and the storyteller (or “raconteur”) frame (p. 55-56). Performative are first-person utterances – “pretending to be the character”, constantive is also first person but descriptive, and storyteller is descriptive but not first person.

Cover [6] looks at tabletop role-playing games in her 2010 book *The Creation of Narrative in Tabletop Role-Playing Games*, and in chapter five, entitled “Frames of Narrativity in the TRPG” she presents three frames pertaining to tabletop role-playing games; the “narrative frame”, the “game frame” and the “social frame” which are further subdivided into six “levels of narrativity” (p. 94). Unfortunately, she is limited to tabletop role-playing in general and Dungeons and Dragons [12] specifically. Also, she is mainly concerned with how narrative is created and not on the communication between the players.

4 Method

Besides looking at earlier work and game artifacts, this article is based on obtaining and analyzing data from several additional sources: focus group meetings held in parallel with *Undercurrents* development (three groups of four participants each, 45-90 minutes, details see [3]), feedback from and discussions with the prototype test groups (two groups of three participants, details see [3]) and discussions with assorted game masters as the prototype matured. The author also has considerable (20+ years) of experience with role-playing and more traditional storytelling. The respondents main area of experience was with role-playing, but many had tried other storytelling games; an unsuccessful attempt was made to find respondents with more extensive broad experience. Given that role-playing games are probably one of the more complex storytelling games this was not viewed as a problem.

The data collection was for the most part conducted in an informal, conversational manner as advocated by e.g. Thomsson [31]. This means that the respondents were presented with the intent of the work, the work done so far and what other respondents had said, inviting comments and an open dialogue.

The analysis consisted of taking Fine [10], Mackay [21] and Cover’s [6] framing as starting points and then matching them with the interview data. When something was found that did not seem to fit into an existing frame, or could be reliably split into several frames, new frames were created, refining the original frames until all data fit into frames.

After the initial modeling of communication frames was drawn up, it was presented to a group (four participants) of other (10-15 years of experience) role-players to see if it concurred with their understanding to increase inter-evaluator reliability. A few minor corrections and clarifications were made.

The main limitation of this study is the national scope of the sample; while the underlying data is sound, it is mostly drawn from Scandinavian respondents and would be easier to generalize with a more diverse sample. Note however that the earlier work is based exclusively on North American samples and that taken together the case presented seems strong.

5 Frames of Storytelling

The identified frames are presented here with a suitable moniker, examples, special requirements and other pertinent details.

Although in some cases inspired by actual quotes or past storytelling sessions, the examples below are fictional creations and clearly denoted by the word "example". Quotes from respondents are indented and have been edited for brevity, readability and anonymity, as well as translated from the original Swedish. They are often included to show additional facets or complications surrounding a frame. Many are comments on the specific frame and expand the descriptions, also showing the respondent's awareness of conflicts between the frames.

5.1 Diegetic Dialogue

Perhaps the most common communication frame is the "diegetic dialogue" in which the words of the player/storyteller have an exact match in the diegesis; i.e. what the player says is what a character says in the story. This is often the "default" frame, where a communication is placed unless it clearly belongs somewhere else, but this depends heavily on the style of play, see e.g. [6]. Sometimes distinguished with a particular tone of voice or style of language designed to mimic that of the character. Note that diegetic monologues or characters talking to themselves are included here as well.

> *"This is sometimes hard to distinguish from poses, like if someone says 'I'm going for coffee' this could either be his character talking, him describing what his character is doing, or himself simply stating that he is going for coffee out of character!"*

Example**:** [in the faux-grandmother voice of the wolf] "Come a little closer, child, so that I can take a look at you!" or [in the proud voice of a paladin] "Begone foul beasts, lest ye taste my blade!"

5.2 Diegetic Poses

In role-playing parlance a "pose" is a description of something that a character does, and might also include descriptions of something that the character says, but not word-for-word. Usage often shifts between first person, common in traditional tabletop role-playing, and third person, used in traditional storytelling. Note that phrases from the dialogue frame above sometimes are appended with a description of which character is the origin of the phrase, something which would belong in this frame. "Emotes" used in online games would also fall into this category.

> *"Earlier, we used to be very strict with using only first person, but of late this has changed, probably because we look more at the narrative as a whole rather than only our own characters. So nowadays we often mix."*

Example**:** "The big bad wolf said: ['So that I can hear you better']", or "I sit down and explain to my fellow Paladins what I have seen in the crypt."

5.3 Diegetic Descriptions

These are descriptions of elements in the setting that are not associated with the actions of a particular character. Depending on the nature of the game, these can come from either the GM/storyteller only, or from players and the GM/storyteller.

> *"Every game begins with a 'description-round' in which everyone describes their character's physical looks, and maybe what gear they are carrying. During the game we also sometimes stop and do an 'update-round' to highlight changes."*

Example**:** "Grandmother's house is small, but cozy, and made of timber and clay" or "The paladin is a stocky middle-aged woman with a stern face and unforgiving stare."

5.4 Non-diegetic System-Related

For storytelling games that have a system component, such as most traditional tabletop role-playing, this is information that relates to that component. It is labeled "non-diegetic", since although the characters in the story could be aware of these things on some level; it is of course hardly in the language of the system. Note however that in some computer games, this is freely mixed into the diegetic dialogue (see e.g. [16]).

> *"For some, the system should be as invisible as possible during play, as they think that 'system talk' disrupts the flow of the experience, but with some systems this is impossible, and many groups don't care that much."*

Example**:** "I spend a willpower point and roll Manipulation + Subterfuge to fool little red riding hood" or "Your paladin is struck for 10 hp in damage!"

5.5 Non-diegetic Story-Related

Also sometimes referred to as "meta communication"; this is participants discussing the story on a level removed from the story itself, they are, in effect, discussing the story as a story. This could involve arguments on where to take the story, how the plot should enfold, and so on. Comments on the story would also belong here, and is naturally present in all storytelling groups. The more intentional debate on the story and its elements is virtually non-existent in many groups, but some make extensive use of it, and have even special techniques to insert it into an ongoing story (see e.g. [15]).

> [regarding meta-communication] *"We do a lot of this, but I think it is rare; we take breaks, discuss where the story is going, and so on. It helps the quality of the story, but it makes the flow sort of broken up."*

Example**:** "I don't like the direction this story is going; the male hunter as savior is too traditionally patriarchal; we need to change it up" or "the episode with the paladin and the old lecher was really good, more of that!"

5.6 Non-diegetic Activity-Related

Communication related to the current activity of storytelling, rather than to the ongoing story. It often concerns the boundaries of the activity and is necessary to form, extend, amend and/or dissolve the activity agreement.

Example**:** "Let's take a break and continue after dinner!" or "pass me the eraser".

5.7 Non-diegetic Non-activity-Related

While by definition not part of or pertinent to the activity, it bears mentioning because communications in this frame are often interspersed among communications of the other frames, which potentially could cause confusion. In most sessions this is considered a disruption; in more casual sessions it is a common feature [10].

> *"We always claim to be 'serious' and 'pretentious' when it comes to our role-playing, but I guess that when push comes to shove, we're as chatty as anyone else. It fills out the 'dead space' so to speak."*

Example**:** "Oh, by the way, have you seen the new science fiction movie?"

6 Comparisons and Further Framing

Comparing the frames in this article with those of the scholars mentioned earlier, we find that Linderoth's [19] three frameworks (rules- theme- and aesthetics-oriented) are seductively easy to compare to the system and diegesis-related frames, but this is a mistake – originally intended for video games, the best translation in this context is to put them all in the non-diegetic activity-related frame, since they are all examples of commentary to the game itself. In contrast, comparing with Fine [10] is rather straightforward; his primary framework covers all the non-diegetic frames, his game frame the system-related frame and the character frame the rest. Mackay [21] complicates the issue somewhat; his performative frame corresponds to diegetic dialogue, but only if it is a diegetic pose at the same time: "*what [NN] says as his character constitutes what is done by that character in the game world*" (p. 55). His storyteller/raconteur frame on the other hand, corresponds to the diegetic poses frame, but only if it is in third person and not said "as the character". Why Mackay chooses to delineate the frames thusly is somewhat unclear, but it could be that he does not see the possibility of an utterance being interpreted in more than one frame. The constantive frame simply corresponds to the diegetic descriptions frame, and the two other are identical to Fine's.

Cover [6] splits her three frames further, dividing the narrative frame into "narrative speech" which corresponds both to diegetic poses and descriptions, and "in character speech" which is diegetic dialogue. The game frame is split into "dice rolls", which is a subset of non-diegetic system related and "narrative suggestions" which has no clear correspondence – it straddles system-related (because "it might involve dice-rolls") but also non-diegetic story-related, but with restricted diegetic control, since the suggestion needs GM's approval before it becomes diegetic. Finally, the social frame is split into "narrative planning speech", a subset of the non-diegetic story related frame, and "off-record speech" which is non-diegetic non-story related, but also contains "comments on the story world", which would be story-related (p. 94).

There are however additional, important considerations to be made that emerged from the data, and are not covered by earlier scholars. Below are characteristics that cannot be viewed as their own frames, but rather as possible additional features of the frames above. They influence the frames in ways that are important to grasp, as they put additional constraints on the communication between participants, and more possibilities of frame confusion.

6.1 Limited Disclosure vs. Open Disclosure

All information is not necessarily for everyone – in traditional role-playing, participants apart from the GM usually receive only information that their character would be able to perceive/recall; or sometimes attempt actions that they want to keep secret from the other characters. If this information is to be kept from the other players as well as their characters, a separate channel of communication is required. This could for example be hand-written notes or temporary limitations (such as non-disclosure participants covering their ears, or leaving the room, see [3]) so that the limited disclosure of the message can be preserved. In turn, this puts further limitations on the message, such as the limited space available on a note or the discomfort of covering one's ears for a long time. When these restrictions are perceived as too cumbersome, the message is curtailed instead, leading to a loss of information.

> *"The amount of 'secret' information differs so much between games, groups and genres. Sometimes it ruins everything if the wrong people have the wrong information, and getting it across without spoilers always requires some sort of hassle."*

Example**:** "You see how the hunter secretly nabs some of grandma's silver spoons" or "I prepare explosive runes, and scribe them on the paladins morning prayer sheet"

6.2 Synchronous vs. Asynchronous

Not all stories are told in synchronous mode; some are more drawn out affairs in which the participants exchange story elements over a longer period of time. Some are told in a combination of both, as participants engage both in storytelling sessions and prepare additional material between the sessions. Though usually easy to tell apart from other frames this is nevertheless important, both because sometimes the delineation between synchronous and asynchronous can be less than straightforward, especially in the digital realm, and because different channels might be required. What is introduced between sessions might also be accessed or referred to during a session, further blurring the picture.

> *"There are actually storytelling games that occur entirely without the players meeting each other; they just write letters[4]. I think it feels a little odd, but I guess there are people that love it."*

***Example*:** Red riding hood's diegetic diary, or a written down description of the paladin.

6.3 Restricted Diegetic Control

In storytelling where the distribution of diegetic control is asymmetric, such as in traditional role-playing or co-authoring systems [14]), it might be necessary for some participants to check with the diegetic authority whether it is all right to introduce a specific story element into the diegesis, or if a specific diegetic truth holds.

> *"This can create *a lot* of trouble if everyone isn't synched and makes the wrong assumptions on what is acceptable or not. And you never want to tip your hand by asking in advance, so to speak."*

***Example*:** [on a separate note to the storyteller] "I'm going to introduce the fact that my version of red riding hood has kick-ass karate skills, ok?" or "Is my shield also considered a holy weapon, or just the sword?"

7 Discussion

Returning to the introduction, where we viewed some attempts at bringing storytelling, games and technology together, it seems that there are three main problems connected to frames – limitations in the ability to clear up confusion when it occurs, limitations when it comes to signaling a shift between frames (and the resulting inability to shift if desired) and limits when it comes to representation. In some games you have only one, in others all three. A good example of the second type comes from the respondents under the "limited disclosure" framing above; shifting from an open to a closed disclosure frame "*always requires some sort of hassle*" and as a result the shift sometimes is not made.

The most important step when designing technological support for a storytelling game is probably to determine which frames will be prevalent during the game, but this can be difficult - the most influential factor on the prevalence of the different frames is of course the storytelling style of the participants, but factors such as genre and theme (there is more diegetic descriptions and less diegetic dialogue in a Hemingway-inspired story than in a Shakespearean one, for example) also exert their influence. There is also a significant impact from how much "live-action" is used in the story, i.e. how much is acted out physically and bodily by the participants, and what is instead described verbally.

Below are two specific examples of how frames are and could be used when designing applications to facilitate storytelling, one from earlier development and one from future development.

[4] The respondent refers to DeProfundis [25].

The first example concerns redundant communication and how it can be solved with the *Undercurrents* [3] system. It regards the so called “echo effect”, occurring when a message is repeated in several frames during a face-to-face tabletop role-playing session, and is best illustrated through an example:

“Let’s say the scout in the party spots something, or the sensors guy on the spaceship receives new information on something; first the storyteller tells it to him [diegetic descriptions frame, limited disclosure] *then his character needs to tell everyone else* [diegetic dialogue frame]. *But everyone just hears the same thing twice. Or, the storyteller skips the first part, which makes the sensors guy feel useless.”*

Since the *Undercurrents* system provides a separate communication channel where the sender selects the recipients, the storyteller would send the first message through the system, which would only be visible to the scout/sensor operator in the example above, and the recipient could then transfer it into the dialogue frame (or not, if he or she would rather keep the information secret). To the other participants, this would presumably be a more seamless and coherent experience than if they got information they already had heard “echoed” in two different frames.

The second example comes from a storytelling application developed as part of the European integrated project TA2 (“Together anytime, Together anywhere” [32]). Its purpose is to allow people to enjoy storytelling activities even if spatially separated, but could also be used to tackle similar issues:

As the participants take on different characters of a story the orchestration and audio/visual composition provided by the TA2 system could be used to alter the speaker’s voice, present images/animations of elements of the story, and so on; but this would require that the application engine knows how to recognize the different frames. The first example of the diegetic poses frame is a case in point – you would only want the wolf-voice modulation to appear on the diegetic dialogue section and not the diegetic pose part. It might of course make the second part redundant, since we hear that it is the wolf that is speaking, but we still need to differ between the wolf and red riding hood, for example. If the storyteller is describing what grandmother’s house looks like, the audiovisual content could reflect this, necessitating a differentiation between the diegetic description frame and others. With a non-interactive story the text could be annotated beforehand, but an interactive story (or a story that left room for improvisations) would require more real-time orchestration. This could either be done automatically by a system if advanced enough, or by providing the storyteller (and/or participants) with an effects interface.

In the same vein, we might want a system to exclude communications that are not pertinent to the activity (non-diegetic non-activity related), and make sure that communications that are activity but not story related (non-diegetic activity related) does not disturb the activity, perhaps by sending it through another channel as in a MUD/MUSH. Sleep Is Death [26] on the other hand, does away with the non-diegetic channel completely, eliminating non-diegetic non-activity related communication, but also forcing players to either skip or send non-diegetic concerns through the diegetic interface (or find an alternate channel, outside the game).

8 Conclusion

This article builds upon interview data from players and outlines frames for the activities in storytelling games. Where earlier work had other areas of focus, this article covers more types of games and in greater granularity, also indicating that there exist additional, "modulating" concerns that alter the frames in important ways. This article also has a clearer design focus, providing examples of how insight into frames can be beneficial when creating support systems. This could also potentially be useful when analyzing the exchange taking place during storytelling.

It can hopefully help bridge the creativity of the non-digital storytelling session with the possibilities afforded to us in the digital sphere, such as storytelling even if spatially separated, audiovisual enhancement and automatic orchestration/narration. There are two paths for further research; one theoretical, where the next step would be to look at detailed transcripts from different storytelling sessions and annotate manually to get a more quantitative measure of how much information belongs in the different frames, and one practical, which would entail creating new tools incorporating these insights.

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Socially Optimized Learning in Virtual Environments (SOLVE)

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Abstract. Although young men who have sex with men (MSM) are at high risk for contracting HIV, few interventions address the affective/automatic factors (e.g., sexual arousal, shame/stigma) that may precipitate young MSM's risk-taking. A National Institutes of Health (NIH)-funded DVD interactive video intervention that simulated a "virtual date" with guides/mentors reduced sexual risk over 3-months for Black, Latino and Caucasian young MSM. In the current work, limitations of the DVD format (e.g., number of different risk challenges MSM encounter; DVD quickly becomes dated) were addressed with 3-D animated intelligent agents/interactive digital storytelling using a Unity Game platform. The development (e.g., design, art, social science formative research, etc.) of this NIH funded game for changing risky behavior is described as well as the ongoing national randomized "on-line" evaluation over 6 months.

Keywords: Virtual Characters and Agents, Narrativity in Games, Games for Health, HIV Prevention, Intelligent Agents, PsychSim, 3-D Animated Characters, Interactive Digital Storytelling (IDS), SOLVE.

1 Introduction

1.1 Gaps in HIV Prevention for Men Who Have Sex with Men (MSM)

HIV infection continues to rise, especially among young men (18-24) who have sex with men (MSM) [1]. Surprisingly few HIV prevention interventions address young MSM's specific needs. Most existing interventions focus on changing more cognitive and deliberative processes. Many MSM, however, guided by contextual cues in

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sexually and emotionally arousing scenarios, "get caught up in the moment" and make more automatic decisions they later regret [2]. Shame, for example, left unaddressed, might be activated in MSM's sexual narratives; with sexual arousal, shame might precipitate risk-taking [2].

Conventional one-on-one and group interventions neglect more contextual and affectively-based decisions. Alternative methods are needed to simulate the ongoing narrative that involves complex and intimate emotions. Although interventions to reduce shame or self-regulate emotion are unavailable, developmental work (on parent-child interactions) suggests ways to achieve this [3]. Adaptations of these interventions might change adult behavior if a similar parent-like mentor/guide could intervene at the critical decision points. But, using real-life mentors raises feasibility concerns.

1.2 Virtual Interactive Interventions Using Interactive Video

Virtual Interactive Interventions Can Successfully Fill the Gap. Virtual interactive interventions can engage young MSM in sex positive narratives that simulate real life risky contexts. Within virtual narratives, these risky situations afford opportunities for self-regulatory interventions. Using an approach called Socially Optimized Learning in Virtual Environments (SOLVE), "virtual date" narratives based on extensive formative research with MSM were constructed [2] and targeted by ethnicity (Black, Latino, and Caucasian) for 18 to 30 year old MSM [2]. On the virtual date, players made a series of decisions (e.g., about alcohol, sex, condoms, etc.) that affected how the action proceeded. If they took risks (e.g., chose unprotected sex) peer mentors/guides intervened to interrupt and challenge their risky choices, acknowledging their emotions and motives, and providing a means to effectively address their choices using what we refer to as "narrative self-regulatory circuitry." Then, after rethinking choices MSM continue the date. MSM's choices were recorded. In two longitudinal studies [2, 4] compared to the control condition, MSM exposed to the SOLVE intervention reduced unprotected anal intercourse (UAI) more over the subsequent period (up to 3 months); although in the second intervention [2] this effect occurred only for younger MSM (18-24). The intervention significantly reduced shame compared to the control and that reduction in shame, rather than cognitive variables (e.g., intentions, beliefs) predicted reduced sexual risk-taking over 3 months [2].

Limitations of Interactive Video. Because Read [4] used human actors and interactive video to create the narratives and guide interventions to risky choices, the intervention could quickly become outdated and updates to the scenarios, dialogue, and interventions were not feasible. In addition, given the space/branching structure limitations of DVD technology, MSM could not be offered a richer experience with more alternative interpersonal challenges. Furthermore, migrating this intervention for over the web use is difficult.

1.3 New Game Approach

Games with animated intelligent characters could readily address these limitations. First, changes using existing interactive digital media within games afford adaptive potential. Visual features of actors (e.g., clothing, hair styles) or dating scenes (e.g., club characteristics) can be updated relatively easily. With sufficient recorded dialogue initially, re-edits and re-animating characters for dialogue changes are feasible. Researchers can modify the nature of and the specifics of the intervention at critical choice points. Second, new venues (e.g., parks, bathhouses) can be added to provide additional risky challenges within which to intervene. Third, because agents have modifiable underlying parameters that guide their behavior, alternative choice points (e.g., given different agent motive settings) can be added. Fourth, migrating game assets is more feasible with cross-compatible platforms (e.g., UNITY).

2 Theoretical Issues and Design Criteria

2.1 Neuroscience Model of Decision-Making: Role of Cognition *and* Affect

Overview. SOLVE is based upon a neuroscience-based model of decision-making [5] that argues that when individuals encounter a situation, two parallel processes are activated. In one, decision-makers use deliberative and conscious processes. In parallel, decision-makers rely on a second set of affect-based processes in which "non-conscious biases," based on the individual's prior emotional experiences in similar situations, initially guide behavior automatically before more conscious processes take effect. SOLVE argues that decisions – in a virtual environment -- can alter players risky decision-making patterns. To do so narratives should first be similar to those in real life.

Cognitive Factors. Second, changes in cognitions are needed. The options for decision-making should be similar to ones typically afforded individuals in that situation. Options may be expanded to more effectively challenge individuals' representation of themselves, others, or the situation. *Knowledge* relevant to reducing risky sex and HIV outcomes should emerge from the narrative, and the interaction should enable changes in client/player's beliefs [4]. Self-efficacy is key to effective behavior change [3]. SOLVE concurrently incorporates observational learning, *virtual* decisional choices/performance outcomes, and persuasive techniques to increase user self-efficacy. Perceptions of one's options in decision-making may also be influenced by *one's beliefs about one's partner*, the ongoing interaction, and future outcomes. To achieve individual's goals, an "if-then" plan specifying when, where, and how to instigate the behavior may be needed. SOLVE incorporates the specific contexts, timing, and procedural sequences needed where users can make choices for their character. The intervention should also facilitate new skills and procedural knowledge (e.g., how to negotiate safer sex) to afford safer options. Critical to interventions is their ability to 1) recreate situations and narratives virtually that are similar to ones that automatically activate risky decisions in real life, and 2) provide opportunities for players to learn to better monitor and effectively respond – both cognitively *and* affectively -- in risky contexts.

Affective Factors. Emotions mediate decision-making processes [5]. Especially under conflict or uncertainty, emotional responses mark the situation as "good" (approach) or "bad" (avoid), assisting, often non-consciously, in decision-making. Research on state dependent learning suggests that if learning occurs (e.g., in virtual contexts) when individuals are sexually aroused, MSM might more automatically activate, retrieve, and integrate relevant skills, knowledge, beliefs, etc., pertaining to safer sex when MSM are in similar real-life risky contexts [4]. Shame is a self-conscious emotion that is directly tied to one's social identity. This painful feeling results when a perceived moral transgression is believed due to a stable, uncontrollable characteristic of the self [6]. Individuals ashamed of their sexual identity may suppress it, which can further intensify negative self-evaluations [6]. If not sufficiently acknowledged and regulated, these negative feelings (e.g., disgust with self; anger with self) may be automatically elicited during sexual situations and increase alcohol/drug consumption and sexual risk-taking [6].

2.2 Role of Self-Regulatory Feedback for Envisioning the Future and Reducing Shame

Self-regulation and Risky Decisions. Risk-taking can be viewed as a failure of self-regulation or the ability to monitor and respond effectively to one's emotions and motives and develop plans to optimize immediate and long-term goals. Self-regulation depends upon accurately labeling emotions and cognitions associated with them, and understanding what these mean for motives, goals, problem solving, decision-making, and behavior [2, 3]. The emotional meanings (e.g., good or bad) of the links among these components can be affected by social interaction (e.g., with caregivers, coaches, mentors, and peers), through, for example, the co-construction of narratives regarding what has just happened. With positive outcomes, self-regulated learners can enhance their self-efficacy and ability to achieve approach goals while avoiding harm more automatically[3].

In SOLVE using interactive video (SOLVE-IAV), guides were two peer counselors who interrupted users when they made a risky decision. Guides would then scaffold self-regulation of emotions, cognitions, motivations, and behavioral options using an **I**nterrupt-**C**hallenge-**A**cknowledge-**P**rovide (ICAP) process [7]. Thus, guides *interrupt* risky choices and players' decisions are frozen before the sequence proceeds. Guides provide *challenging* messages, *acknowledging* MSM's emotions and short and long-term desires (e.g., anal sex with an attractive man, staying healthy) and provide a means (e.g., condoms) to satisfy long-term and short-term goals. We refer to this narrative reframing process as the "narrative self-regulatory circuitry".

Shame reduction. Shame was significantly reduced in SOLVE-IAV compared to the control [2]. To achieve this for MSM, we first acknowledge MSM's desires for attractive men as normative/acceptable for them. The intimacy between men is portrayed in a sex and gay-positive way. Models also non-verbally stress the value of the self as loveable while guides encourage players to have fun but also protect themselves because "we don't want you to get this disease."

Virtual Future Self. In SOLVE using intelligent and gaming technologies (SOLVE-IT), we had to decide who/what would assume the role of the mentor/tutor/guides. Because players could create their own characters, that also made it possible to "age" each player's "self" to create a virtual future self (VFS) who was a few years older.

Prior work suggests that messages are more persuasive if the virtual character delivering the message appeared or acted similar to the self [8]. This virtual future self-character is illustrated in Figure 1.

2.3 Variability

Different MSM experience different obstacles to safer sex. For example, a major obstacle for some MSM to using condoms was ensuring that they took condoms with them (and ensuring that they had fresh ones). Other MSM had obstacles associated with certain drugs (e.g., methamphetamine) or with drinking too much alcohol. Other MSM were concerned that their partner might reject them and this led them to not insisting on safer sex. This variability was addressed by incorporating as many obstacles as feasible given budgetary constraints.

MSM vary considerably (e.g., in the types of sexual behaviors preferred; positions preferred, types of relationships sought): The game incorporates this. Some variability in MSM's responses is predicted by varying beliefs about the self and others as loveable. We developed options for players reflecting those attachment differences. Player style differences are measured and might provide agent parameters to model user game choices.

2.4 Tailoring

Message Framing. Part of the ICAP process involves selecting an effective challenge message for the guides/virtual future self. Prospect Theory [9] predicts that with low risk, gain-framed messages (what the player stands to gain) should work better but under high risk, loss-framed messages (emphasizing what the player might lose) might work better. A recent meta-analysis of prevention-oriented framing, though, found little gain-frame advantage. Pilot work (see below) illuminated what messages to use and when.

3 Design

3.1 Overview of Criteria and Formative Research

The theory and research delineated above suggests a number of criteria to implement in the game's design, including (1) ensuring venues for risk are similar to those MSM encounter in everyday life, (2) ensuring attractive partners, appropriate sexual positions, and similar narrative structures (to engender sexual arousal as in real life), (3) ensuring dialogue is realistic for target audience, and (4) tempering decision-making and ensuring appropriately tailored framed messages in interventions that are discussed in more detail below.

Ensuring Similar Venues for Risk. In our national sample 501 MSM 18 to 24 years of age from each of three ethnic groups indicated the most common place in the last 90 days to meet a sex partner. Although hooking up was over the Internet is most common, a game within a game is artistically boring and compared to face to face negotiation MSM find internet negotiation less challenging (in terms of achieving their goals). Therefore, we use the next two most popular venues (meeting at a dance club or at a house party). The house party may be especially relevant to rural/small town MSM and 18-20 year olds who are excluded from bars. Most MSM eventually frequent a bar/dance club. As is typical in real-life, the game player is invited to the party by his friend.

Inducing Similar Affective States. Inducing sexual arousal within the game is important since this typically occurs prior to unsafe sex. In prior work with interactive video, the video successfully enhanced sexual arousal compared to the control. We achieved that by ensuring attractive partners, appropriate sexual position options, and sexual and dating narrative structures that activated sexual arousal. Formative research with a national sample determined which faces and body types were most attractive and what sexual positions were most preferred. Earlier extensive formative research established the nature of the scenarios to virtual dates for MSM [2,4].

Ensuring Appropriate Options at Decision Points for Target Audience. The primary purpose of a formative pilot study was to understand the various ways men who have sex with men (MSM) might verbally respond to a sexual partner that wants to engage in unsafe sex. The information gained might then inform the dialogue and choices in the videogame. Those eligible to participate were 18 to 24 years old, HIV negative, previously had anal intercourse with another man, and self-identified as Black, Latino, or White. Participants were asked to imagine a situation in which their sexual partner wanted to have UAI. Participants were then asked to rate the likelihood they would say 10 possible phrases in response. The likelihood scale was 7 points from (1) very unlikely to (7) very likely. A paired-sample t-test indicated that, across the sample, participants reported that they were significantly more likely to "directly" object to unsafe anal sex compared to suggesting safe, "alternative" sexual activities.

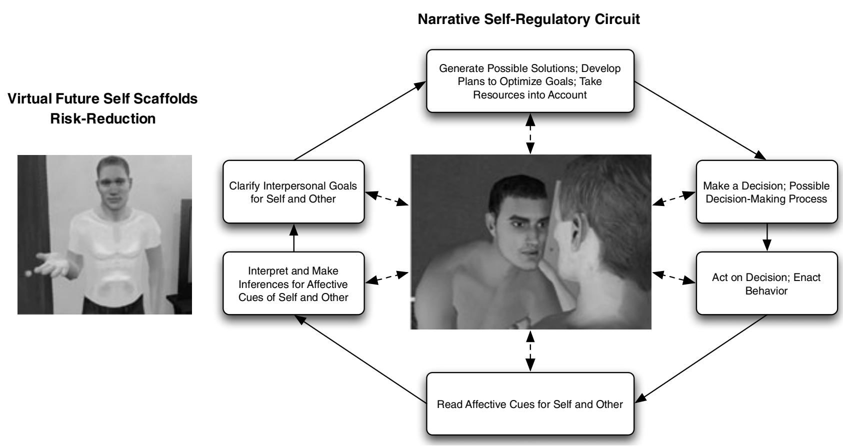

Fig. 1. Narrative self-regulatory circuitry enhanced by one's virtual future self (Source: Miller et al., 2011)

Tempering decision-making. Acknowledging MSM's emotional responses (e.g., attraction to another man) could backfire, and result in MSM engaging in risky behavior if shame is activated – without defusing it appropriately. While enhancing sexual arousal/partner desirability via the art/animation, one must ensure sex-positive and protection-promoting VFS animation and verbalizations.

3.2 Interactive Story

Basic Structure. The SOLVE-It game begins with the player “dressing” in his apartment by customizing his character's hair color, eye color, ethnicity/skin tone, T-shirt, shoes, and jeans. Before going to a house party, his Virtual Future Self (VFS), an embodied conscience throughout the game, introduces himself.

From then on, the player’s goal is to meet a guy, go home with him, and negotiate safe sex. In Level 1 he meets guys at a friends' party, in Level 2 he meets them at a dance club. He can walk up to guys and have a conversation with them, and if things go well, can have a drink or dance with them. The player’s conversational choices are via a menu system. Once the player chooses a partner, the game moves into a critical living room scene, where the player has an interactive negotiation about safe sex. This VFS comments on the outcome of that negotiation. Following a transition to the bedroom, another negotiation about safe sex occurs. The player can change his mind about condoms, or the type of sex he wants. He can perform different sex acts. The bedroom scene ends the level, followed by a "recap" scene, where the VFS reviews choices. Tracked choices are number of drinks, type of sex chosen, and the final decision about condoms. After Level 1 (House Party) the player enters similar scenes for level 2 (Bar/Club), and the negotiation is more difficult. At level 2’s end there’s another recap with new messages about meth and condom use.

3.3 Feedback Design (VFS)

In a pilot study, we examined participants’ risky decision-making as a potential moderator. After choosing to either avoid or take a virtual risk, MSM were randomly assigned to a gain-frame condition, a loss-frame condition, or a no message control condition. Participants’ resultant intentions indicated that when players made risky (safer) choices we should use a gain (loss) frame message.

3.4 Art and Animation Design

The design goals were to realize an engaging environment creating emotional states similar to that in real life. Having designed the characters to be physically attractive, their behavior needed to support this. Known male flirtation signals (e.g., complimenting each other’s appearance, direct gaze, smiling, coy glances, intimate touching) primed the player for the greater intimacy to come. Given the role of affect in decision-making, the game, especially the bedroom scenes, is purposefully quite steamy.

3.5 Technology Design

Just as in the art and animation design, there were pedagogical design concerns that raised challenges for the technology design. A key concern was to create a rich, engaging experience that adhered to the pedagogical concerns. It should be possible for the player to tailor the experience by selecting from a range of partners and choosing a range of topics when they meet. We wanted challenging negotiations about safe sex between the player and his chosen partner that gave the player the ability to chose between offers, to reject the partner's offer, make counter-proposals, and concede, as well as employ affective strategies (e.g., trust appeals). Still, this richness had to be achieved under budgetary constraints.

The game is realized in Unity. Because non-programmers would be informing the game design, we developed an XML scripting environment to control all aspects of the game, including dialog choices, events, animation, camera control, and level changes. To afford players partner choices while keeping animation costs within budget, we used a set of floating dialogs in those scenes. These floating dialogs were attached to a specific character when the player conversed with that character. Once used, a floating dialog couldn't be reused. Subsequent characters chosen used different dialog. The final dialog the player encountered, in effect the last one remaining to be used, was designed so a player could not reject the agent so as to ensure the player would move to the living room negotiation.

Each floating dialog was additionally designed to support a range of discussion topics (Where are you from? what do you do for fun? what is your favorite film? etc.). These topics existed in "topic pools" that allowed the player to choose a topic and then when that topic was exhausted optionally to select another topic or alternatively move on to essentially sealing the deal. The floating dialogs and topic pools overall supported a rich, tailored experience in these opening scenes while keeping production costs down.

The pedagogical concerns for the living room negotiation were different – here the concern was for the player to be engaged in a negotiation that mirrored and therefore provided practice for the kinds of open-ended challenges and negotiation moves that would occur in a real world negotiation over safe sex. Also, because different players as well as different characters may be more or less risk averse, have different sexual preferences, and differ in attraction to the other partner, they may very different behavior in the negotiation. This need for richness and variation led us to an agent based approach that generated the scene automatically, discussed below. We could incorporate such a space of variations by varying the goal preferences of an agent-based model.

However, because we would deliver the game over the web, it was not feasible to incorporate the agent code itself in the game and have the player play against an agent directly. Instead, different variants of two agents were played against each other. The system then passed the negotiation paths to a simple natural language generation system that generated the surface utterances, coalesced the paths and generated the XML script automatically to control the scene, including providing menu choices for the player's character. Using this approach, numerous multiple negotiation paths could be generated automatically during development, as many as feasible given development resource limits. The paths generated by the agent system were vetted/filtered by the pedagogical design team as realistic, balanced in terms of various negotiation moves (e.g., complimenting occurring on paths resulting in safer and riskier choices) and finally constrained to always result in some negotiated settlement that enabled the next scene/level. The final bedroom scene was a hand-scripted scenario where player and partner could renege on the agreement and thereby re-open negotiation.

3.6 Agent Design

The SOLVE-IT game consists of two agents that can make various negotiation moves, offering, counter-offering and complimenting in an effort to persuade the other to accept their offer. The agents were modeled in the PsychSim multi-agent system [10] that uses a decision-theoretic framework for quantitative modeling of multiple agents that allows agents to reason about tradeoffs in achieving their goals. PsychSim agents are additionally equipped with a Theory of Mind that allows them to reason about beliefs and behavior of other agents.

A full description of the agent models is beyond the scope of this article but is described elsewhere [11]. Key aspects of the model include the basic goals of the agents – which are the conflicting goals of maximizing affective states of arousal and feeling safe and an agent's relative preferences for those goals (how important each is). In addition, there are the basic mechanisms of keeping track of the negotiation state (e.g., who has offered what) as well as the state of the agents. The latter includes how risky another agent is (i.e., does the other agent have an STD) and how attractive the other agent is. In addition the model distinguished between actual state (e.g., having an STD) and an agent's beliefs about that state (does an agent believe another has an STD).

Agents have a set of actions that they can take: proposing or counter-proposing various forms of safe or unsafe sex, complimenting the other agent, making trust appeals ("trust me I am not infected with HIV"), *accepting* an offer or *rejecting the negotiation*. The actions influence the negotiation state and more interestingly the agents' affective states. For example, *Compliment* can alter an agent's beliefs about the riskiness and attractiveness of another agent. This has the consequence that he is more willing to accept an unsafe offer for two reasons: First, he will believe there is a higher reward for *Arousal* which is caused by the increased *Attractive*ness of the other agent and second, the smaller penalty for *FeelingSafe*, caused by the lower *Risky* value. In essence, the compliment changes one's view of the payoff, the benefit and cost, of having sex with the other, while agreeing to sex impacts arousal (as well as feeling safe). And of course having sex will impact the agents' *Arousal* and *FeelingSafe* states, depending on how Attractive and Risky, respectively, the other agent is. The agents are able to think several steps ahead, so they can reason about their future actions and, because of the Theory of Mind, can reason about the other one's future actions. This affords reasoning about potential benefits of complimenting.

Variations of this basic general model can be created by altering the goal preferences of the agents for getting aroused and being safe as well as altering the state of the agents (how attractive the agent is and how risky they are). In having two agent variants negotiate to generate the negotiation, we chose the extreme parameter settings, so, for example, one would prefer feeling safe more and the other would prefer getting aroused more to maximize negotiating training. To entice the agent who preferred feeling safe, the other agent would be especially attractive to him. The user could take on one position and the negotiation partner will demonstrate the other extreme position for a more challenging negotiation. Also to make the level 2 negotiations more difficult, the agents have even more extreme preferences that make them harder to negotiate with in order to enhance training effects. Regardless, the negotiation is biased towards an agreement so the user experiences the rest of the game. In future versions of the game we plan to explore additional factors like drinking alcohol that would change an agent's preferences for *Arousal* or *FeelingSafe*, their beliefs about the other's attractiveness or their decision-making. Thus, when drunk, they will perceive others as less risky and more attractive, their arousal will go up and their horizon over which they compute the consequences of their behavior reduces. Therefore, the likelihood for unsafe sex increases.

4 Future Work

The SOLVE-It game is being evaluated in a randomized controlled trial over 6 months with over 2500 MSM nationally. Participants are recruited online, fill out a baseline measure (demographics, personality, cognitive and affective measures, past sexual behavior) then download the game (if in that condition), fill out an immediate post assessment of cognitive/affective variables. Participants' perceptions of the game and the agents are also assessed. After three months and six months, participants will fill out the baseline measures again. Game choices are recorded.

An additional goal is to collect individual difference measures relevant to the parameters in PsychSim (e.g., beliefs about self and others involving differences in attachment styles). Our plan is to use individual data to model the behavior of agents set to their human users' parameters to attempt to anticipate and model the decision making choices of the user in the game.

5 Conclusion

Over the last decade, there has been a rapid growth in the use of interactive narrative games and agent technologies in the design of health interventions. For example, Carmen's Bright IDEAS [12] uses interactive stories to teach problem solving skills to mothers of pediatric cancer patients. FearNot![13] enables children to consider coping strategies for school bully issues. A virtual café populated with conversational agents [14] is used to teach children with autism spectrum disorders social skills. In this paper, we report on the design of SOLVE-IT, an animated interactive narrative game to address risky behavior and HIV prevention. The game has been crafted based on a model of the cognitive and affective biases that influence decision-making and as well as our earlier experiences in developing an interactive video for AIDs prevention. SOLVE-IT is currently in a large scale, 6-month longitudinal clinical trial. This paper highlights the nuanced ways social science research and theory can be incorporated into and leverage intelligent design.

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Event-Centric Control for Background Agents

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Abstract. This paper describes a framework for controlling the varied activities of groups of background characters (representing extras or supernumeraries). Our platform is built upon an event-centric agent control model, which shifts behavior authoring from writing complex reactive agents to authoring particular activities. This approach allows us to achieve diverse, complex, and collaborative activities while the agents themselves stay simple and generic. An event is defined generically on agent roles, and can be dispatched to any set of agents that can fill those roles. This allows us to control macro-level group behavior with a centralized entity called the Group Coordinator that dispatches events to agents based on their situational and locational context (which can be controlled by an author). What results a structure for controlling macroscopic behavior for groups of background agents.

Keywords: Virtual Characters and Agents, Narrativity in Digital Games, Story Generation and Drama Management, Real-time Techniques for Interactive Storytelling.

1 Introduction

With few exceptions, the settings of interactive fiction and simulations are populated by autonomous individuals. Some of these individuals consist of bystanders, pedestrians, or other non-focal characters in the background. In traditional cinematography, these individuals are represented by "extras" – actors performing minor tasks that, on a macroscopic level, affect the mood, atmosphere, or illusion of realism. While a great deal of work has been put into simulating the positioning and locomotion of crowds, less attention has been paid to the performance of a group's coordinated activities within a spatiotemporal context [1, 4–6].

To make the background agents of a scene more useful, they must perform actions consistent with their surroundings. For instance, in an urban simulation, some agents could sit and read a book, but this action is more appropriate in a park than in a movie theater. Furthermore, agents must interact with one another in a coherent manner given their spatiotemporal context, such as having a conversation in the park, or sharing popcorn in the movie theater.

In order to simplify the interactions between agents, we centralize the control of multiple agents in a structure called an event. An event specifies the role each

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participating agent plays and the sequence of actions each role should perform on one timeline. For instance, a transaction event would involve a buyer and a seller, and direct each participant to play the correct animations and sounds in the proper sequence to simulate the exchange of goods. We see a similar system with Smart Events [10], but with some key differences. Smart Events notify subscriber agents, at which point the subscriber agent can decide the manner in which it responds, if at all, on an individual basis. Our events take full control of their involved agents, and suspend those agents' autonomy [8]. When an agent is under the control of a dispatched event, it follows the 'script' provided by the event's description. Events of varying priority can preempt one another, but an agent can only be a member of one event at a time.

This provides two advantages. First, once an event is dispatched, it requires no external oversight, and will properly direct each agent involved to behave consistently until complete. Second, since multiple agents are controlled by a single event, it is easy to describe what groups of agents are doing in the environment. By contrast, suppose we authored all conversations reactively in each agent, so that if an agent greets another, that other agent knows to reply to the first, and so on. It may be difficult to inspect those two agents and know that they are in a conversation, or what kind of conversation they are in, since they are each only responding to the stimuli the other provides. If the two agents were in a 'conversation' event, however, we could immediately inspect those agents, recognize that they were being controlled by a conversation event, and retrieve the parameters of that event for more information on its purpose or mood.

In this paper we present our event-based framework enabling centralized simultaneous absolute control of groups of agents with one logical structure. We then discuss a system that dispatches these events in order to direct groups of simple agents to perform collaborative actions with respect to the context of their environment. We show how the distribution of actions appropriate for a location can be controlled based on environmental factors and time. We then conclude with final thoughts and ongoing work.

2 Event-Centric Behavior Authoring

We cannot feasibly build a single Director that controls every aspect of every agent's behavior in a scalable fashion. Even by abstracting complex behaviors into simpler commands and suggestions on the part of the Director (as in [9]), it is impractical to expect a designer to author the logic of an entity for centralized, active control over every agent at all times for larger-scale groups. On the other hand, we do not want to increase the complexity of each agent, as large groups of significant, high-dimensional characters are difficult to model and coordinate [11]. Furthermore, relying on emergent reactive behavior in each agent to properly perform interactions offers limited control over the distribution of events in the environment. If a type of cooperative behavior only occurs when the situation is favorable and the agents decide to perform it (say, a conversation begins when two agents are facing one another), we cannot guarantee that that event will occur with a spatial distribution or temporal frequency, which may be desirable for expressing the overall mood of a crowd.

We balance this conflict with an event-driven architecture. Conceptually, events sit above groups of agents and below a top-level centralized Director [9]. The Director can concern itself with the problem of deciding which events, broadly speaking, should occur in the environment, and let the 'script' of each event handle the detailed execution of those particular collaborative actions. Since events take full control over the agents involved, the only individual behavior logic agents need is a set of actions to perform so as to look busy when not involved in an event. This keeps agents simple, since any reactions to other agents are handled by the event logic. With background characters we are mostly interested in the broad-scale behaviors that the agents can perform to make the scene feel alive, so we can afford to reduce the fidelity of the individual agents.

This approach is described in more detail in [8], which uses parameterized Behavior Trees that act generically on classes of agents. An event behavior tree, when instantiated, takes full control over the agents in its role fields and executes its internal 'script' on them, which can also take parameters to modulate its behavior (say, the mood of a conversation). When the event terminates, the involved agents return to their idle behaviors and wait to be selected for another event, sitting in a pool of available agents.

3 Ambient Event Selection and Population

To control ambient background agents as the "extras" of a scene, we use a dedicated entity we call a Group Coordinator. We make an important distinction between background characters and principal characters, the latter being pivotal story-driven agents that drive the narrative forward. Principal characters are usually controlled with a planning approach, using actions and preconditions as a dynamic script for the intended plot [3] or with global constraints based on actors' collaborative or competitive goals [2]. We are instead concerned with background agents whose sole purpose is to decorate a scene, so planning and long-term causality are unnecessary. Principal character agents and background agents can both be controlled with the same event (such as an event where a principal agent gives a speech to a cheering crowd of background agents), but a detailed explanation of the interactions between these two categories of agents and the player is outside the scope of this discussion.

The Group Coordinator's sole purpose is to enforce author-specified spatiotemporal distributions of events. Each event is given a category when written and placed in a database. Then, for each location and general time period in the environment, the scenario author specifies a desired distribution over each event category. The Group Coordinator is responsible for enforcing that distribution. If the distance between the desired event distribution and the actual distribution (that is, a normalized count of the currently active events' categories) exceeds a specified threshold, the Group Coordinator identifies the most severely underrepresented event category, selects an event within that category (by some criteria),

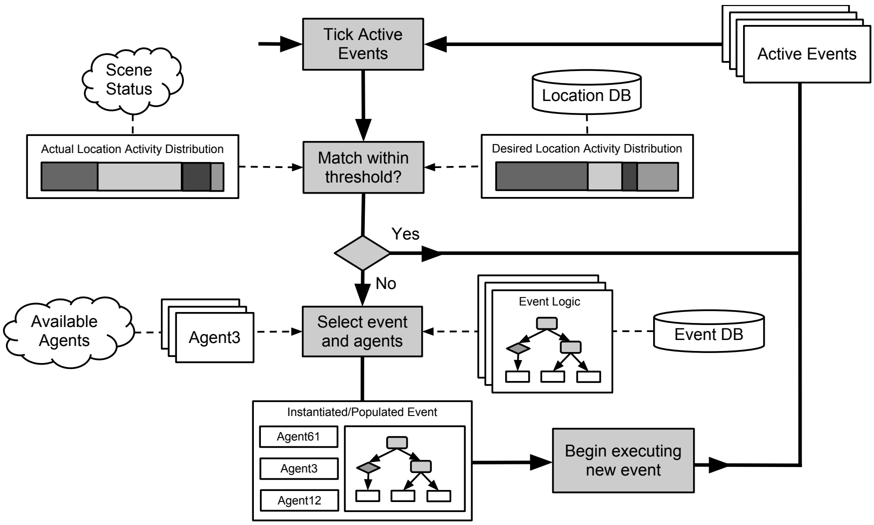

Fig. 1. A conceptualization of the Group Coordinator control process for background groups

and dispatches that event to some agents to perform. The Group Coordinator's decision process is illustrated in more detail in Fig. 1.

The expected distribution of events in a location can change over time or according to some situational factors. An adjustment to the distribution of events for a location can represent effects such as a day/night cycle (a temporal adjustment), or a slow mood shift based on some narrative progression (a situational adjustment). These changes are gradual, since they only affect the selection of new events and have no bearing on events in progress. For instant reaction, such as responding to a fire, it is better to place all of the relevant agents in a high-priority event that instructs each agent to flee (or assist, depending on some decision).

The process of selecting agents to fulfill the roles in an event is more complex. Preliminary work on this issue is discussed in [7], but we will briefly address it here. Agents can be selected based on any number of criteria, including location, age, occupation, and so on. The degree of constraint on the agent selection process influences how readily the Group Coordinator can function. Events that place more restrictions on the selection of agents for its roles will prove more difficult to populate, as it is less likely that agents will be available to meet these criteria. If the event database is populated with a large number of very exclusive events, then the Group Coordinator will have difficulty instantiating events, and will therefore be less able to enforce the desired distribution of events for the environment.

It may be appealing to enforce constraints such as "I cannot purchase an item if I have no money", so that no agent acts inconsistently after prolonged examination. However, the player also has the expectation when observing a shopping mall that there be agents involved in transactions. If no agent can purchase because they have all depleted their monetary allowance, then the player's observation of a scene is inconsistent with her expectations. We see individual agents as less important than the groups they comprise, so we forego some agent-level constraints for the sake of whole-group behaviors.

4 Conclusions

Adding background agents to a scene is important for narrative; well-populated areas represented in a story are less convincing if only a few simulated actors inhabit them. Individually, however, these agents are not meaningful to the player, and so we have no reason to personify them beyond their specific role in the scene. Since ambient characters may only play one or two minor roles in a scene before they are discarded, we do not want to waste a complex behavioral repertoire on each of them. At the same time, we do not want to author a diverse pool of simple agents that are specialized to certain ambient tasks.

Event centrism provides a means to retain agent action diversity while mitigating individual agent complexity. When complex behaviors, especially interactions and coordination between agents, are abstracted in a centralized event structure, behavioral repertoires for agents expand when needed. Any convenient agent can be selected to perform a complex sequence of actions while being neither unduly sophisticated nor unnecessarily specialized. Furthermore, we can describe and control the world based on what is happening in it, rather than just who or what is in it. Events capture and denote activity in the world.

As alluded to in Sec. 3, we would like to author narrative progression as sequences of events as well. Background agents are not given narrative qualities (like a backstory) and are not integral to the plot, but they can be used to react to the actions of principal plot characters. An event could easily coordinate both a principal character giving a speech on a podium, and a crowd of background agents gathering and responding to the oration. Events provide an opportunity to develop a story in the domain of plot occurrences.

Currently this framework is being implemented in what we call the Agent Development and Prototyping Testbed (ADAPT), which features toolkits for agent modeling, behavior authoring, and full simulation on top of the Unity game engine. We expect to evaluate the degree to which an event-centric agent control methodology simplifies the task of adding multi-agent behaviors to the environment. Since event centrism allows direct control over the spatiotemporal distribution of behaviors across agents, we expect groups controlled in this manner to act more believably on a macroscopic level than groups of agents authored solely with agent-centric reactive control logic. Understanding the consequences of these design decisions will allow us to better balance the degree to which we depend on either agent sophistication or event-centrism, and how specifically we design our events with respect to agent selection and roles.

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Multi-user Interactive Drama: A Micro User Drama in Process

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Abstract. Process dramas emerge through the interplay of a number of factors including the types of participants and the context of the interaction. The term 'process drama' was coined by Cecily O'Neil, whose approach to theater in education practice explores the interplay of structure and spontaneity in dramatic workshops directed towards a thematic dialogue. The analysis presented here refers to O'Neil's model in order to explore the factors that influence what is arguably the focal point of computer-mediated multi-user dramas, the individual user's real time experience of that drama. It is proposed that *The User Drama* can be identified as a six phase process: 1) Perceive and Expect, 2) Invest and Express, 3) Experience Results, 4) Loop, 5) Merge and 6) Reflect.

Keywords: Interactive Drama, Interactive Narrative.

1 Introduction

This paper introduces a two part preliminary poetics for multi-user interactive drama. It is partnered with an additional paper that explores the concept of interactive drama located amidst three structural layers [1]: the source drama (first layer), defined as the primary system that evokes a dramatic user experience, (the second layer, the user drama), in combination with other users and networked media (the third layer, the multi drama).

The user's real time encounter with these structures is the focus here. As a starting point the paper asks you to consider the non-linear performance installation *Tawdry Heartburn's Manic Cures* (For the sake of expediency referred to here as *THMC* [2]). *THMC* is staged at cultural festivals by Australian performance artist James Berlyn. In a large marquis tent amidst a table full of old typewriters and stacks of empty bits of A5 paper, participants encounter the invitation to 'Get It Off Your Chest.' Palm readings and manicures are offered in exchange for secrets, or if users prefer they can simply launch in and type. Anonymous confessions lodged in a locked box soon line the walls of the tent. Many are later uploaded to a partner website, http://tawdryheartburn.com/ for archiving purposes.

As delivered, *THMC* explores a theme, rather than a linear plot. As one journalist reported, "Secrets range from chuckle-worthy ("Look, I'm going to be straight. I stole

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the money from the Project Compassion box in grade three.") to practical ("The secret to really good puff pastry is to add a tiny bit of cornflour") to thought provoking ("It has taken me 10 years to learn to love my mother") and kooky ("I can only perform 'the act' when my wife is dressed in American civil war attire"). All are intriguing. Berlyn maintains that spilling those beans can be a valuable exercise.

In process, the user's experience becomes the drama. *THMC* certainly guides that experience and employs metaphors that color the interaction. The yellowed pieces of paper and collection of old typewriters suggest something historic and outmoded. However, *THMC feels* like a drama because the *core action* is performative and evokes stories that are deeply personal, yet also universal. The combination of the two can create a psychological and cultural force that reframes both. At the same time these links between source, (private) user and (public) multi-drama intensify the unknowns that inject tension and delight in to that exchange.

Fig. 1. *THMC* in process (photo by Ashley de Prazer)

THMC crosses the borders of game, drama, play and conversation. Participants might perform their own story in a masterful way, but the installation does not employ explicit rules to define an end goal beyond dialogue so it is not a game in the traditional sense [3]. Neither is it clear if it is even a drama in the traditional sense. Like social media, *THMC* appears to stage a kind of 'social playfulness' [4], but unlike social media the source system deliberately stages a reflective, dramatic theme. Whilst traditional models of both games and narrative are still relevant to convergent spaces, something else may also be evolving. *THMC* reflects a renewed embrace of the playful in a media-scape increasingly characterized by games and play. It also reflects the shift from passive viewership to active participation in collaborative media. So too the presentation of this model for interactive drama across two networked chunks affords a variable reading that prompts an active, engaged synthesis. Can procedural authors also stage these sorts of dynamic and playful dialogues to generate computer-mediated, multi-user drama?

2 Computer Mediated Process Drama

THMC is a kind of 'process drama', a term coined by innovative Theater in Education teacher, Cecily O'Neil, who explored the interplay of structure and spontaneity in process drama. Her thematic workshops incorporate improvisations and reflective dialogue to generate "a text in action [5]". This approach is also relevant to computer-mediated, multi-user environments. Both can evolve out of a shared discourse related to a context, rather than one overarching story or character. This paper explores the similarities and differences in these two contexts.

A dramatic engagement normally occurs in response to a dramatic prompt. In *THMC*, prompts might be the colorful tent, or curious title, or the confessions already on display. Users respond to this network of influence according to their perceptions, inclinations and agency within the system constraints. This cycle of prompt and response creates a feedback loop which in gaming is commonly referred to as micro-narrative [6]; here it is referred to as a micro drama. The overall drama develops through the rise and fall of a modular rhythm of layer after layer of these contextual events, or engagements, both over time in the case of the individual user's exposition path and across time, in terms of the inter-relatedness of that event to the entirety of the dialogue.

Although is still much easier to blow up digital objects than have conversations with them computer-mediated systems also afford increasing multi-user intervention through such things as pervasive gaming, portable media, trans-medial networks and online worlds. These collaborative systems can be designed to stage dramatic dialogues between users and also across systems. With that in mind the user drama is approached as an active process in itself.

3 The Six Phases of a User Drama

The complexities involved in crafting a compelling, subjective experience for numerous people demands a keen awareness of the psychological processes at work during interactive play. Luckily, the potentially overwhelming variation inherent to multi-user systems is simplified by at least one probability: All human experience is grounded by real time embodiment, therefore it is posited here that each user potentially enacts a linear process of engagement that can be broken down in to six phases:

Perceive and Expect (variable)
The user's initial encounter with a system, or narrative prompt
Invest and Express (optional)
The user's response, both internal and external, to a system, or narrative prompt

Experience Results (dependant upon earlier investment)
The effect of that combined response
Loop (optional)
The continuing encounters that emerge when an earlier result creates a new prompt for the user
Merge (optional/dependant)
The user and system are increasingly linked, so that boundaries between the two appear to dissolve.
Reflection and reappraisal (variable)
The user processes the new information that they gain from this experience

Each is described briefly below:

3.1 Perceive and Expect

Users arrive with an internal script that helps them decide whether to engage with that space, often on the basis of how they feel about it.

THMC prompts engagement through the materials at hand (light and constrained, yet pointed), combined with the promise of anonymity. An interactive prompt can be either subtle, or intense, depending on its context. In *THMC* this deeper engagement occurs over time, through reflection, where complexity is introduced through the overall dialogue.

3.2 Invest and Express

Once the user is engaged they can then be lured in to the drama through their own efforts. Lodging a confession intensifies the user's involvement in *THMC*. This exploratory process, which includes dialogue, can also manifest a discovery of self.

Links to real world experience can help to imbue real world resonance in virtual play. Similarly, dramatic contexts can be intensified through such things as real time interaction, pseudo physics, narrative mirrors, mimetic interfaces, sound effects and cultural affiliations.

3.3 Experience Results

Bizzocchi argues that catharsis acts as a reward and that micro-dramas create the same effect [6]. When a reward also acts as a prompt for further action it may be necessary to highlight its dual function. "A juicy game feels alive … tons of cascading action and response for minimal user input. [7 :45]" Participants in *THMC* need to return to the tent in order to experience the thrill of seeing their secret on display. When they do they also discover a shared experience. This 'juicy', shared catharsis affords a new perspective and prompts further reflection. Interactive dramas don't need be as loud and exuberant as a casual games interface, but in order to sustain a more prolonged engagement some overt form of user reinforcement is generally prudent. Another possible tactic is to give users regular and easy access to rewarding micro dramas that can either build links over time, or alternatively be designed to provide relief from the demands of social engagement.

3.4 Loop

Just as a particular mix of items on display in an exhibition space (as in *THMC*) can punctuate a theme, over time micro-dramas can and do build upon each other to flesh out their initial, networked context. As the drama progresses the user's expectations and perceptions are adjusted by each subsequent encounter. The pace of this loop rises and falls in cycles of involvement that draw forth either extended, or lighthearted engagements and emerge as patterns [5].

Interactive media is generally more dynamic if that repetition also allows for the possibility of reinvention [7]. Whether an event space presents the same situation from different points of view, or allows for strategic variations, users are generally more likely to maintain interest if they are able to discover, or create something afresh with each new encounter.

Variety of pace and action can be introduced through the range of encounters on offer and the different levels of engagement available. As O'Neill observes, prompts, or pre-texts as she calls them, work best when they pose more questions than answers [5]. In this sort of setting, the repetitive contemplation of a single theme becomes dramatic when each new round reveals another aspect, or layer of meaning that the user is invested in and must now re-integrate. Any change in user behaviour that occurs over time as a result can be marked by periodic micro-dramas designed to manifest and therefore test the user's position. Given that the individual user's progression through these various layers is inherently variable, O'Neill urges that structure takes primacy over script. "It is important not to allow the linear development of the story-line to take over. .... Instead, drama is more likely to arise from moments of tension and design [8 :41]." Rather than worry about climax, shape plots and sub-plots, O'Neill scripts for episodes, transformations, ritual, spectatorship, alienation and fragmentation. In terms of application of this principle to the digital domain consider the ill-fated migration of *The Sims* to the multi-user online environment. In *The Sims* Wright originally used tensions between the competing demands of work and home life to stage an ongoing drama. In order to do this he first compensated for the limits of contemporary AI (artificial intelligence) capabilities by abstracting sim behavior, so that their thoughts were either represented ichnographically, or through gibberish [9]. This strengthened links between the player's internal thoughts and the sims' directed behaviors so that players were able to project their own subjective identity on to their creations. Once that link (of source and user drama) [1] was established further tension points (micro dramas) were injected in the game-play in the form of sim demands. Wright consciously set up competing demands to explore a work versus life balance theme within the limits of play time: "In some sense the game is very much like bowling. If you kind of went off to the side, you'd end up in the gutter, and you had to get it right down the middle to get the highest level of success in the game [10: 12]" This dramatic faltered, however, in the *The Sims Online,* a multi-user online world where Wright had hoped to encourage socialization through the incorporation of delayed and tedious robotic controls [11]. Instead the tedium broke the link between what users might want to do in social environments and what their sims could do, or should do given that in game incentives also appeared to be directed towards task management, rather than making friends [11]. In this case the tension points in fact became obstructions. In the multi-user domain competing demands marked by decision points, or psychological challenge, are nevertheless useful tools. Wright's latest venture, for example, aims to integrate the portability of phones with the ubiquity of *Facebook* in order to both prompt and augment a more social core action: The exchange of real world acts of kindness [12]. The different contexts of each act add variety and depth to the dramatic exploration.

3.5 Merge

Merger equates to the intense flow experience that signals even deeper engagement [13]. User participation in *THMC* is short term, so it is unlikely to produce the type of active flow experience that evolves through repeated practice of an activity such as a dancing game [14]. What emerges instead, in *THMC*, is a dance that dips and sways between immersive engagement - where the everyday world is still present, but the user is distracted from it by a theatrical prompt that evokes their personal dramas in to participatory action – and reflective engagement – where the prompt lingers in the participant's thought processes, whether they are physically present to it, or not – which can be equally distracting in terms of the participant's psychology. The link that evolves out of this dance can be both delightful, emotive and thought provoking. In *THMC*, the multi-drama gains depth because it provides a safe (anonymous) encounter – but not too safe! The open display of secrets adds a tension point that can be thrilling without being overly earnest, but still maintains a respectful anonymity, so there's room to play. Without the stage to separate participants from the drama it is important not to push users too far past their comfort zone. Challenging scenarios may require discursive support and insightful guidance.

3.6 Reflect and Reappraise

Reflexivity is central to the art of making story out of experience, a core aspect of human consciousness. As Aristotle observed the emotional power of tragedy was to provide a form of catharsis, or purging linked to the relief of narrative closure [15]. The delight arises from a combination of safety and empathy in relation to pain, rather than a lack of personal pain per se. *THMC* suggests that in interactive drama the rewards of tragedy are also felt. They just need to be made safe (but not too safe) and personalized through a sense of expression and acceptance, or recognition. O'Neill uses dialogue to continually press reflexivity in to the dramatic process. Brechtian drama practice has demonstrated that the pleasure of reflection and distance rival the pleasures of immersion. Together the two can challenge previous conditioning and introduce the opportunity to inject conflicts of interest between emotion and reason.

Perhaps surprisingly, a useful strategy to support this reflexive transformation is to allow interruptibility, a quality that Juul [16] observes in casual games. Interruptibility is constructed through a variety of tactics including automatic saves, ease of entry and exit, notifications of likely duration and break facilitating moments [16: 36-37]. Engagement with THMC, for example, rolls out in phases between when a secret is lodged to when it is displayed on the walls. The space in between can build tension, or provide a pause that allows the mind to gather a new perspective.

THMC's potency lies in its ability to link each user-drama to a reflective multi-drama. It achieves this through a layered combination of repetition and variety. Due to the subject matter intra-participant interactions such as collaboration and conflict are excluded. As a starting point, *THMC* nevertheless illustrates the six-phase user process within a non-linear, yet potent dramatic dialogue. Although this framework is yet to be tested in empirical investigations it is posited here as an observation to help guide future design efforts to activate and deepen a dramatic dialogue. By highlighting the potential causal links between such things as user expectations, perceptions and the levels of participation and engagement that result these indicators point "procedural authors [17]" towards those aspects of multi-user interaction that, once activated, generate drama.

4 Conclusion

Proposed here is a preliminary poetics for multi-layered, computer mediated, interactive process drama. Interactive environments stage networks of influence that motivate and guide user engagement. Naturally, user experiences vary. Propelled by the user's own perceptions and motivations the drama unfolds differently for each player. Nevertheless each user experiences a linear process that can be broadly characterized according to six phases of engagement: 1) Perceive and Expect, 2) Invest and Express, 3) Experience Results, 4) Loop, 5) Merge, 6) Reflect and Reappraise. These phases describe a process that is, admittedly, an artificial abstraction of a highly variable experience, nevertheless it is posited here as a repetitive motif of the cycles that inform the rhythms, linked themes and tensions of interactive drama. Encounters with digital worlds may be ambient, or intense, ongoing or casual. New information can be continually introduced. Expectations can be continually modified by experience. Insight can be thought to exist only to be subverted. In computer-mediated drama the narrative texture and interactive prompts embedded in the source drama combine to motivate the user to respond to opportunities to achieve what they desire, or risk what they fear, dependant in turn upon their level of agency and skill.

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Full Body Gestures Enhancing a Game Book for Interactive Story Telling

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Abstract. Game Books can offer a well-written, but non-linear story, as readers always have to decide, how to continue after reading a text passage. It seems very logical to adopt such a book to investigate interaction paradigms for an interactive storytelling scenario. Nevertheless, it is not easy to keep the player motivated during a long-winded narrated story until the next point of intervention is reached. In this paper we tested different methods of implementing the decision process in such a scenario using speech input and tested it with 26 participants during a two player scenario. This revealed that with an omitted on-screen prompt the application was less easy to use, but caused considerably more user interaction. We further added additional interactivity with so-called Quick Time Events (QTEs). In these events, the player has a limited amount of time to perform a specific action after a corresponding prompt appeares on screen. Different versions of QTEs were implemented using Full Body Tracking with Microsoft Kinect, and were tested with another 18 participants during a two player scenario. We found that Full Body Gestures were easier to perform and, in general, preferred to controlling a cursor with one hand and hitting buttons with it.

Keywords: Interactive Storytelling, Full Body Tracking, Quick Time Event, User Experience, Game Book, Kinect, Gesture Recognition.

1 Introduction

With the release of the Kinect sensor[1], Microsoft has made depth sensors easily available for every home. This makes it possible to take the next step in human-computer interaction by using Full Body Gestures and Movements. However, it is a challenging task to apply this new way of interaction and to find possibilities for offering a good user experience and usability along with it.

In this paper we use the Kinect sensor to provide different types of interaction for our interactive storytelling scenario adopting parts of the story of the game book "Sugarcane Island" by Edward Packard [10].

[1] http://www.xbox.com/kinect

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Various approaches for providing innovative interaction modalities in interactive storytelling have been investigated in the past. Some of these are described by way of illustration below, though none of them uses Full Body Interaction. Cavazza and colleagues presented an interactive storytelling system[3] where the user can influence the story by speaking to and giving advice to a virtual character, such as "don't be rude". They therefore have speech recognition that uses template matching.

Façade is a well-known interactive drama by Michael Mateas and Andrew Stern [8]. The user can interact by typing any kind of text message on the keyboard. Façade was further evolved further to an augmented reality version, additionally implementing speech recognition with a Wizard-of-Oz setting to provide a more natural interaction [4].

Project Geist is an augmented reality storytelling system [2], where users can perform gestures on a magic wand and speaking basic sentences that are recognized by the system.

To our knowledge, there have as yet been no scientific studies about the application of QTEs. However, good examples of games where there is extensive use of QTEs are *Fahrenheit (Indigo Prophecy)* and *Heavy Rain* from the games developer Quantic Dream [12]. To implement the QTEs, they use mouse gestures and keyboard input on the PC. On the game console, they use button and analog stick input, together with gestures performed on a game pad with an accelerometer. This means that the user is required to perform abstract actions or gestures on a controller in opposite to our implementation of QTEs.

The Kinect games currently available on the Xbox console mainly comprise sport and fitness games (e.g. *Kinect Sports*), racing games (e.g. *Kinect Joy Ride*), and party and puzzle games (e.g. *Game Party in Motion*). They all have some sort of motion or gesture interaction, but none of them concentrates on a story. Indeed, nearly all of them do not have any story at all.

Game books offer a well-written and non-linear story well-suited to an interactive storytelling scenario. Some early examples of the game book genre are described below:
In 1941 Jorge Luis Borges published a short story called *An Examination of the Work of Herbert Quain*[1]. It discusses several works by the fictional author Herbert Quain, including the non-linear novel *April March*. This novel is made up of thirteen chapters, covering nine different story lines. This is achieved through the fact that the first chapter can lead into any one of three subsequent chapters, and each of those in turn has three possible subsequent chapters. It could be considered the first example of the basic idea behind game books.

Another publication along similar lines were the educational books published under the series *TutorText* between 1958 and 1972 [14]. The idea was to enable students to learn without a teacher being present. Multiple-choice questions led to different pages depending on the chosen answer. While an incorrect answer leads to a page explaining what is wrong with the answer, a correct answer leads to a page with more information and the next questions.

2 Application and Methods

For the story line of our application, we adopted parts of the game book "Sugarcane Island" by Edward Packard [10], briefly described in section 2.1. However, unlike the book, our application is designed for two users listening to a virtual narrator and interacting at specific points to influence the story.

We have two different interaction types enabling users to do this. The first is close to the decisions that have to be made while reading the book, and is explained in section 2.2. The second adds QTEs with Full Body Gestures, and is illustrated in section 2.3. For each type of interaction, we have realized two different modes that outline different ways of implementing them.

Our application runs on the *Horde3D GameEngine* [6]. Additionally, we are using *SceneMaker 3* [9] to model and execute the story as a hierarchical finite state machine extended with multimodal scene scripts that consist of the text to be spoken including additional commands like animations or sounds.

2.1 Sugarcane Island

"Sugarcane Island" is the first book in the popular *Choose Your Own Adventure* series. It starts with a shipwreck on an expedition. Waking up on the beach of an unknown island, the reader needs to find a way to survive.

After each text section of the book, the reader has to decide how to proceed. The given choices refer to different pages in the book to read next. For example, the reader has to make a decision on page 17 of the book[2] in the following way:

Page 17: You wake up in a thatched hut. [...] You take a peek outside and observe ferocious looking natives doing a tribal dance around a fire.
You decide to flee. Go to *Page 27*.
You stay. Go to *Page 28*.
Page 27: You start up and sprint into the woods. [...]
Page 28: A little while later, some natives appear in your hut. [...]

2.2 Implementation of Decision Modes

For the decision modes, we chose to implement a part of "Sugarcane Island" that covers about one third of the text. Figure 1 visualizes that part as a decision graph. Each node of the graph refers to one page of the book. The decisions in the story are represented by an edge leading to a subsequent node. Blue edges mark modifications to the original story line. Blue edges without a target node stand for omitted decisions. The black edges constitute a tree, and therefore a story without any multiply used nodes like the one described by Borges in his short story [1]. The red edges lead to different parts of the tree, and sometimes add circle paths to it. There are a total of 12 different endings to the story as implemented. These endings can be clustered into three different types: in the

[2] Re-translated to English from the German version [10].

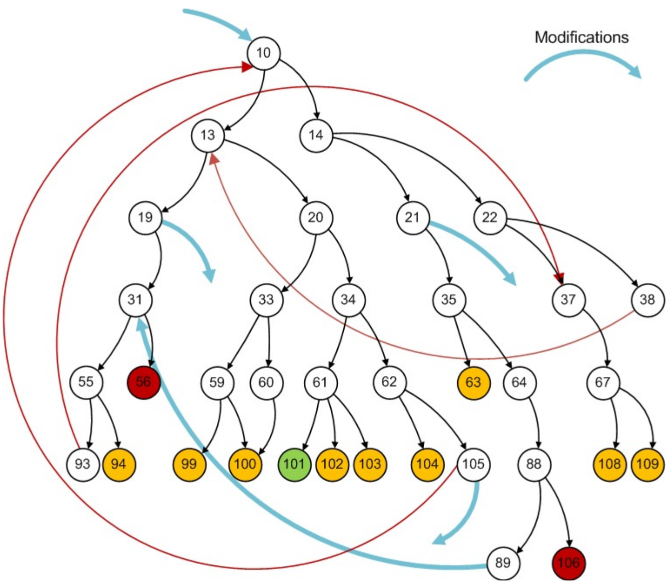

Fig. 1. Decision Graph of the implemented part of the book

only *good ending* (green node), the users return home having found a treasure. In the two *bad endings* (red nodes) the protagonist dies. The nine *neutral endings* (yellow nodes) stand for everything in between, like staying on the island or returning without a treasure.

For each node, the corresponding text section of the book is narrated by a virtual character (see Figure 2). A background image is displayed behind the character and a background sound is played, matched to the content of that text section. In addition, the character changes his facial expression depending on the content (e.g. he has a fearful expression if something unexpected happens), and at specific parts of the text short sounds are played (e.g. in one scene wild dogs appear, so the sound of barking dogs is played in parallel with this). When reaching the end of a node (a decision in the book), the narrator asks for input from the users and continues with the next node depending on the decision taken.

We have implemented two different modes for decision-making:

In the first mode (*indicated mode*), users have to speak out the decision they choose from an on screen prompt, as shown in Figure 2.
In the second mode (*freestyle mode*), we simply omit the on-screen prompt, so users have to figure out the possible answers for themselves. That may sound relatively simple, but it already gives users a sense of having more scope to take an influence on the story. In addition, users are allowed to ask for possible decisions in that mode when they cannot find one for themselves.

In the corresponding study, no actual speech recognition is used to recognize the spoken words of the users; instead, this is realized using Wizard-of-Oz.

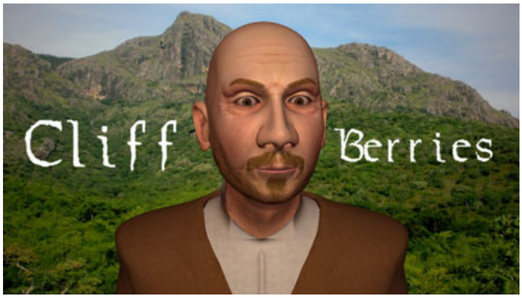

Fig. 2. The screen with decision overlays

2.3 Implementation of Quick Time Modes

To make the interaction more interesting and less predictable, we implemented another possibility for altering the story line, via the *Quick Time Events* (QTEs) that are frequently used in current video games. Whenever a QTE occurs in a video game, a symbol representing a specific action on the control device appears on screen. The user then has a limited amount of time to perform that action in order to complete the QTE successfully. Most times, successful performance of the QTE results in a particular action by the player avatar, while unsuccessful performance causes the player avatar to fail in this action. The utilization of QTEs ranges from enriching cutscenes with interactivity to using QTEs as the main gameplay mechanic.

We adopted this idea to provide another instrument for adding interactivity to the story and for bridging long text passages.

QTEs in "Sugarcane Island". Some passages of the book already contain situations that are well-suited for the application of QTEs. One example in the original text (p. 13)[3] reads as follows:

You start to climb the steep hill. It is highly exhausting and one time you loose your grip and almost fall down a rock face. But finally you arrive at the top.

The modified text part looks like this (modifications marked with bold font):

*You start to climb the steep hill. It is highly exhausting and one time you **almost** loose your grip.*

The QTE then starts, and when it is solved the following message is narrated:

***You manage to hold on just in time and** finally you arrive at the top..*

Otherwise, the text is:

You fall down a rock face but you are lucky that you did not get hurt too badly.

If the QTE is solved, the story continues like the original version (p. 20), but if not it jumps to a different, but appropriate, node in the story graph (p. 14).

[3] Re-translated to English from the German version [10].

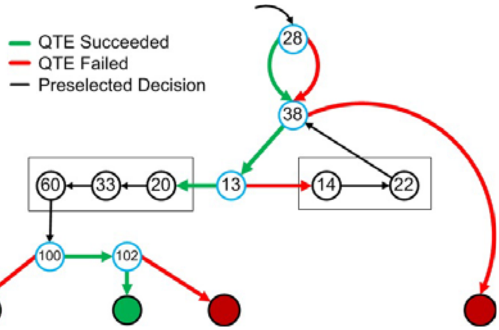

Fig. 3. Decision Graph for the QTE implementation

Figure 3 visualizes the story line implemented for testing the QTEs. As we want to concentrate on the execution of the QTEs and their user acceptance, all normal decisions are omitted and the only possibility for influencing the story are the QTEs. For the same reason, we also shortened the adopted texts in the story, trying to keep the story line consistent and to retain the cues leading to the inserted QTEs at all times.

As soon as a QTE starts in our application, a countdown appears centrally in the upper part of the screen with a symbol shown for each user representing the action requested (see Figure 4). As soon as one user solves a QTE, a mark is shown on top of the symbol, providing immediate feedback. The full QTE is solved if both users successfully complete their action before the countdown reaches zero.

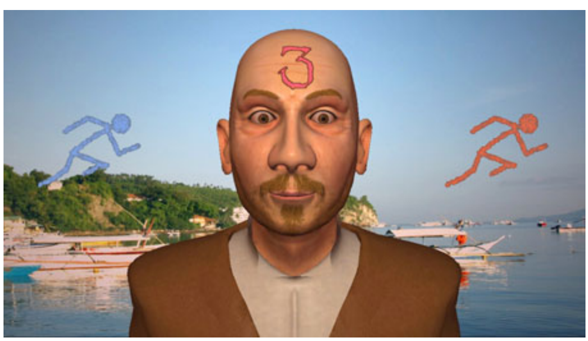

Fig. 4. Screenshot for the QTE "Run"

Implementation with Microsoft Kinect We employ the Microsoft Kinect sensor in order to provide Full Body Interaction. Kinect is an additional peripheral for the Microsoft Xbox 360 that provides a depth image in a 640x480 resolution at 30 frames per second. User tracking applied to the depth image allows users to interact with their whole body via gestures and movements.

The most important parts of the Kinect are an infrared (IR) camera and an IR laser projector. They are used to provide a depth image that is created according to the structured light principle [11].

To work with the Kinect on a PC, we are using the "OpenNI" (Open Natural Interaction) framework, "NITE" (Natural InTEraction)[4] middleware and a mod of the corresponding PrimeSensor driver[5] that supports the Kinect. Besides access to the raw data from the Kinect, this also provides user body tracking with resulting 3D positions of specific joints from the tracked users.

We employ two different modes to carry out of QTEs, both using the Kinect: in the first mode (*button mode*), each user has to press a randomly-positioned and -sized button on screen, using a cursor controlled by moving the hand. In the other mode (*gesture mode*), users need to perform gestures that are indicated on screen via one of the symbols shown in Figure 5.

Fig. 5. Quick Time Symbols

The requested user actions for each symbol are (from left to right): *Balance*: Hold hands out at shoulder-height; *Kick*: Perform a kick with one leg; *Catch*: Put the hands together in front of the body; *Climb*: Move hands up and down in front of the head, as if climbing; *Left and right Hand*: Raise the left or right hand; *Run*: Move the feet up and down like running, but without moving.

Figure 6 shows two users in front of a screen, performing the QTE gestures "Kick" (left user) and "Catch" (right user). Note the Kinect placed centrally below the screen. The left user has already succeeded in the QTE "Kick", so a green tick has appeared over the corresponding symbol.

To implement the *button mode*, we take the tracked vector from one hand to the corresponding shoulder for each user. By moving this hand in front of their body on a plane parallel to the screen, both users control their own cursor displayed on-screen, similar to normal mouse input. By hovering a button for more than 1.5 seconds with the cursor, the button is activated. Alternatively, the users can perform a short and fast movement directed to the screen (push gesture) to activate the button directly.

As soon as the QTE starts, a button containing text for the requested action is shown for each user. The buttons are positioned randomly: on the right half of the screen for the right user, and on the left half for the left user. In addition, they

[4] http://www.openni.org
[5] https://github.com/avin2/SensorKinect

Fig. 6. QTE gestures performed by two users

randomly have a slightly different size for each QTE. Once a button is activated, it disappears and a tick appears to inform the user about the successful action.

The implementation for recognizing the gestures shown in Figure 5 is somewhat more complicated. However, some of them can be recognized directly from the joint positions, as they only require static postures from the user. For example, "left hand" is recognized in our system by getting the positions of the left hand and shoulder from the tracker and simply testing whether the left hand is currently above the left shoulder (y-coordinate of the hand greater than y-coordinate of the shoulder). The same method of looking at how specific joints are positioned in relation to each other is used for recognizing "right hand", "balance", "kick", and "catch". Of course, "balance", "kick", and "catch" would normally include some kind of movement, but for the recognition purposes it is sufficient to wait until the most meaningful part of that movement is performed. For example, "kick" only needs one foot being high enough above the ground, as the speed or direction of the movement are not important in our case.

To implement the other gestures, we recognize combinations of postures with specific time constraints. Figure 7 shows the recognition of the action "run" as an automaton. The states in the automaton define multiple postures that have to be fulfilled in parallel. The numbers on the black edges define the order in which the states have to be performed, in order to eventually complete the posture combination in the end node. The green edges represent the timeout for each state: if there has been no transition for 500 ms, the automaton reverts to the start node and the recognizer waits again for the first-state postures. To successfully complete "run", the user is consequentely required to move the left and right knee up and down alternately, with this being measured by the distance between the knee and hip joint. Those two postures have to be performed at least

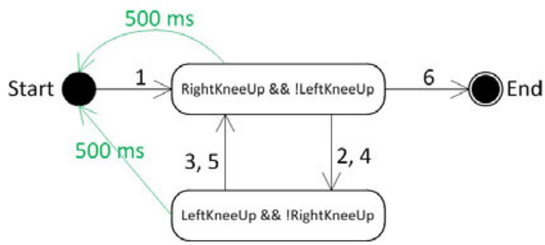

Fig. 7. Recognition automaton for running

two times and with not more than 500 ms in between. The posture combination "climb" can be realized in the same way, but in that case the user has to move his or her hands up and down in front of the head.
The implementation of the mentioned gesture and posture recognizers led to the development of the Full Body Interaction Framework [5].

3 Study and Results

We conducted two user experiments. The first one was to investigate the differences between the user experience in the *freestyle* and the *indicated mode* in a two-party storytelling setting. We further hypothesized that the *freestyle mode* would lead to more user interaction (H1). The second experiment aimed to investigate user acceptance of the QTEs in our virtual storytelling setting using Full Body Interaction with Microsoft Kinect. We assumed that the *gesture mode* would be preferred to the *button mode* (H2).

3.1 Study on Decision Modes

For the first experiment, we chose a Wizard-of-Oz design to ensure that all user decisions were recognized correctly. The participants had to sit at a table and a 50 inch plasma display was located in about two meters in front of them. A camera was installed on top of the display to capture the whole user interaction. The questionnaire for both experiments was derived from the IRIS (Integrating Research in Interactive Storytelling) Evaluation Measurement Toolkit [13]. Each statement was given on a nine-point Likert scale ranging from "strongly disagree" (-4) through "neutral" (0) to "strongly agree" (4).

An application run consists of a short introduction and the main story part. The introduction was meant to understand how to interact with the system. 26 participants were involved in the first study. We applied a "within subjects" design, and thus each group had to participate in both conditions (i.e. *freestyle* and *indicated mode*). To prevent positioning effects, we counterbalanced the order in which the conditions were encountered. In addition to the questionnaires, we collected nearly four hours of video material to objectively measure the number and duration of the user actions during the interaction with the application.

The average age of the participants was 27.2 years, and we applied two-tailed paired t-tests to show the validity of the results.

Results. The results of the questionnaire show that the users found the *indicated mode* (M: 2.9, SD: 1.2) significantly easier to use than the *freestyle mode* (M: 1.2, SD: 1.8), where they had to decide on their own from the story what to do ($t(25) = 4.7, p < 0.001, r = 0.49$). Further, they would imagine that most people would learn the *indicated mode* (M: 3.4, SD: 0.8) significantly quicker than the *freestyle mode* (M: 1.8, SD: 1.8), where they had to figure out the decisions by themselves ($t(25) = 5.1, p < 0.001, r = 0.50$). The participants also found the *indicated mode* (M: -3.2 , SD: 1.0) significantly less inconvenient to use than the *freestyle mode* (M: -1.6, SD: 1.9; $t(25) = 4.5, p < 0.001, r = 0.47$). All the other items regarding satisfaction, immediate impact of actions, influence of the decisions, and curiosity were not significantly affected by the two modes.

The whole interaction was captured by a camera on top of the display. The videos generated were subsequently annotated using the freely-available video annotation tool ANVIL [7]. In addition, the whole system actions and calls were logged in an ANVIL readable XML format. The focus of the analysis was the participants' gaze and speaking behavior during the two modes. Furthermore, we measured the overall duration of each run. The results are described below:
Gaze: In *freestyle mode* (M: 31.5 s, SD: 31.1), the participants looked significantly longer at each other than in *indicated mode* (M: 9.8 s, SD: 8.4; $t(25) = 4.3, p < 0.001, r = 0.43$). Moreover, in *freestyle mode* (M: 4.4, SD: 3.0) the participants looked significantly more often at each other than in *indicated mode* (M: 9.9, SD: 7.3; $t(25) = 4.6, p < 0.001, r = 0.44$).
Speech: In *freestyle mode* (M: 34.0 s, SD: 29.0), the participants spoke significantly longer with each other than in *indicated mode* (M: 12.2 s, SD: 9.1; $t(25) = 4.8, p < 0.001, r = 0.45$). Furthermore, in *freestyle mode* (M: 12.8, SD: 7.8) the participants spoke significantly more often to each other than in *indicated mode* (M: 6.3, SD: 3.9; $t(25) = 5.2, p < 0.001, r = 0.47$).
Duration: The longest run of a group in *indicated mode* was *5:50 min*, whereas it was *7:50 min* in *freestyle mode*. The average duration was *3:40 min* in *indicated mode* and *5:21 min* in *freestyle mode*. The 1:41 minutes longer average duration is caused by longer durations of the interactions. This indicates a deeper interaction between the participants in *freestyle mode*.

3.2 Study on Quick Time Event Modes

In the second experiment, our intention was both to discover if the *button* or *gesture mode* is preferred, and to establish the quality of our system's recognition.

18 participants were involved in the study; none of these were involved in the study of decision modes. The participants were arranged into groups of two. The two participants in a group had to stand in front of a 50 inch plasma display at a distance of between 1.5 and 3 meters. The Microsoft Kinect was installed slightly below the display.

We applied the "within subjects" design, and therefore each group had to participate in one application run of both conditions (i.e. button and gesture mode). To prevent positioning effects, we counterbalanced the order in which the conditions were encountered. An application run consists of two parts, a short introduction and the main story part. The short introduction was intended only to familiarize the participants with the interaction with the system. After each run, the participants had to fill out a questionnaire that was again derived from the IRIS Evaluation Measurement Toolkit [13]. Each statement was given on a nine-point Likert scale ranging from “strongly disagree” (-4) through “neutral” (0) to “strongly agree” (4).

The average age of the participants was 24.7 years, and we applied two-tailed paired t-tests to show the validity of the results.

Results. The results of the questionnaire show that the participants found the gesture-based QTEs (M: 2.9, SD: 0.9) significantly easier to use than the button-based events (M: 2.0, SD: 1.9), where they had to simply point at a specific button label ($t(17) = 2.1, p < 0.05, r = 0.29$). The participants also would imagine that most people are able to learn the system with the gesture-based QTEs (M: 3.3, SD: 0.8) significantly quicker than the one without (M: 2.4, SD: 1.5; $t(17) = 2.2, p < 0.05, r = 0.35$). The *gesture mode* (M: -3.1, SD: 1.0) was considered more comfortable to use compared to the *button mode* (M: -1.3, SD: 2.1; $t(17) = 3.5, p < 0.01, r = 0.48$). The participants were significantly more satisfied with the *gesture mode* (M: 2.3, SD: 1.0) than with the *button mode* (M: 1.6, SD: 1.4; $t(17) = 2.4, p < 0.05, r = 0.28$). The *gesture mode* (M: 0.0, SD: 2.5) was also considered as significantly less inconvenient compared to the *button mode* (M: -2.3, SD: 1.7; $t(17) = 4.0, p < 0.001, r = 0.47$). Interaction in *gesture mode* (M: 3.1, SD: 1.0) was experienced as significantly more fun than in *button mode* (M: 1.0, SD: 2.3; $t(17) = 3.8, p < 0.01, r = 0.51$), and lastly the participants stared at the screen with significantly higher expectations in *gesture mode* (M: 1.4, SD: 1.6) compared to the *button mode* (M: 0.8, SD: 1.5; $t(17) = 2.2, p < 0.05, r = 0.19$).

The recognition within the button and gesture mode worked very well. The participants succeeded in 93% of all actions within the button-based QTEs (i.e. 67 out of 72). For the gesture-based QTEs the participants were even more successful, with 97% of all possible actions (i.e. 65 out of 67).

4 Conclusion

We showed that a game book like “Sugarcane Island” can be easily adopted to create an interactive storytelling scenario. In addition, we made some interesting observations regarding implementation of our interaction types: in relation to the usability of the decision implementation we found that *indicated mode* was preferred to *freestyle mode*. One may conclude that a system that is easier to use is automatically rated better on other aspects as well, but in our questionnaire the two modes (freestyle and indicated) are rated similarly in all other statements. However, if we also take the results from the video recording into account, it becomes apparent that the *freestyle mode* generated considerably more user interaction, proving our first hypothesis (H1).

One result regarding our QTE implementation is that *gesture mode* was preferred to *button mode* in terms of usability. This implies that natural gestures for

QTEs not only support better usability, but also greater comfort. Moreover, using natural gestures also made more fun. The effect sizes (r) of the results further indicate strong findings, so our second hypothesis (H2) can also be considered proven. But not only perceptions of usability, comfort and fun were improved; we also showed participants were better at solving QTEs using natural gestures than the cursor-button interaction. This indicates, that it may be worthwhile designing new and more natural ways of interaction for a Full Body Tracking system, instead of adapting the conventional point-and-click paradigm.

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Hooked! – Evaluating Engagement as Continuation Desire in Interactive Narratives

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Abstract. Engagement in interactive experiences is a complex, multi-dimensional concept that can be determined by a variety of factors which are dependent on user preferences and media content. However, one fundamental requirement of any interactive experience is the desire to continue the experience, and this study is concerned with investigating engagement in interactive narratives by focusing on this aspect. In the present approach, engagement is described as the user's desire to continue an activity in order to accomplish an objective while experiencing affect. In order to investigate engagement during run time, this description is used as a foundation for formulating an intrusive method and the Engagement Sampling Questionnaire. The application of the method and the questionnaire is exemplified by an investigation of continuation desire in the experiential learning scenario, "The First Person Victim", where participants experience a non-pleasant emergent narrative concerned with being a victim of war.

Keywords: Engagement, Continuation Desire, Measurement, Evaluation, Interactive Narrative, Emergent, Questionnaire, Game, War Victim.

1 Introduction

"I want to continue… Now…!" – This user feedback might very well be one of the utterances every game designer or interactive experience developer hopes for when their application is paused during run time. In the area of interactive storytelling this also holds true, and as more interactive storytelling applications are being developed, there is a greater demand for acquiring knowledge about the user experience in interactive narratives [1].

In the related field of game and play studies, several investigations have focused on identifying the various dimensions and aspects of the player experience – both theoretically, e.g. [2], and empirically, e.g. [3]. Engagement is one key facet of interactive experiences, and due to its multi-dimensionality the concept can be related to various other concepts such as Immersion, e.g. [4], Flow [2, 5], Presence (as psychological immersion) [6], Enjoyment [7, 8], Motivation, e.g. [9], and Fun [10, 11]. There are thus a number of diverse explications of how engagement relates to

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these concepts, and there is a difference in how the term is understood and used when investigating player experiences.

Findings from [12] suggest that engagement can be described as a process whereby players dedicate themselves to performing activities in order to accomplish objectives set up either by the application or the player. While performing activities or when accomplishing objectives, players can experience feelings of positive or negative affect as well as the aforementioned concepts. Engaged users are also motivated to begin an experience, they want to continue experiencing and they want to try again. One could consequently argue that engagement is a prerequisite for experiencing fun, enjoyment, pleasure, flow and immersion because players need to become engaged before these other concepts can be experienced (see also [4]). Furthermore, in [13], one fundamental element of the concept of play is described as the willingness to continue playing, and this ‘continuation desire’ is driven by pleasure emanating from the experience of play itself. The desire or willingness to continue an experience can therefore be argued to be a necessity for engagement and thus a fundamental aspect of any interactive experience investigation.

Different methods can be useful for acquiring knowledge about the elements of an interactive storytelling application that make the user want to continue, as well as to which degree he or she wants to continue. However, investigating the various concepts that have traditionally been associated with engagement is a well-known problem, especially when dealing with the concepts of immersion, presence and flow, which are all challenging to measure and can ‘break’ if they are investigated by interrupting the player with a self-report survey during the experience. These investigations are thus often based on post-experience questionnaires [e.g. 14]. Nevertheless, it can be argued that since the willingness to continue will remain, even if a user is interrupted, it would be possible to investigate his or her desire to continue during run time by pausing the experience and administering a self-report survey.

In the following sections, examples of player experience studies related to engagement in games will be reviewed in order to form a foundation for the development of an intrusive method and a survey instrument – The Engagement Sample Questionnaire – which aims at exploring and assessing the aspect of continuation desire in interactive narratives.

2 Investigating Player Experiences and Engagement in Games

In [14], engagement is described as a term which is “used as a generic indicator of game involvement” [14, p. 624]. The authors present the Game Engagement Questionnaire (GEQ) with 19 questions, intended to measure the subjective experience of deep engagement, which according to the authors is a construct related to immersion, presence, flow and absorption. The GEQ is not intended to investigate the triggers of engagement or the willingness to continue in-game; rather, the self-report post-game questions “I feel like I just can’t stop playing” (related to flow in that study) and “I play longer than I mean to” [14, p. 627] (associated with presence in that study) point somewhat to the continuation desire aspect of engagement.

A research group working on The Fun in Gaming (FUGA) project [7] developed and validated the self-report Game Experience Questionnaire (GEQ) [15]. This questionnaire is intended to investigate player experience through seven different dimensions: sensory and imaginative immersion, tension, competence, flow, negative affect, positive affect and challenge. These dimensions have been identified through focus group explorations and the theoretical analysis of accounts of player experiences [3]. However, none of the 14 questions in the iGEQ in-game version of the GEQ is concerned specifically with indicating how much the players want to continue playing. Additionally, none of the 17 questions from the post-game module focuses on how much a player wants to try to play again. As there is a question related to boredom – "I felt bored" [15, p. 6] – it can be argued that the questionnaire takes into account the opposite concept of engagement. However, even if a task can be boring to accomplish – such as the concept of 'grinding' – a player might still be engaged because he or she wants to continue in order to advance.

In the games industry, pausing the game and asking questions is becoming an industry standard approach. In [16, 17] the TRUE (Tracking Real-Time User Experience) instrumentation is concerned with the automated collection of gameplay feedback, which is useful for the design team to understand the player experience during the entire exposure to the game. In order to support the information gathered via the contextual data, what players do in the game and player behaviour, the TRUE method also collects attitudinal data about opinions and feelings through in-game surveys and pop-up questions. Although the TRUE method can map self-reported enjoyment over time via time-based surveys, and users can indicate if they feel bored in on-demand surveys, it appears that there is no mention of investigating how much the player wants to continue playing in the cases presented in [16, 17].

In another study [10], an initial experience playtest focuses on in-game components such as players' ability to take control over their characters, while experiencing satisfaction and being motivated to continue playing. This playtest is conducted by asking participants to stop playing after each mission and report their experience of the excitement, fun and clarity of the objectives. In extended playtests, which run for more than two hours and gather attitudinal data, participants are asked to provide feedback about a specific point of time in the game or at experience intervals (e.g. after a mission). This procedure and the TRUE approach are very similar to what is needed in the current study and can be used as an inspiration for developing the intrusive method as a means of investigating continuation desire and engagement in interactive narratives.

3 Evaluating Continuation Desire in Interactive Narratives

The Engagement Sample Questionnaire (ESQ) and the intrusive approach are based on the Player Engagement Process (PEP) [12] combined with inspiration from findings in the above review and Csikszentmihalyi's work with the Experience Sampling Method [18]. The idea with the intrusion method is that even if the application is paused the assumption is that users will still want to continue the experience and be able to a) indicate how much they want to keep on going and b) reflect on why they want to continue in more detail. The questions in the ESQ are organised according to the following components and categories found in the PEP framework [12]:

1) *Objectives*, which are either set up by the experience (extrinsic objectives) or by the user (intrinsic objectives)

2) *Activities*, performed in order to accomplish the objective (e.g. interfacing, socialising, solving, sensing, experiencing the story and characters, exploring, experimenting, creating or destroying)

3) *Accomplishment* of an objective (by advancement, achievement or completion)

4) *Affect*, experienced while engaged users perform an activity or accomplish an objective (positive: e.g. enjoyment and pleasure; negative: e.g. frustration and boredom; and absorption: e.g. flow and immersion)

The first part of the ESQ includes questions concerned with the respondent's demographics (gender, age, frequency and amount of playing, favourite game and genre, etc). The second part focuses on the pre-experience motivation to begin the experience by investigating how much respondents want to begin and what motivates them to start the application (their objectives). The third part is repeated at various points during run time, whereby quantitative application run time data can also be gathered before and after the intrusion (e.g. which event the user has just experienced and which activities the user performs before and after the interruption). At these points the user should answer a series of questions addressing the desire to continue playing: a quantitative question assessing how much he or she wants to continue the experience (captured by a seven-point Likert scale) and open-ended questions concerning what makes them want/not want to continue (their objective), what they are doing in order to reach their objective (the activities) and what they feel/experience (affect). Finally, a question stating, "What is happening (in the application)?" is included in order to capture information concerning the generation of the user's own (emergent) narrative. The fourth and final part of the ESQ focuses on the post-experience willingness to want to try the application again, as well as what it is that makes the respondent want/not want to start again (their objectives) and other aspects related to the end of the experience.

Ideally the survey should be an integrated part of the application, so that questions are presented automatically at various predefined pauses in the game. An example of the use of the ESQ, accompanied by the exact wording of the questions, is presented in Table 1 in the following case study.

4 Case Study: Engagement in 'The First Person Victim'

In order to exemplify the usage of the ESQ and the intrusive method, a playable prototype of the experiential learning scenario 'The First Person Victim' (FPV) [19] will be investigated. This application is chosen in order to explore continuation desire in an interactive emergent narrative, where the objective is to communicate a range of negative feelings associated with being a victim of war. These feelings and the users' experiences are intended to support in-class discussions on various issues related to war victims and refugees [20]. The theme is communicated through the use of tragedy and the first person shooter form, and turns the roles around by letting each user enact the experience of being an unarmed civilian and to encounter a realistic war scenario while being confronted with ethical issues. An ‘Interactive Drama Experience Manager’ [19] organises 42 possible events, which vary in tension in six scenes. The user’s narrative construction depends on their encounter with these events, and each event is mediated in the form of text, audio, visuals or video recordings of actors integrated into a 3D environment and implemented with the game-engine Unity [21].

4.1 Participants and Procedure

A total of 22 media technology and game university students and staff participated in the pilot test. Eighteen were male (82%) and four female (18%). Ages ranged from 20 to 56 years, with the average age being 27.5 years, and the average amount of hours of playing games per week ranged from 1 to 35 hours, with an average for all respondents of 9.6 hours per week. One test was conducted in labs (11 participants) and another evaluation took place at the respondents’ homes (11 participants).

Table 1. The Engagement Sample Questionnaire

<table>
<tr><td colspan="8">ESQ Part One: Demographics (gender, age, frequency and amount of playing, favourite game / genre)</td></tr>
<tr><td colspan="8">ESQ Part Two: Before the experience</td></tr>
<tr><td colspan="8">Q1. Please indicate below the extent to which you agree or disagree with this sentence: “I want to begin the experience” (to quantify the users Continuation Desire (CD))</td></tr>
<tr><td>Disagree strongly</td><td>Disagree moderately</td><td>Disagree a little</td><td>Neither agree nor disagree</td><td>Agree a little</td><td>Agree moderately</td><td>Agree strongly</td><td>Other</td></tr>
<tr><td colspan="8">Q2. “What makes you want/not want to begin?” (to identify the user’s CD and objective)</td></tr>
<tr><td colspan="8">ESQ Part Tree: During the experience</td></tr>
<tr><td colspan="8">Q3. Please write the code which is written on the screen in the application: (identifying the latest event)</td></tr>
<tr><td colspan="8">Q4. Please indicate the extent to which you agree or disagree with this sentence: “I want to continue the experience now!” (Response options as in Q1)</td></tr>
<tr><td colspan="8">Q4. “What makes you want/not want to continue?” (to identify the source of the user’s CD and objective)</td></tr>
<tr><td colspan="8">Q5. “What do you feel now?” (to indicate the user’s affect)</td></tr>
<tr><td colspan="8">Q6. “What is happening in the experience?” (to explore the narrative generated by the user)</td></tr>
<tr><td colspan="8">Q7. “What do you want to do next?” (to identify the user’s activity)</td></tr>
<tr><td colspan="8">Q8. “General comments concerning the experience so far” (technical, content)</td></tr>
<tr><td colspan="8">Q9. “Do you want to continue?” (yes/no) (“yes” resumes, “no” directs to the final part of the ESQ)</td></tr>
<tr><td colspan="8">ESQ Part Four: After the experience</td></tr>
<tr><td colspan="8">Q10. Please write the code which is written on the screen in the application: (identifying the latest event)</td></tr>
<tr><td colspan="8">Q11. Please indicate the extent to which you agree or disagree with this sentence: “I want to try again!” (Response options as in Q1)</td></tr>
<tr><td colspan="8">Q12, “What makes you want/not want to try again (in the application / experience)?”</td></tr>
<tr><td colspan="8">Q13. “What do you feel now?” (to indicate the user’s affect)</td></tr>
<tr><td colspan="8">Q14. “What did you just experience?” (to explore the narrative generated by the user)</td></tr>
<tr><td colspan="8">Q15. “Why do you want/not want to try again?”</td></tr>
<tr><td colspan="8">Q16. “General comments concerning the experience” (technical, content)</td></tr>
<tr><td colspan="8">Q17. “How many minutes do you think you have spent in the experience?”</td></tr>
<tr><td colspan="8">Q18. Extra questions related to communication of the theme and learning outcomes, not used in this study</td></tr>
</table>

The respondents in the labs participated in an in-class discussion with the author after the test, while respondents partaking at home conducted the test alone without debriefing. In both evaluations, respondents were asked to download the FPV and fill out the first two parts of the online ESQ (Table 1) before commencing the experience.

They were then asked to explore the environment until one of the first events was encountered, for example a friend calling to tell about how her neighbourhood was hit by a bomb and where to meet her. After each event, the application was automatically paused and the respondents were instructed to switch to the online questionnaire and respond with a code that indicated the scene and event they just encountered and then answer the remaining questions in the third part of the ESQ. The final part of the questionnaire occurred after the last event and inquired about the desire to try again.

4.2 Results

The 16 respondents who answered the question about the perceived time spent in the experience (not a mandatory question) reported that they used an average of 31 minutes on the experience (range: 8-100 minutes).

Of the total 22 participants, eleven (50%) went all the way through the experience. Four of those (36%) wanted to try the experience again, mainly because they wanted to try out different choices and possibilities. Out of the seven (64%) who did not want to try again, four (57.1%) thought the application had too many technical difficulties, two (28.6%) stated that it was due to no progression and boredom and one (14.3%) did not want to try again, because of feeling helpless in the experience.

Eleven respondents (50%) quit the application for different reasons: five (45.4%) experienced technical issues or became stuck, three (27.3 %) thought it was boring due to lack of progression, one was frustrated (9.1%), one was confused (9.1%) and one (9.1%) became dizzy and had to take a break. However, four (36.4%) of these respondents wanted to try again: one (25%) wanted to explore the environment more, one (25%) wanted to experience something new, one (25%) wanted to learn more about the situation and one (25%) was curious to experience more of the story. Of the seven who did not want to try again, three (42.8 %) reported that it was boring, two (28.6%) answered that it was due to technical issues, one (14.3 %) stated that it was hard to understand anything and finally one (14.3 %) did not give any reason.

Overall, eight (36.4 %) wanted to try the experience again, while five (22.7%) out of the total number of participants did not want to try again due to technical problems in the prototype.

Activities, Accomplishments and Objectives. The answers concerned with objectives, activities and accomplishments from all respondents were analysed by simple coding and organised according to the components of the PEP framework (Table 2). A wide range of individual intrinsic objectives and application-defined extrinsic objectives drove the respondents forward throughout the experience. The main activities were related to exploring the environment and experiencing the story and characters, as well as experimenting with other endings and the application itself. The objectives were accomplished by completion (e.g. finding an exit) or advancing (e.g. in the story).

Table 2. Reported Activities, Accomplishments and Objectives

Activities	**Accomplishments**	**Intrinsic Objectives**	**Extrinsic Objectives**
Explore the environment (Navigate)	Completion	Find cues, information, people, exits or novelties. Help other civilians. Explore the whole environment. Try other ways to proceed. Get to safety, escape or flee. Get in and out of rooms and buildings or get out of the city. Survive.	Find the friend at the shop (after phone call event 'A5'). Avoid being shot by soldiers (after shooting event 'E3'). Get away from helicopter (after chopper attack event 'C5').
Experience the story and characters	Advancement Completion	Experience what is going on. Experience what happens next. See how it is going to end.	None.
Experiment	Completion	Experiment with the application. Try to find other endings.	None.

Affect. Respondents also encountered a range of different feelings (see Table 3) and reported having experienced a negative affect due to the grave theme and tragic narrative. Some of the accounts referred to technical problems and others were related to the narrative, content and theme. However, there were also examples of positive affect, amongst which were curiosity, suspense and feeling captivated by the setting.

Table 3. Reported Affect

Positive affect	Curious, in suspense, intrigued, interested, startled, relaxed/relieved (after the experiences), enthralled/engaged, captivated by the setting.
No affect	Indifferent.
Negative affect-Technical related	Confused, lost, annoyed, frustrated (controls).
Negative affect-Narrative related	Agitate, nervous, excited and anxious, tense, wired, shocked, dizzy, fearful, worried, frustrated (cannot help others), powerless, angry, miserable, sick, desolated, bored, empty, frightened, scared, paranoid.

Continuation Desire. In order to exemplify the method of indicating a user's level of continuation desire, three representative respondents with major differences in their experiences have been selected to illustrate the variations.

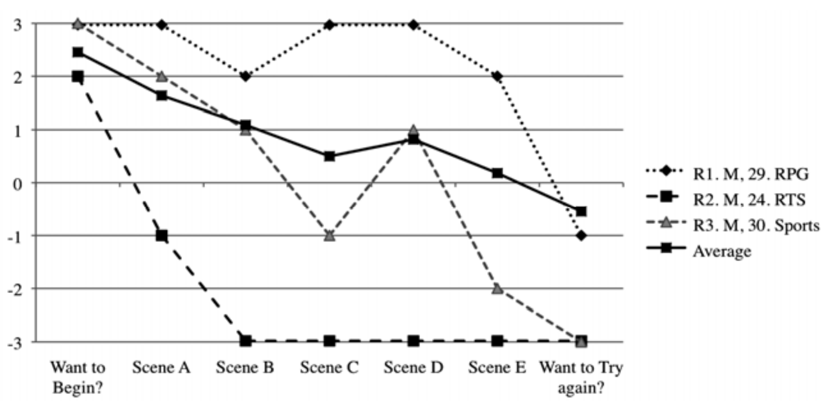

Fig. 1. Continuation desire levels

Fig. 1 depicts individual continuation desire levels reported by the three users. An average based on the 11 respondents who did not halt the application before the end is also included. The number '3' indicates "Agree strongly", '0' signifies "Neither agree nor disagree" and '-3' means "Disagree strongly". Table 4 shows their reported willingness to continue and the corresponding explanations. The questions were asked before the experience, after events during run time in scenes A-E and after the last event at the end of the experience.

Table 4. Sample continuation desire responses

R1: Male, 29. Genres: Role-play, Adventure and Strategy. Favourite game: "Fallout 1"
Do you want to begin? Strongly agree. "Sounds like an interesting concept". Do you want to continue? Scene A: Strongly agree. "I'm curious about what happens next". B: Agree moderately. "I still want to continue, but I would like to be able to interact with objects. Also, I don't have any idea about where I'm going. I feel I'm running around aimlessly". C: Strongly agree. "Now there are more things happening, and I feel that it actually matters what I do. I like what happens when you get shot". D: Strongly agree. "I got captivated by the setting". E: Agree moderately. "It seems like there are no other places to go. I might go and hike in the mountains, though". Do you want to try again?: Disagree a little: "I feel that I explored everything I could".
R2: Male, 24. Genres: Real-time Strategy, Action, FPS, Puzzle, Quiz. Favourite game: "Starcraft 2"
Do you want to begin? Agree moderately. "I'm interested in what the game is about and how it looks". Do you want to continue? Scene A. Disagree a little: "Low mouse sensitivity, boring graphics". B: Disagree strongly. "Weird dialogue and glitchy game elements". C to E: Disagree strongly. "Same reasons as before". Do you want to try again? Disagree strongly. "As mentioned, it was boring and very unfinished. The lack of other persons and realism made everything very dull".
R3: Male, 30. Genres: Sports, Adventure. Favourite game: "FIFA 2010"
Do you want to begin? Strongly agree. "I am interested!" Do you want to continue? Scene A: Agree moderately. "I don't know what is going on". B: Agree a little: "I still don't know what is going on yet. I want to figure it out". C: Disagree a little. "The experience of seeing the person in the car die was tough. I could not help him and lost control. I am confused whether to rescue myself or help others. I am not sure what I can do..". D: Agree a little. "I want to call someone and figure out what is going on". E: Disagree moderately. "The woman was shouting for help but I could not help her. That feels horrible..". Do you want to try again? Disagree strongly. "This is quite a horrible experience".

4.3 Findings

The results are intended to exemplify information which can be acquired through the intrusive method and the ESQ, and as this study was administered as a prototype pilot test with a limited amount of respondents it was not the intention to present statistically significant findings (e.g. related to gender, frequency/amount of play or favourite game/genre). Nevertheless, some indications are worth noting.

With the possibility of encountering six scenes, each consisting of seven potential events, users can construct very different emergent narratives. As expected, the acquired data thus contains a great variety of individual accounts reporting what is happening as well as inferences about the causes of experienced events, speculation about future events and a diversity of intrinsic objectives (see Tables 2 and 4).

The three respondents' answers (Table 4) and corresponding self-reported levels of continuation desire (Fig. 1) also show differences. The real-time strategy user (R2) quickly lost interest in continuing and instead focused on technical glitches and the lack of realism. The sports games user (R3) was very emotionally involved and did not want to try again because he was unable to help a woman who was harassed; in fact, he concluded "this is quite a horrible experience". The role-play user (R1) had a generally high desire to continue, with a drop at scene B, followed by a rise at scene C because "Now there are more things happening". However, this respondent did not want to try again because "I explored everything I could".

The average continuation desire level of the 11 participants who completed the experience is also shown in Fig. 1. However, this result can only be seen as an indication of how the general level of continuation desire develops in the FPV experience, both due of the diversity of the events encountered and because four of the respondents did not want to try again due to technical difficulties, which obviously had an effect on their willingness to continue.

5 Discussion

Although it is not new to conduct in-game investigations of user experiences, there has been limited documentation in the literature concerning the investigation of engagement as continuation desire in interactive narratives through run time self-report surveys – as proposed in this study.

When evaluating interactive storytelling applications such as 'The First Person Victim', which is intended to communicate serious topics and initiate discussions based on a variety of user experiences, it is also imperative to investigate how users can be motivated to continue despite the tragic content. The intrusive method and ESQ can address this issue by investigating whether users still want to continue due to aspects other than enjoyment, fun, flow, pleasure and similar 'positive' facets of engagement. Therefore, it can be beneficial also to include investigations of continuation desire in order to supplement other methods such as game inquiries with the iGEQ [15] or [8], which evaluates interactive narratives.

Findings in the current study furthermore support the measurement scales from [8], where five key prerequisites of meaningful user experiences in interactive stories are presented: system usability, correspondence of system capabilities with user expectations, presence, character believability and effectance. As evidenced in the results, some users mention that they stopped the experience due to technical and system usability problems. Responses moreover support the prerequisites concerned with user expectations about system capabilities (especially those who play a great deal) and character believability (e.g. the actors on video textures seemed out of place to some users who were used to 3D animated characters). Presence as 'being in the world' was also mentioned, as some respondents reported that they were affected by the audiovisuals to a degree where they became dizzy or felt lost in the desolation of the virtual environment. Furthermore, there are also examples of respondents who wanted more effectance by stating that the application could have additional interaction possibilities than mere navigation (many wanted to have a gun, which is intentionally not possible. See [20] for more about these intended design choices). Finally, the affect responses shown in Table 3 support three of the five types of user responses in [8] that represent the 'typical' common patterns expected to take place in different interactive storytelling systems, namely curiosity about what will happen next, suspense and aesthetic pleasantness (reported as "captivated by the setting"). There are no accounts of the responses in [8] concerned with flow and only a few responses related to enjoyment, which is possibly due to the intrusive method of inquiry and the tragic theme. However, accounts of negative affect are plentiful, and in the case of the FPV any reported negative affect related to the narrative and theme are actually signs of successful communication, for example when the sports games user (R3) feels horrible because it is impossible to help others.

When comparing the method proposed in this study with in-game, think-aloud and observational approaches, it is an advantage that it is possible to conduct surveys in respondents' homes with no interference from the researcher. There is also no need to transcribe qualitative data due to the online survey technique, although it can be a time consuming challenge for respondents to answer five open-ended questions after each event. One way to address this issue and acquire quantitative data (while saving time and avoiding bias when analysing answers) could be to add standard choices in the questions related to objectives, activities, accomplishments and affect. These questions should still offer the choice to respond "other" in order to give the respondents an option for reporting qualitative answers.

It remains to be verified whether the subjective self-report survey indication of continuation desire is reliable and accurate. The ESQ could therefore be combined with other methods such as observations, run time think-aloud interviews, questionnaires (e.g. related to enjoyment, flow and immersion) or possibly psycho-physiological measures, e.g. [22, 23], in order to supplement the current approach.

Furthermore, ESQ metrics could be expanded upon and refined in future work by correlating continuation desire ratings with additional run time data such as events and application-defined objectives, as well as captured user activities and accomplishments. Establishing these relations may help form new theories about engagement and the willingness to continue, and perhaps even make it possible to predict the level of continuation desire of interactive applications based on the nature of the run time events.

6 Conclusion

In this study the Player Engagement Process framework and in-game evaluation methods were combined to develop the Engagement Sample Questionnaire and an intrusive method of inquiry with online surveys, in order to evaluate continuation desire as an aspect of engagement in interactive narratives.

Results from the case study demonstrate that there is a wealth of information about a user's willingness to continue, which can be gathered during run time, and that the ESQ and intrusive method can be used to investigate and quantify a user's desire to continue. Information acquired with the ESQ is also valuable in evaluating the communication potential of interactive narrative experiences.

The findings indicate that even with the non-pleasurable content in the FPV, users become engaged because they want to continue exploring the environment, experience the story and characters and experiment with the application and alternative endings. If the inquiry had been concerned with investigating other concepts traditionally related to engagement, such as enjoyment, fun, flow and immersion, some of this information might not have been gathered.

The ESQ method may prove valuable for both game and interactive experience designers, as continuation desire can be a fundamental indicator for engagement and a successful user or player experience. Feedback from run time investigations of continuation desire, investigating in detail users' objectives, activities, accomplishments and affect, can additionally assist in generating process-oriented data on what users dislike or value in an interactive experience. This information can then be used to redesign environments and arrange events in order to improve an experience or to create novel interactive concepts, because no matter what kind of interactive narrative with serious content or any other interactive experience designers create, one of the key concerns will always be: how do you keep users hooked?

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StoryStream: Unrestricted Mobile Exploration of City Neighbourhoods Enriched by the Oral Presentation of User-Generated Stories

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Abstract. In this paper we present the StoryStream system, a mobile application that constructs a documentary type of narrative of user generated non-fiction stories, which are orally presented to a visitor of a neighbourhood while he or she freely explores the surroundings. The aim of the system is to enhance the exploration experience by providing context related information that adapts to the information interests of the user.

Keywords: Mobile storytelling, location-based narrativity, context, city exploration, oral storytelling.

1 Introduction

Cities provide more information about themselves then their boastful nature might let forebode. Beyond the "here are our three-star attractions, go thou and marvel" they offer deep insights into the memory of their neighbourhoods, mainly through web pages in the form of social story networks for urban districts.

An example of such a social story network is the storytelling site by Mediamatic (http://www.mediamatic.nl/page/5971/en), an initiative of the Amsterdam Museum (http://en.ahm.nl/) and the Mediamatic Lab. The site provides access to story collections related to particular neighbourhoods in Amsterdam, such as Amsterdam East. The site for this area, called "The Memory of East" (http://www.mediamatic.nl/page/73/en), makes available more than 1400 stories. With over 100.000 visitors per year it has developed into a social meeting point, where personal, every day stories can be presented, gathered and kept up-to-date by local residents.

The stories are presented in article format, containing text and images. The website functions as the surrogate of a location's memory and falls into the realm of what Rabiger [13] describes as the evolutionary power of technology transforming the notion of a documentary.

In this paper we present the StoryStream system, which facilitates a visitor who freely explores a neighbourhood with orally narrated stories. StoryStream is an adaptive, user-centred and theme driven system that exploits story environments such as "The Memory of East". The system utilizes the current location of the user and the user's story preferences for orally presenting narratives in a coherent order.

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The basis for our approach is to root technological developments in the understanding that information interest is based on sensory experiences that are shaped and filtered by emotional and cultural stimuli. Living and experiencing a city is an infinitely personal and dynamic process that exists as a joint cultural memory that constantly changes as we experience it over and over again [8].

2 Background

A substantial body of work has been established in the field of automatic story generation. The variety of work is necessarily wide as it relates to any presentation of human experience [11].

Tuffield et al. [19] proposed a taxonomy of approaches to modelling narrative and how these techniques can be utilized to the problem of narrating life memories. Riedl and Young [15] provide a comparison between linear and branching story generation in interactive story environments. They show that control and coherence often conflicts in interactive narrative systems but that "narrative mediation" in form of a centralized author agent (essentially a casual dependency planning system) can establish controllable branching, as suggested by their Fabulist system. Hargood, et al. [7] investigated the use of theme for the generation of photo narratives and found that a thematic model is capable of successfully connoting themes within these narratives. Systems as the virtual storyteller system [18] and AConf [14] are examples for approaches that seek to generate full narratives for entertainment. Systems like Topia [16] make use of narrative devices, such as sequencing, emphasis and omission, to incorporate discourse into Web technology and the Web experience.

Davenport and Murtaugh [5] proposed a model for the "evolving documentary" to be applied on a large audio-visual hypermedia system that covers the public works on rebuilding the Central Artery and the project's impact on surrounding neighbourhoods. The idea behind the "evolving documentary" is that a story rarely includes all relevant material but that only material is selected and sequenced that best fits the viewer's information interest. As argumentative continuity plays a key role in a documentary, Davenport and Murtaugh introduced description feedback, which establishes a numerical relation between the viewer's experience model and the material's context model created by the author of the hypermedia space. Based on the ranking of the different relations the next clip is chosen.

Bocconi and Nack [2] presented an experimental rhetoric engine (Vox Populi) that utilizes the IWA (*Interview with America*) repository of video interviews with U.S. residents on the events happening after 9/11 to generate biased video documentaries. They defined a simple rhetoric annotation system, based on the Toulmin model, which facilitates the identification of statements and the analysis of the rhetoric structure in which the statements are placed, to encode the verbal information contained in the audio channel. The annotations formed the basis for the generation engine.

Nisi et al. [12] presented a mobile handheld application where exploring locative narrative in form of cinematically rendered narrative content is used as a means of raising place-awareness in a Dublin neighbourhood. The aim of this work was to show how stories embedded into spaces can contribute to place-making, resulting in design requirements, such as to make the connections between place and media explicit, and that the mobile screen should primarily be used for visualization, rather than interaction. Some approaches combined storytelling and pervasive gaming techniques for location-aware games in the context of cultural heritage [1, 17]. The authors showed that applications taking this direction need to be carefully planned and designed so that the actual locations can play a role in the game advancement. Other approaches followed the use of animated characters that take the role of the narrator [9]. Similar to the pervasive gaming approaches carful and time-consuming authoring needs to be performed for such applications.

A different direction has been followed by Hansen et al. [6], who introduced the concept of mobile urban drama. In applications based on their framework players equipped with mobile phones participate in dramas, e.g. a murder mystery set in the Viking age of the city of Aarhus, where the real environment forms the scene. Hansen et al. combine location-based technology with well-crafted conditional-branching hyperfiction, which allows more flexibility than state-of-the-art stand-alone mobile audio drama as described in [20, 22].

Løvlie [10] describes a localized poetry system "Texttopia', where a wiki web site is used that facilitates users to upload their own literary texts in a geotagged manner, which allows other users, who are using the mobile component of the system, to hear these texts when they pass by that place in the real world

StoryStream follows the ideas of state-of-the-art audio storytelling systems [20, 10], only that in StoryStream the user does not have to follow defined routes but can freely explore a neighbourhood. With its approach of connecting user-generated stories into a coherent oral, documentary-like presentation of a neighbourhood, StoryStream relates closest to systems, such as ConText, Vox Populi and Textopia. It differs, however, as the coherence of the overall experience needs to be established in real time and cannot be planned before hand.

3 System Description

The StoryStream application has been developed for the Android operating system on a HTC Desire running Android 2.2. StoryStream facilitates users to explore user-generated stories in an oral fashion. The system picks the relevant content from authored contributions from the Mediamatic story repository, based on the current location of the user and according to his or hers history of content preferences. In that sense StoryStream follows the structuralist approach, in particular the discourse part of the story model described in [4]. StoryStreams applies a documentary style as it connects not only locations to the thoughts, memories and dreams of people who have lived there but also stitches these individual pieces of inner life representation together to form a larger narrative whole [13]. As the presentation is situated in a real world environment that is already cognitively demanding, we decided against an opposition-based documentary style [2] and opted for the juxtaposition of story pieces to achieve presentation coherence guided by user's preferences.

In this section we will describe the key parts of the StoryStream framework, namely the Corpus database, the Localiser, the User Profile, the Transition Engine, and the Storyteller (see Fig. 1 on the following page).

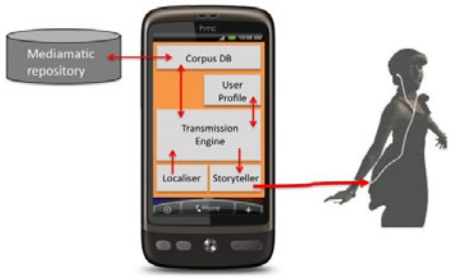

Fig. 1. StoryStream system overview

3.1 Corpus Database

The stories StoryStream has access to are part of Mediamatic's story database that covers material for areas such as history, education, broadcasting and product branding. For StoryStream we make use of a subpart of this repository, namely the collection “Geheugen van Oost”[1], a collection of over 1400 stories. The stories are provided by the people living in the neighbourhood but each story is edited by a member of the Amsterdam Museum. Each story set, that is a story and related photos, is associated with a metadata section containing 4 concepts, which represent structures of “substance of content” and “expression of form” as described in [4]:

Location As the stories are only presented through the associated web site no geo-location tags are available. Instead, each story contains textual descriptions of locations. We applied reversed geo-coding[1] in order to make the material accessible through the Localiser, described in section 3.2.

Author This contains the name of the person who has submitted the story

Narrator This is the person who tells the story (in most cases author and narrator are identical but there exist exceptions).

Keywords At the moment there are 46 different predicates for the related keyword descriptor. Examples of these predicates are, “school”, “geloof”, “dieren”[2] etc.

We established a special corpus database on the mobile phone that stores the story body text and story descriptor information available for a particular neighbourhood when being switched on. The synchronization makes use of available WIFI networks but can also utilize the mobile provider service, if there is need. Users also have the option to preload story sets if they know in advance which area they intend to visit.

3.2 Localiser

The Localiser scans the current surrounding of the user for available stories. It makes use of the GPS sensor of the mobile phone and updates the current location variable once the user has changed the position by 200 meters, which represents a change of

[1] http://www.mediamatic.nl/page/73/en

[2] geloof = belief dieren = animals.

0.002 within the horizontal or vertical value of the GPS coordinate. The location variable is used by the Transition Engine (see section 3.4) to establish the story selection process.

As the GPS sensor only provides geo-coordinates it is the Localiser that matches those to the textual location descriptors in the corpus. The matching is based on the attribute **gearsAddress** of the Position Class in Google's Geolocation API. The attribute provides a reverse-geocoded address, if requested and available, which is then matched against instantiations of the Location concept in the corpus database.

Once the match is done the Localiser also ensures that sufficient stories are available in the periphery of the user. For that the unit incrementally increases the radius around the user by 0.001 on the horizontal and vertical GPS axis and calculates the available story elements associated with the covered streets. In case the threshold of 10 stories for one iteration step is achieved the system considers this area as covered. Considering the duration of stories and the walking speed of a user 10 stories are usually enough to cover potential non-covered areas the user might encounter. Figure 2 describes this mechanism graphically for 3 iteration steps, though we determined during our experimentation with the system (see section 4) that usually 2 iterations are necessary for the story-wise well-covered neighbourhood of East Amsterdam.

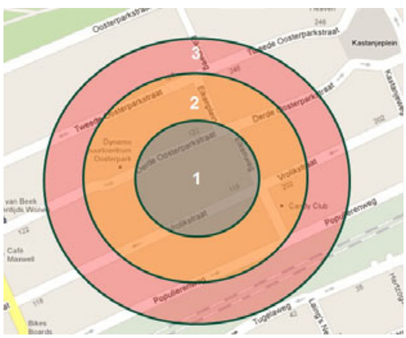

Fig. 2. Location Determination

3.3 User Profile

As the goal of StoryStream is to facilitate the user with a personalized documentary experience of a location, the user profile maintains a "history log" holding data regarding previously experienced stories and the preferences of the user regarding story types, authors, and narrators. The profile is established through explicit and implicit preference tracking methods. Both methods support the aim of coherence provisions, as explicit tracking allows the user to guide the system towards better judgement, where the implicit method supports the free exploration and hence immersion of the user with the story material for the current context.

Explicit methods are best described as methods visible in the user interface. In StoryStream the user has *a like* and *dislike* button to express an opinion regarding a currently playing story (see also Figure 3, right part later in this paper).

Implicit methods are invisible to the user [21]. In StoryStream user actions with respect to the navigation through or with the story are utilized. For example the tracking of buttons such as "*stop*" or *"skip story"* generate a negative score value as they indicate that the story does not fit the current context. Positive scores are generated once a story is successfully completed.

To cope with the different nature of both explicit and implicit tracking methods, StoryStream introduces a scoring scheme, which combines the implicit and explicit observations into a single score that is then applied to the four corpus concepts. The base scoring value used for stories is 0. This increases to 0.3 when a user allows the story to finish (implicit). When a user taps the *like* or *dislike* button the score value will be in- or decreased by 1. The difference between the two types of values reflects the notion that an explicit statement of the user is more valuable than the assumption-based implicit scores.

In whatever way the user terminates a story at the end the profile is always updated in the form of a log record that describes the current history of the user in the form {storyid, date, descriptor, predicate, rating}, or short {S,D,P,R}, where

- **storyid** represents the id of the story in the Mediamatic repository
- **date** stands for the date when the story was listened to
- **descriptor** covers any of the 3 model concepts
- **predicate** provides the instantiation of the type
- **rating** contains the current rating.

The logs are all stored and hence serve as a historic model that represents the development of the user's preferences.

3.4 Transmission Engine

The transmission engine represents the discourse part of the narrative progression, where the transition engine establishes the structure of the narrative transmission (form of expression) that is then communicated to the Storyteller unit (see section 3.5), which establishes its manifestation (substance of submission).

The transmission engine performs two basic processes that determine which story needs to be presented next according to the current position of the user and the established preferences. First it has to establish the current state of preferences (calculation of the {descriptor, predicate, rating} vector, in short {D,P,R}). Second it has to establish the relation between the currently played story with its successor based on the user preferences (calculation of the story relatedness).

Calculate {D,P,R}

In order to calculate the relatedness, a conversion of the {S,D,P,R} vectors into relative scores for each of the descriptor and predicate combinations {D,P,R} is needed.

Let R|P be the rating R for predicate P (for example, 1.3|School), and N|D (e.g. 15|Related) be the total amount of log lines N for descriptor D. N|P is the amount of log lines for P (e.g. 5|School). To calculate the normalized {D,P,R} score for each of the predicate values, we use the following function:

$$\{D,P,R\} = \mathrm{sum}((R|P)N|D) \,/\, N|P$$

This process results in a list of predicates and their scores. The higher the predicate score, the more the user favours that particular predicate.

Calculate Story Relatedness

The transition engine considers only the currently identified stories for the perimeter established by the localizer unit (see section 3.2). For each of the stories the engine queries the rating for the relevant parameters of the stories and compares them with the currently established preferences related to the current story. The closest match of this comparison determines the successor story.

In situations where it is unknown whether the user likes or dislikes a story topic because the now available topic has not yet been introduced, the system will use a dummy value. Missing values will be substituted by the average of the available {D,P,R} values. In that way we overcome the problem of facilitating users with always the same topics by adding occasionally new ones into the narrative flow and potentially enhance the exploration space.

The ranking of the available stories in descending order of their DPR values identifies the next suitable story to be told. The relevant ids are transmitted to the storyteller, which then presents the story. As all presented stories are kept in the history element of the user profile we avoid that stories that have already been presented will show up again.

3.5 Storyteller

The storyteller module facilitates two types of narrative manifestation, namely text and verbal speech.

As the texts in the Mediamatic repository are in Dutch, StoryStream makes use of Google's translate service[3] to overcome the language barrier. The fact that the texts are short and edited, i.e. follow grammar and spelling rules and provide a common use of language, the translation works well. The currently supported languages are English, French, German, Italian and Spanish.

The narrative text elements are extracted from the available body form the selected story. The text is presented on the display of the mobile phone to make it accessible for people who rather read than listen. The default presentation mode is, however, oral. For that StoryStream makes use of the text to speech engine[4] that ships with the Android platform. This TTS supports the languages English, French, German, Italian and Spanish. The drawback at the moment is that the original Dutch texts then will be read with a German accent, as German is phonetically the closest language (in the interface the user can chose Dutch but it will be connected to German for the vocal presentation).

The storyteller also provides a zoomable Google-map based presentation that allows the user to identify areas of accessible stories. The user cannot only see how many stories are available but, due to colour coding, how many of those cover his preferred topics. In that way the system allows the user a further option for the exploration of the neighbourhood, namely adding feedback about the available story space to the actual locative context the user is currently in.

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[3] `http://translate.google.com/#`

[4] `http://developer.android.com/resources/articles/tts.html`

4 Use Experiment

The aim of StoryStream is to facilitate the free exploration of a neighbourhood but at the same time provide a coherent and user adapted story experience. For testing in particular the coherence of the established story presentation we set up a use test with the aim to verify our hypothesis that the system generated story order is perceived better by users than a randomly generated order of stories, where random here means to pick any story available for the perimeter the user is currently detected in[5].

4.1 Setup

The test had to be performed in the neighbourhood of "East" to ensure that the participants experienced the system under real world conditions. It was important that the users listened to the stories in a context where they instantly compared the story with what they perceived and had to follow the ongoing traffic.

For establishing comparable results we picked a sub area of the neighbourhood with a rich set of available stories, where the participants were given a general direction in which they could explore the surroundings. We also had to assure that the participants would receive the same pattern of system versus random generated successor story. We therefore altered the engine to generate a pattern of 10 stories in the following distribution [1,1,0,1,0,0,1,1,1,0] (1 = StoryStream, 0 = random), directly followed by another pattern of 6 stories, representing blocks of this distribution [1,1,1,0,0,0] (1 = StoryStream, 0 = random).

The average length of the stories available for the chosen area is 3 minutes, which results in a story exposure of around 45 minutes (it could not be stated in advance which stories get picked), which represents a realistic time of use of a system like StoryStream.

As none of the participants had used the system before, we provided a small user profile so that StoryStream had a basis to work with. As all users should start with the same profile we analyzed the streets of the chosen area with respect to the available topics so that we were sure that enough material was available for the free exploration of the users.

Finally we altered the actual StoryStream interface by adding a screen that states the start and end of the experiment (see the left part of Figure 3 for the start interface) Moreover, we added a "transition rating" button at the bottom of the storyteller interface (see the right part of Figure 3). Users were asked to evaluate the transition between two stories once the successor has been played. The rating provided a scale between 1 (no relatedness between the two stories) and 5 (strong relatedness between the 2 stories). Users could interrupt a story at any time and were encouraged to use the like and dislike buttons.

In March 2011 the use tests were performed with 12 participants, aged 22 – 29, all university students with a mixed domain background but all experienced Smartphone users. Each participant received an identically setup test phone (Model HTC Desire, operating system, Android 2.2) equipped with headphones. Each participant also

[5] As a comparable system does not exist, to our knowledge, we had to rely on a comparison with random selection.

received an introduction to StoryStream's functionality. The participants were informed about the already installed user profile and then were familiarized with the task to be performed, namely rating the relatedness of 16 stories while walking through the pre-defined area.

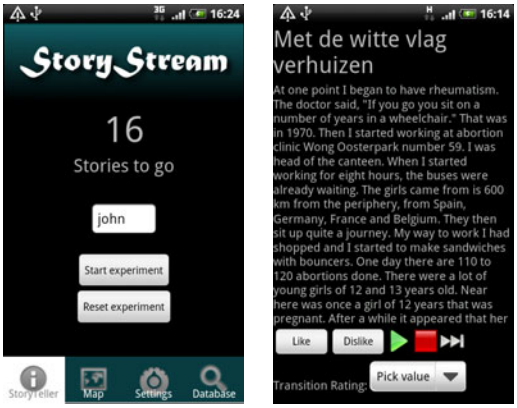

Fig. 3. StoryStream's test environment, left: experiment intro, right: story rating screen

4.2 Results and Evaluation

The 12 participants generated 192 experiment records, of which each record represents a vector containing values for *participantname*, *storyid*, *transitiontype*, *usertransitionrating* and *systemstoryrating*, where

transitiontype states if the transition was system (1) or randomly (0) generated

usertransitionrating represents the user rating (1 – 5) of the relatedness between story and successor

systemstoryrating represents the internal StoryStream story relatedness regarding the experiment user profile. This value is always available regardless whether or not the transition was selected by random or by the application.

We looked at the results in two steps. First we investigated the complete experiment record to see if indeed StoryStream produces a better experience for users because it relates stories better to each other, thus generates a better documentary feel. We then split the experiment record in two parts, one representing the results related to the 10 short-term transitions, and the other bundling the results for the 2 block sets. In this analysis we mainly look at the correlation between the system generated value for "relatedness" and the values provide by the users to establish an indication about the performance of the systems story selection algorithm.

We found a significant correlation (Pearson correlation 0.479; 0.586 and 0.349 with Sig (2-tailed) equals 0 and 0.003 respectively) between the independent scale variable *systemstoryrating,* the ordinal variable *usertransitionrating,* and the nominal value *transitiontype indicating that* whenever StoryStream selects the story based upon the user profile, the test subject is very likely to give a higher rating to this transition. However, the correlation for the block result set is considerable weaker (0.349). This result is quite unexpected considering the strong correlation found in the other two sets. After having analyzed the story content corresponding to these specific experiment records, we found one possible cause. It seems that there is the possibility of a semantic gap between the actual content of the stories and the keywords associated to it by the editor of the story corpus. As a result the participants might have missed the relation between two stories, as the system only relies on the tags. That is also a clear indicator that, even though human annotated, additional care needs to be devoted to the classification process of stories.

In addition we performed an independent T-test for the different data sets to investigate if there is a significant difference between system or random generated transitions from the current story to its successor from a user point of view. We found that for all 3 sets participants gave a higher rating to system-selected stories when compared to randomly selected stories.

Finally, we investigated the correlation between the *transitiontype* and the *systemstoryrating* on all 3 data sets, where high correlations should show that the system selects stories that match the user profile best. With values of .670 (complete set), .660 (10 story set) and .731 (2 block set) strong positive correlations are measured, which is a clear indication that the algorithm performs well. Interestingly here we also see that the block set performs best, as had been expected.

Based on the established results there is enough evidence to support the hypothesis that the StoryStream application improves automated story selection when compared to random automated story selection.

In addition we also asked the participants to write down comments about how they experienced the stories. All participants stated that they found the application useful and would consider using it if available as an App. However, all of them also mentioned that the current text to speech engine used during the experiment sounded monotone, resulting in a weakened experience as the users had to refer to the text on the screen to fully understand the story, rather than freely looking at the surrounding for identifying location landmarks mentioned in the story. The participants also mentioned that they would like to see additional media, e.g. images, as long as they add to what is visible in the real environment.

5 Conclusion

In this paper we demonstrated StoryStream a new approach for enhancing the free exploration of city neighbourhoods by providing orally presented user-generated stories that reflect in a documentary form on the current location of a user as well as the user's content preferences. The use case experiment showed enough evidence that the three key components, i.e. the im- and explicit ratings of presented stories based on user behaviour, a user profile that presents the current preferences and a context-related historic view of user preferences, and the oral presentation method, establish a coherent experience that is better than the experiences gained by randomly choosing stories from the pool of available stories for the current user location. Thus, StoryStream is solid for generating coherent story experiences on the fly without pressing the user into a pre-defined route, as current state-of-the-art techniques do.

We are aware that our approach is mainly suited for a documentary presentation style and we do not claim that it works for a character-based presentation style, as for example used in Hansen's approach on mobile urban drama [6].

The current state of StoryStream should also be understood as a first step into the development of mobile experience computing. Further investigation is required to establish more substantial models on sentiment analysis, for example by comparing the full texts instead of "tags", which might improve transition decision but might also improve mood alignment.

Mediamatic is currently integrating StoryStream into their story environment. Based on our findings in the experiment this also involves a critical analysis of the currently bag of keywords assigned to stories. On a long term the collected logs will be analyzed for getting a better understanding of potential semantic misalignments between tags and actual content. The findings of this line of work will also be used to establish an automatic classification mechanism that allows enhancing the currently less well-annotated parts of the repository.

Further research is necessary to establish mappings between the way storyteller present stories and the available story metadata representations to establish a content adequate phonetic presentation. We currently work together with storytellers who tell us how they would present the given story pieces available in the repository.

Based on the request for additional media we started to investigate awareness cues that can be inserted into the story to inform the user about available additional media. We aim to better understand the interaction and user experience (UX) of such digitally augmentation, especially concerning the optimal encoding and communication of this information to mobile users at the right place and time.

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Exploration of User Reactions to Different Dialog-Based Interaction Styles

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Abstract. How human users perceive and interact with interactive story-telling applications has not been widely researched so far. In this paper, we present an experimental approach in which we investigate the impact of different dialog-based interaction styles on human users. To this end, an interactive demonstrator has been evaluated in two different versions: one providing a continuous interaction style where interaction is possible at any time, and another providing system-initiated interaction where the user can only interact at certain prompts.

Keywords: Dialog, Interaction, Evaluation, Storytelling.

1 Research Problem

Interactive stories are envisioned and designed to facilitate positive, enjoyable, and moving experiences in their users [1]. The simple fact that interactive stories rely on user interaction suggests that involving users in the design process is essential for building successful systems with high end-user acceptance. To the extent that solid conceptual reasoning is underlying user-centered formative research, user studies can therefore help system creators make better choices when several design options are available [2].

The present paper illustrates the value of systematic, concept-based user research in designing interactive stories by an examination of user reactions to two different ways of managing text-based dialog between user and story characters. The conceivable modes of managing user dialog come with specific advantages and caveats both from a designer's and from a user's perspective. Exploring potential differences in user reactions to manifestations of different design options

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regarding text-based dialog can help system creators make an informed decision about which kind of dialog option to select. For example, if one mode of managing dialog is particularly costly from a designer's perspective, exploring user reactions to an interactive story prototype that employs this mode will allow concluding whether gains in (enjoyable, engaging) user experiences can be expected that justify the effort of a full-scale implementation of the dialog mode in question in the final system (see also [3]).

For this purpose, we present a dialog-based interactive storytelling prototype that was implemented in two different versions: One version enabling continuous dialog interaction to users, whereas the other version offers round-based, system-initiated dialog possibilities. With it, we want to investigate in how far the user's freedom of choice or the guidance by the system influences the user's perception of the experience. This is a crucial question in interactive storytelling systems, since the user's autonomy has proven to be an important feature that influences the user's experience of the entertainment [4]. However it is not clear to what extent the design of a system needs to be adapted in order to reach a feeling of autonomy.

2 Dialog-Based Interaction in a Virtual Scenario

In order to test the impact of different interaction styles on human users, we implemented a storytelling application using virtual characters that is able to cope with a user's typed text input and provides appropriate reactions. Therefore several components were needed, such as language understanding to parse the user's text input into abstract dialog utterances [5], an authoring tool that allows us to model different interaction strategies [6] as well as a graphical representation holding the virtual characters [7].

For our demonstrator, we chose to model a soap-like story, where the characters are involved in a romantic conflict. The user, who is represented by an avatar, can interact with a group of girls, a group of guys, or a waitress that is working in the Virtual Beergarden scenario. Through observation and interaction, the user will learn that there is a love story secretly going on. Dependent on the user's interactions, the characters will reveal their love, ask for help and follow the user's advice. For different outcomes of the game, the constellations of the conversational agent groups can change. In that manner, one of the guys can, for example, walk over to the waitress and ask her out for a date.

To investigate the impact of different dialog-based interaction styles on human users, we implemented two different versions of the application that are described in the subsequent subsections.

2.1 Continuous Interaction

In the continuous version, the user is able to interact at anytime. With it, we aim at providing interpretational freedom to the users and to enhance their perception of the story by inspiring their curiosity and encouraging their spirit of exploration. Therefore, the graphical user interface for the user's typed text input is always enabled.

This version of our interactive demonstrator is a lot more complex, since agent dialogs need to be interruptive in a manner that characters are able to react to user interaction at any time. Therefore a much lager set of interaction possibilities needs to be provided, as users might interact differently during an ongoing dialog than they might interact after being asked a specific question. By providing a continuous interaction style, user interaction should be perceived a lot more natural and intuitive, since dialogs in real life work in a similar manner, too.

An important issue arising due to this interaction style is the timing of user input and system output. The dialog management tool of our system [6] provides concepts for hierarchy, concurrency, variable scoping, multiple interaction policies and a runtime history, which is needed for this kind of interaction. In the continuous version, the current dialog needs to be interruptive as a prompt reaction to the user's input is required. In case of a user input, the dialog that was currently active is stopped at utterance level and the dialog is not further executed.

For prompt reactions, the process modeling of the target of an interaction needs to be properly synchronized. After a user's utterance has been detected, the conversation either continues with another dialog or with reentering the previous dialog. For the latter, a runtime history provides the possibility to remember the last substates of the conversational flow.

With this version of the demonstrator, we provide a highly interactive system that might help engage the user. Potential issues with this version might be a confusion of the user, in case he or she does not know how or at what point in time to interact with the system-controlled characters. In addition, the impact of the user's interaction to the flow of the story might not always be clear, since virtual characters do sometimes need to block or redirect the user in order to continue with the story line.

2.2 System-Initiated Interaction

For the system-initiated interaction style, the story flow and dialog scripts from the continuous version were reused. However, not all states are likely to be reached, since the graphical user interface for the user's typed text input is disabled during agent conversations. Only at points in time when the user can state an opinion or advise a character, and thus make a contribution to the narrative flow, the user is actually able to communicate with the system. Thus, clear interaction prompts are provided by the characters, and only user interactions that are typical of the particular branch are likely to occur. In that manner, on the one hand the user knows what kind of input is required. On the other hand, the parsing of these sentences is easier, since the domain is limited. If the user is, for example, explicitly asked for his or her opinion on the waitress, it is likely that the user states an opinion and does not try to comment on other things. Hence, only a few of the possible characters' responses are therefore needed.

Dialogs that are held by system-controlled characters are not interruptive in this version. Only if the end of a dialog is reached, a contribution from the user's side is possible. However, the runtime history is still maintained, since a dialog might have to be reentered, e.g. if the user walks away and approaches the target group again afterwards.

This interaction style is a lot simpler to model than the continuous version. As a possible advantage, it might be more intuitive to use for unexperienced users, since clear questions are asked at certain points in time only. Since interaction is only possible at story branches, the impact of the user's interaction on the flow of the story should be comprehensible to the user. However, this version might be perceived as boring by the users.

3 Exploratory User Study

An experimental user study was conducted to explore the impact of the decision for continuous or round-based user dialog on the end-user experience. Conceptually, the term "user experience" was grounded on previous theoretical and empirical work (see [1] and [2]). The framework includes diverse modes of experience such as suspense, curiosity, flow, and effectance (perceived causal influence onto the story). For this conceptual framework, a self-report measurement tool [2] was used in the present study. It was expanded by the experiential aspect of autonomy [4], which is particularly relevant to the comparison of continuous versus round-based dialog: The former might cause stronger perceptions of autonomy, whereas the latter may make users perceive constrained autonomy, as users need to 'wait' until it is their 'turn' to speak during interaction with the story characters.

A total of 42 university students (mean age: 22 years, 30 females) participated in the study. They were randomly assigned to either experience the Virtual Beergarden scenario with continuous (n =20) or round-based dialog (n=22). After receiving a brief introduction of the system, their exposure typically lasted for five to ten minutes. Afterwards, participants filled in a questionnaire about the various dimensions of user experience. Subsequently, they took part in another study that is not reported here, were thanked and dismissed afterwards. They received a financial compensation of overall 15 EUR for both studies.

For all scales of the user experiences, the rating questions on whether expectations were met, and the items about which conventional media experience was perceived to be similar, mean comparison of index or item means between participants exposed to either the continuous or the round-based dialog were computed. T-test statistics were applied to determine group differences of particular importance. Table 1 summarizes selected findings. Users who interacted with the system through continuous dialog reported greater perceived autonomy and curiosity, were less disappointed in terms of engagement, and rated the experience more similar to improvisation theater than the user group confronted with round-based dialog (see table 1).

Table 1. Selected findings from exploratory user study. All items and scales used five-point ratings ranging from 1 (do not agree at all) to 5 (fully agree)

	Users confronted with continuous dialog		Users confronted with round-based dialog		t-test
Dimension of user experience	M	SD	M	SD	p
Autonomy	2.68	0.93	2.17	0.79	0.055
Curiosity	3.78	0.77	3.33	0.92	0.095
Suspense	3.16	0.74	2.82	0.79	n.s
Enjoyment	3.45	0.95	3.07	0.94	n.s
Comparisons with expectations					
"I had the expectation that the experience would be more engaging"	1.75	0.97	2.18	0.59	0.09
Similarities to other experiences					
"The experience reminded me of playing a video game"	4.25	1.33	4.82	0.39	0.06
"The experience reminded me of watching a movie"	2.45	0.99	1.77	1.15	0.049
"The experience reminded me a little of playing improvisation theater"	2.10	1.33	1.36	0.49	0.02

4 Conclusions

Findings indicate that shifting between technologically quite different options does not affect user experiences in a fundamental way: Many conceptually relevant dimensions of the user experience were found to be equal in both experimental groups, and only a few (nearly) significant differences emerged. These differences are highly interesting, however: They suggest that users value continuous dialog, which comes with greater technological requirements, higher in terms of autonomy and curiosity about how the story will evolve. Moreover, users' comparisons of the interactive story with previous media experiences shift if the dialog mode is changed: Continuous dialog is perceived to be closer to film and improvisation theater experiences, whereas users judge round-based dialog to be more similar to video game play, probably to classic menu-based adventure games. So overall, the technologically more ambitious design option of continuous dialog seems to contribute to a more unique, novel kind of user experience, whereas the less demanding option of round-based dialog directs users' perceptions towards well-known experiences of interactive entertainment.

Designers can now discuss whether they want to provide a higher degree of perceived autonomy and more of an improvisation theater kind of experience to users [8] or whether they strive for an experience similar to playing a video game. Of course, standardized measures do not tell designers the full story; qualitative approaches with single users are equally important. Yet the fact that theory-based, standardized measures (such as [2]) reveal interpretable and relevant effects of design decisions even with prototype systems, clearly indicates that quantitative-experimental approaches in early user research can make important contributions during ongoing system development.

An interesting observation is the user's perception of how the Virtual Beergarden scenario is perceived by human users. Initially, the interactive system was designed to resemble a virtual improvisational theater [9]. Our evaluation study, however, reveals that the story reminds more of playing a video game. This perception does not necessarily need to stand in the light of an improvisational theater experience, since graphics and virtual worlds are directly adopted from video gaming. Nevertheless, our findings indicate that a continuous interactive dialog style enhanced the users' perception towards an improvisational theater experience. Although our soap story in the Virtual Beergarden scenario was not directly perceived as improvisational theater, integrating more autonomy for the user can can be seen as a step in the right direction.

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How Authors Benefit from Linear Logic in the Authoring Process of Interactive Storyworlds

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Abstract. We present a case study of interactive story creation, in which we applied a proof mechanism based on Linear Logic to the authoring process. After initial scenario modeling for dynamic plot generation based on planning, we used the mechanism in iterations of refinements to find possible problems within a huge possibility space of resulting discourses. We describe first results of our case study, discuss prospects and limitations and point out future work.

Keywords: Interactive Storytelling (IS), Authoring, Planning, Linear Logic, Scenario Validation, Proof Graph.

1 Introduction

In Interactive Digital Storytelling (IDS), the use of generative technologies offers to go beyond linear or branched stories. It helps to achieve higher degrees of variability in responses to user interactions, for example by dynamically influencing the sequencing of events or actions. However, generative technologies also raise new challenges for story creators. Authors not only have to conceive stories in novel non-linear ways, they also need to adapt story ideas to technological concepts underlying the used IDS systems. Mostly, abstract models of storyworlds need to be created, describing dynamic behavior through rule-like formulas to be processed by story and behavior engines [19].

On top of abstraction, another authoring challenge is that generative processes possibly create huge amounts of different plot results that are difficult to anticipate. Therefore, authoring tasks need to follow iterative cycles [20] [15]. Starting out from adding content and rules, it is then necessary to test their outcome, try to find flaws, suggest possible improvements and start again by adding or modifying elements and rules. In the following, we refer to this iterative problem solving as '*debugging'*. During debugging a complex generative storyworld, 'manual' methods of testing and keeping an overview can easily reach their limits. As solutions to this problem, automatic methods have been proposed [5] [12]. Using our automatic proof approach proposed in [5], we undertook a case study to explore prospects and limitations of

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using such a proving tool within a concrete authoring process. The employed approach is based on *Linear Logic* and able to perform a so-called validation of a scenario. While it is still the responsibility of authors to look for shortcomings in the entertainment value and experiential qualities, we expect that the method provides automatic help in finding specific technical flaws, such as dead ends within marginal but possible courses of events.

In the following, we describe the first results of our case study, discuss prospects and limitations and point out future work. Thereby we bridge technical offerings with motivations of authors. We describe the initial creation of content, followed by its step-by-step transformation into representations interpretable by Linear Logic. Finally, we discuss the results of the performed proving process with our tool and its use for authors.

We use the following technical terms:

- A *discourse* is an ordered sequence of actions/events that is a possible unfolding of a story. One storyworld can be the base to let generate various discourses.
- A *scenario* is a set of all the possible discourses for a story. If we change anything in the storyworld then we will receive a new scenario.
- The *goal* of a story is the authors' desired ending. There may be one or multiple *goal state(s)* and each *goal state* corresponds with one desired possible ending.

2 Related Work

Our case study explores the use of automatic logical proofs in authoring. The case has been built upon an example story, which we initially created as educational material for introducing authors to the concepts of planning [9]. AI-based *Planning* – as described by Russell and Norvig [17] or LaValle [11] – is a prevalent method researched in IDS for drama management, such as by [4] [21] [15] [16] [18]. The role of *Planning* in IDS applications *"is to define the actions or events that must occur during the story so that the world changes from its initial state to some goal state"* [2]. This also means that planners create the order of actions dynamically.

Enabling 'debugging' can be considered a main requirement for IDS authoring tools [14]. There exist a couple of systems and tools in the context of generative IDS designed directly or indirectly with this purpose. The Virtual Storyteller system [20] lets explore debugging as an active part of 'co-creation' during the creative authoring process, in which the generative outcome may influence the authorial intent. Hence it reduces tensions between authorial intent and the partially uncontrollable outcome of story generation. The Emo-Emma authoring tool [15] allows authors to step-by-step choose among possible unfoldings of plans, visualized as a tree graph. Enigma [13] is the conceptual design of an authoring tool that solves the problem of authoring emergent narratives by letting planning-based virtual actors learn during a rehearsal mode. In that mode authors can watch and modify the outcome directly. Both previous examples are more focused on the manual testing of single discourses.

In [22], the use of Petri nets is proposed for game analysis and specification. It has been considered as a starting point for a game design method, to guarantee that the actions carried out by the player maintain the coherence during the game experience.

KANAL [12] is a tool that helps authors to create sound plans by simulating them, checking for a variety of errors and allowing to see an overview of the plan steps or timelines of objects in the plan. However, it was not designed for validating interactive storyworlds.

The current state of the art shows that the problem of managing and validating a scenario has not been efficiently handled yet, although it has been considered as important. Our goal is to offer authors an automatically generated list of all possible discourses in a scenario, (almost) complete necessary statistical information, as well as some suggestions to repair unwanted errors. We believe that our approach – in spite of some limitations – supports authors to achieve well designed results, by letting them validate scenarios more quickly and easily than with manual testing.

3 Case Study and Its Initial Authoring Process

Our case study began with the creation of a simple story named ‘Harold in Trouble’ (explained below). We explored the transformation process of the first linear draft into a story model suitable for AI-based planning, in particular based on the STRIPS approach [6]. In order to illustrate the dynamic plot generation offered by planning, we created a physical card game based on the model to be used as a paper prototype [9]. The story was further test-implemented with an authoring tool equipped with planning software[1] [15]. We expected a greater degree of non-linearity and variation within the conceived content due to the software’s replanning possibilities.

The cards were helpful as a first paper prototype in the creation process as well as a didactic method to explain the planner’s search process [9] to be understood by novice authors. However, this method soon met natural limitations once the story reached a certain complexity. The planning-based authoring tool [15] then allowed to dynamically visualize more possible variations within our created story domain. However, authors still had to manually click through these dynamically created trees of possibilities, for example if we wanted to detect unwanted dead ends within some possible paths. Therefore, we further explored means to create semi-automatic answers to such questions of consistency within complex storyworlds. We translated the material into a Linear Logic representation, to then test the story structure with the SV Tool, our proof software based on Linear Logic. This translation and the verification will be shown in the next sections.

The conception and creation process of the ‘Harold in Trouble’ story consisted of several steps and is in detail described in [9]. Here, only a brief summary is given:

- The first written story outline consisted of scenes, characters, their goals and actions. Our story resembles a simple ‘James Bond’ plot in a comedy genre, in which the criminal super brain ‘Silvertoe’ blackmails the world. The comic character ‘Harold’ – a wannabe womanizer – is the clumsy assistant to the agent who negotiates with Silvertoe. The goal for our first implemented scene is to let Harold make Silvertoe so angry that he leaves the party during which the negotiations take place. Harold, by trying to seduce female party guests, creates chaotic chain reactions that influence Silvertoe’s mood negatively.

[1] EmoEmma-AuthoringTool, `http://redcap.interactive-storytelling.de/authoring-tools/emo-emma`

- The first step to remodel the linear outline as a planning domain was to extract possible meaningful actions and events from the draft. We identified two abstract actions at a high hierarchical level (subsuming other concrete actions) to achieve the intended story experience: 'seducing' and 'creating havoc'. This abstraction allowed for ramifications of actions that were not necessarily linear.
- Further, it was required to describe factual statements that are possible in the storyworld. Story-relevant variable attributes have been identified that would serve as such 'propositions', for example 'Cigarette is lit'. The most important emotional states in our story are the increasing anger levels of Silvertoe.
- Then, a strict order in our designed actions has been partially abandoned in that we described for each action under which circumstances ('preconditions') it can occur and how it changes the storyworld (its 'effects'). For author-intended action chains and connections we had to imply partial orders just by the design of these conditions. Table 1 in section 4 shows how the action 'Harold lights cigarette with a match' is described with a set of preconditions and matching effects.

  In the planning jargon, the elements to be described by authors are the following:

  - *Propositions* (facts): elementary and changeable situations in the storyworld, for example: 'The cigarette is lit'.
  - *Operators* (actions): possibly modify the validity of facts and hereby change the state of the world, for example: 'To light a cigarette'.
  - *Preconditions* declare under which conditions a certain action is allowed to be performed. Example precondition for 'To light a cigarette': 'The cigarette is not lit'.
  - *Effects* declare which facts are added to or deleted from the world state after the action is executed. For example, the action 'To light a cigarette' adds the fact 'The cigarette is lit' and deletes the fact 'The cigarette is not lit'.
  - *Initial state* and *goal state(s)*: The initial state is described by facts that are already in the world when the story begins. One or more goal states are described by facts that have to be in the world to let the story end.

With this information, a planner can generate sequences of actions. The process has two steps: 1) Depending on the current world state, *find* possible actions, and 2) if multiple actions are possible, *choose* the 'best' action. The choice of this 'best' next action is determined by a quality function, which is currently not described here.

After these primary steps, the first version of the paper prototype has been created as a card game (described in detail in [9]). For testing outcomes, action cards can be played after valid comparison of their preconditions with the current world state, which is then influenced by the action's effects by adding or removing proposition cards to/from the table. If more than one card can be played at once, the card game players have to decide which one would be the 'best' fitting. This process simulates the use of a quality function in a fully fledged software planner.

The design of prototypes and their testing – whether by cards or by software – is a crucial task in authoring after an initial design of a storyworld, which is not less important. During many iterations we need to keep an overview of the final outcome regarding consistency. Most importantly, we need to identify unwanted deadlocks, which would end a discourse without reaching any goal state. Initially, we largely underestimated the amount of possible discourses even with a small set of actions and propositions. This first became obvious by the help of the automated proof tool, described in the following chapters.

4 Case Study Modeling by Means of Linear Logic

Linear Logic [7] is an executable formal model which considers propositions and actions/events as resources that are consumed and/or produced. It is employed to represent the validity of how resources are used when proving an assertion. Linear Logic is well suited to model the natural reasoning through the mechanism of sequent calculus introduced by Gentzen [10]. Besides, linguistic theory uses a subset of Linear Logic (intuitionist multiplicative and non commutative), that corresponds to Lambek calculus [1]. Consequently, Linear Logic provides a framework to model causality as well as resource allocation mechanisms.

In addition, the concept of *linear implication* in Linear Logic is also close to the logic of the concept of *narrative program*, which in Greimas' analysis [8] is an 'abstract formula' employed to express an action/event. The foregoing has inspired us to create a semantic framework of using Linear Logic to model an Interactive Storyworld and then using its reasoning to directly assist authors in managing the generated scenario. In order to reduce the complexity for readers, we do not present the complete approach, but just mention the necessary points applied within the framework of this paper (interested readers get more information in [3]).

- $\otimes$: multiplicative conjunction (times): this connective is used to express a set of propositions.
- $\multimap$: linear implication (imply): a linear implication formula is used to express the validity of transforming propositions from its left side into its right side. As a result, it is used to express an action/event in the storyworld. The transformation of an action/event from its planning representation (the action A01 in the Harold storyworld is described in Table 1 as an example) into a linear implication formula is given in Table 2.

Table 1. Example of an action and its corresponding preconditions and effects

Preconditions	Actions	Effects	
		Add	Delete
P01: Bored woman is present	**A01: Harold lights cigarette with a match**	P04: Cigarette is lit	P03: Cigarette is not lit
P02: Woman has cigarette in hand			
P03: Cigarette is not lit			

Table 2. Transformation of an action/event from its planning representation into Linear Logic

Transformation steps	Linear implication formula	
	Left side	Right side
Put the propositions in the *Preconditions* list in the left side of the formula; if there is (are) one (or some) proposition(s) in the *Effects/Delete* list that is (are) not included in the *Preconditions* list, continue to put it (them) in the left side of the formula; all propositions in the left side are connected by the connectives ⊗ (*Note: For A01, the proposition P03 in the Effects/Delete list is included in the Preconditions list*)	P01 ⊗ P02 ⊗ P03	
Copy all propositions in the left side of the formula to its right side	P01 ⊗ P02 ⊗ P03	P01 ⊗ P02 ⊗ P03
Add the propositions in the *Effects/Add* list to the right side of the formula	P01 ⊗ P02 ⊗ P03	P01 ⊗ P02 ⊗ P03 ⊗ P04
Delete the propositions in the right side of the formula corresponding to the ones in the *Effects/Delete* list	P01 ⊗ P02 ⊗ P03	P01 ⊗ P02 ⊗ P04

Finally, we receive the linear implication formula P01 ⊗ P02 ⊗ P03 ⊸ P01 ⊗ P02 ⊗ P04 which expresses the action A01 in the storyworld. The transformation for the remaining actions/events in the Harold storyworld is similar.

- A sequent is composed of two parts (separated by ⊢ (turnstile)): the left part includes initial proposition(s) and action(s)/event(s); the right part represents the goal of the story which includes authors' desired possibilities of ending (goal states). Proving a sequent consists in executing one of its actions/events at each step until the set of current available propositions in the left part (in the world state) contains one of the goal states in the right part of the sequent. As a proof expresses the actions/events to be executed, to reach a goal state of a sequent (may be successful or unsuccessful), it is equivalent to a discourse which is an ordered sequence of actions/events that is a possible unfolding of the story. From a sequent, we are able to build its full proof graph, therefore the sequent corresponds to a scenario which is a set of all the possible discourses for a story.

  For instance, the sequent P07, A04, A10, A11, A27, A28, A29 ⊢ P12 has the full proof graph given in Fig. 1. It expresses all the possible discourses in the scenario corresponding to this sequent, in which: P07, P10, P12, P18, P19, P37 are the propositions; P07 in the first node (in the initial state) is the initial proposition and also the current available proposition in the beginning; the propositions in the other nodes are the current available propositions (in the world state) at each step; A04, A10, A11, A27, A28, A29 are the actions/events; the sequent has one goal state including only the proposition P12; the scenario has two discourses (two proofs/branches): A10 → A28 → A27 → A04 and A11 → A29 → A27 → A04.

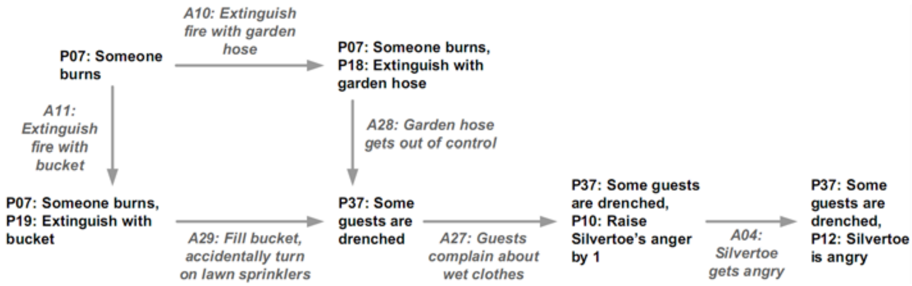

Fig. 1. Full proof graph of the sequent P07, A04, A10, A11, A27, A28, A29 ⊢ P12

In our case study, after modeling the storyworld (propositions, initial propositions, actions/events and goal states) by means of Linear Logic, we received a sequent which represents its corresponding scenario. The scenario is verified thanks to the proof of this Linear Logic sequent. In the next sections, we will describe in detail how Linear Logic helps authors do that.

5 Scenario Validation and Debugging

As mentioned before, *debugging* means here the process of testing a storyworld and modifying and improving it if unwanted results occur. The developed tool, called Scenario Validation Tool or short SV Tool does not make use of a potential quality function which would be used by a planning system. Therefore the collected information can be seen on a more structural level because they are not the result of a higher level decision process to pick 'best' actions during the planning.

Here we provide a selection of IDS properties and requirements that are found to be important during the authoring process and which influenced the design of the tool:

- *Reachability*: It has to be ensured that every situation of a story can be reached from its initial situation. If certain actions should not be reachable they would be meaningless for the story.
- *Deadlock free*: Finding discourses that are not leading to goal states is crucial to provide stories without or at least a minimal number of deadlocks. Identifying these discourses and providing information to track the reasons is desirable.
- *Sequencing*: The discourses should be coherent regarding the logical order of certain events. It should be verifiable whether the intended order is adhered to.
- *Complexity*: The discourses should have a certain duration or length in terms of numbers of actions. This length, as a measure of complexity, should be verifiable.

Another interesting question is whether loops are existing in a scenario. That question concerns the action control mechanisms in Linear Logic. Indeed, there are two ways to control the execution of actions in a story: (1) an action is only executed once (it will be deleted from the list of actions just after it is executed); (2) an action may be executed many times (which needs more complex modeling). To reduce complexity, each action is deleted after its use, thus making loops impossible.

The SV Tool was tested on a reduced version of the Harold storyworld, which was composed of 24 actions, 46 propositions (8 initial propositions), and 1 goal state (including 1 goal proposition: to reach the anger level 2). The tool provides assistance for authors during the creation process of an interactive storyworld by offering a number of statistical values received after the proving process. These values can be distinguished in simple and parametrizable statistical information and direct debugging information. Here we present these statistics, give examples and explain how they helped us to improve the storyworld.

5.1 Simple Statistics

- **Number and list of (un-)successful discourses (deadlocks):**
  All discourses can be shown and are distinguished in successful (reaching goal state(s)) and unsuccessful ones (not reaching any goal state(s)). By looking at the unsuccessful branches it is possible to start there to find deadlocks. Our example consists of 132 possible discourses of which 94 (71%) were successful and 38 (29%) were unsuccessful after the first implementation. So these 38 discourses were at first in the scope of further investigations to find possible deadlock reasons. Because the number is still high, we used more of the provided statistical information to reduce the possibilities.
- **Number and list of last actions in unsuccessful discourses (deadlocks):**
  Taking a look at this list we found that most unsuccessful discourses were ending with action 15 (*'Harold extinguishes burning poodle with floor vase'*) or 30 (*'Poodle falls into pool'*); both appeared 15 times each. They seemed to be dead ends regarding the desired goal to raise the anger level to 2. That means that these two actions are a starting point to improve the story. The simplest solution was to add the proposition 10 (*'Raise Silvertoes anger by 1'*) to the effects of both actions. Running the SV tool after the changes have been made showed a success, because now all discourses were leading to the desired goal.
- **Number and list of longest/shortest (un-)successful discourses (deadlocks, complexity):**
  Because the discourse lists can be very long, they are filtered to show the shortest and longest successful/unsuccessful discourses. That way, we can identify too short successful discourses that may contain unintended shortcuts. It is also helpful to find deadlocks in very short and very long discourses, which may be a hint for flaws in the very beginning or end of discourses. Our example had 42 successful discourses with the maximal length of 11 actions and 10 with the minimum length of 9 actions. There were also 30 unsuccessful discourses with the maximal length of 8 actions and 8 with the minimal length of 7 actions. These 8 would be a good start to begin with the debugging of the storyworld. Comparing them to the before-mentioned 'suspicious' actions 15 and 30 showed that they were among 6 of these 8 actions. This can be seen as a confirmation of the assumption that very short discourses would be a good starting point for flaw identification.
- **Number and list of successful discourses for each goal state (reachability):**
  This list provides all successful discourses organized and depending on the goal state(s). It is possible to see how many and which discourses lead to a certain goal

state, as well as which goal states are not reachable. In our example we had only one goal state. However, if multiple goal states exist, it is for example possible that authors want to give one certain goal state a higher probability than another. This can be checked directly to lead to modifications.

- **Number and list of unused propositions (reachability):**

  These are propositions which are not included in any action, neither in the preconditions, nor in the effects. Normally it is not intended to create propositions which are never used. This information may help to identify actions which could not be performed because of missing propositions. On the other hand, there also may be actions that do not contain appropriate propositions in the effects. In our example we found a lot of them (*'18 propositions among 46 propositions (39%) are not used in any action'*), because we removed actions from the original card game. As a result, unused propositions were left over, because it was hard to track all spare propositions manually in the first instance. In a complex authoring process with several testing iterations, such cases are likely to happen and can be easily corrected with the help of the proof.

- **Number and list of unused actions (reachability):**

  Unused actions do not appear in any discourse. Normally it is not intended to create actions that are never used, but it may happen during processes of redesign. Identifying unused actions may help to find possible reasons for deadlocks (for instance). In a sophisticated storyworld, authors may have made the reaching of some propositions dependent upon certain actions, which in turn depend upon other true propositions. In our example we found 3 (13%) of the 24 actions were not used. All three of them could be identified as parts of other story chains which were previously taken out of the reduced version, so it was impossible to fulfill their preconditions. By removing them the issue was solved.

5.2 Parametrizable Statistics and Additional Debugging Information

The SV Tool also provides lists and information depending on parameters authors may enter. This way authors can search for certain aspects they are interested in to aid the debugging process and more easily identify possible reasons for flaws:

- **Number and list of discourses containing certain ordered or partially ordered actions (sequencing):**

  Authors can define a list of actions which have to appear in a certain order within the scenario, because they may want to check if the intended order of some key actions occurs in general or often enough. It is possible to define that these actions have to appear in exactly the given order or just in a partial order, meaning that an action may appear any time after the previous one. In our example we wanted to proof if and how often the action A04 (*'Silvertoe notices trouble and gets angry'*) is happening right after A03 (*'Poodle burns'*) because it seems to be more believable that Silvertoe gets angry right after he notices the burning poodle. The results showed that only 15 (16%) discourses of the 94 successful discourses fit the desired order, so that this point seems to be interesting for improvements.

- **Number and list of (un-)successful discourses containing certain actions:** It is also possible to test if certain actions appear in general in the discourses regardless of their order. On one side this is useful if authors have some key actions in mind and want to know if and how often they are happening. On the other side it is possible to take a closer look at 'suspicious' actions which may have been identified in previous proofs. In our example we wanted to know if and how often the actions A01, A02, A03 (the beginning of one story chain in which Harold accidentally enflames the poodle) are happening together with the action A08 (in which Harold does not care about the poodle and waits). The results showed that this is very likely the case, because 78 (83%) discourses of the 94 successful discourses contain all four actions, regardless of their order.
- **Number and list of discourses with a certain length (complexity):** It is not only interesting to know how many and which discourses have a maximal and minimal length, but also to set a desired length and find out how many and which discourses are below or above this length. This information is useful to get an impression of the possible durations of the discourses. In our example we found that 5 actions would be an insufficient length for the discourses. Fortunately no discourse was found that consisted of 5 or less actions. Otherwise these discourses would have been a good start to look for shortcuts or deadlocks.
- **Suggest actions which are the possible reason for unsuccessful discourses (deadlocks):** An additional feature of the SV Tool is that it suggests 'suspicious' actions which could be the reason for unsuccessful discourses. They are computed depending on their frequency of appearance in those discourses (the higher the frequency of appearance is, the more 'suspicious' is the action). Authors can take them as suggestions and starting points to identify possible flaws.

6 Discussion

When authors use IDS technologies generating a non-linear order of events, like it is the case in planning-based approaches, they are quickly faced with the issue of keeping an overview of the storyworld structure and the possible outcomes. In our case these outcomes are a high number of possible discourses. The given example, which only used 24 of originally 40 actions in a storyworld, resulted in 132 different discourses. This already caused problems for authors to keep an overview, so that we indeed benefited from using proof software like the SV Tool.

The first question authors would have is: *"Does any of the discourses reach my desired goal state(s)?"* The result can lead to other questions, such as: *"How many of the discourses reach the goal state(s)?"* and *"How can I improve the storyworld to prevent a lot of deadlocks?"* The proposed SV Tool answers the first and second question. It further helps authors to answer the third one by giving hints where to start with a debugging process.

However, the software proof quickly reaches limitations if a storyworld gets too big, for example by rather unconstrained actions with few preconditions. As a consequence of the 'computational explosion', the process may take too long to wait for results. It is also possible that the resulting data is too big to be explored by authors: When we tried to prove the whole set of 40 actions in the first instance, we achieved more than 200 million possible discourses. In future work we will explore using more constrained worlds, either by more preconditions or/and by quality functions to prioritize actions. Further, also the presentation of the proof results can be enhanced by visualizations and prioritization.

7 Conclusion and Future Work

Debugging is one of the main requirements for IDS authoring tools. IDS authors need to specify large numbers of rules and actions, so that finding possible flaws becomes complex and support is needed. In that context, we presented a case study of an interactive story creation process that was supported by a proof mechanism based on Linear Logic. We showed how a scenario has been modeled for dynamic plot generation based on planning. We transformed it into a Linear Logic representation to be processed by our proof tool.

The results show that such a proof tool is suitable to support authors during the authoring process, namely in the debugging of a created scenario. It helps to identify deadlocks and provides hints to find the reasons for these deadlocks and other unintentional flaws, in order to be corrected in a following iteration.

To overcome the limitations regarding the size and the resulting ‘computational explosion’, future work will have to find ways to reduce complexity. For example, we could select a storyworld’s most important key aspects, reduce it to sub-stories or let the computation stop if certain subgoals or key actions are reached. The SV Tool can further be improved to be more accessible for authors by providing graphical representations of the results and to allow them to easily modify proof parameters.

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Imagining New Design Spaces for Interactive Digital Storytelling

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Abstract. Research into Interactive Digital Storytelling (IDS) is often undertaken through a process of conceptualization, design, prototyping, and evaluation. In this paper we describe a framework of questions intended to interrogate the fundamental intellectual commitments that underlie the design of interactive narratives. We close with a brief description of two interactive narrative systems that were developed to demonstrate how different design commitments can result in new and interesting IDS experiences. We contend that examining the underlying intellectual commitments of our designs reveals new avenues for research and design in IDS that are as yet unexplored.

Keywords: Interactive Narrative, Design, Case Studies, Games and Narrative.

1 Introduction

Interactive Digital Storytelling (IDS) has long concerned itself with the project of creating opportunities for readers to meaningfully alter the telling and outcome of an interactive story. The challenge, as it is often framed, is to support meaningful reader choices without the loss of plot coherence or narrative quality that ordinarily occurs when the narrative event sequence deviates from a set of crafted, pre-authored situations. One of the dominant approaches to this problem frames it as a simulational challenge: a simulated narrative world with sufficiently autonomous and knowledgeable agents within it, guided by a director agent with a sophisticated understanding of narrative principles, could create a living story situation that could possibly create satisfying narratives directed by the actions of an interactor. For a recent survey of these techniques, see [1]. While these systems are developing essential tools for the future of IDS, they are beholden to a set of intellectual commitments[1] about the nature of interactive stories that limits the design space which they can explore.

When we design anything for research purposes, it is our intellectual commitments which underlie the design decisions that we make. In the case of Interactive Digital Storytelling, the ways in which we understand narrative, our expectations of how

[1] We use the term *intellectual commitments* here rather than *assumptions* to highlight the fact that these are *intentional* positions about the nature of IDS. In some cases, the intellectual commitments driving research and design are agenda driven, however in many others they are the result of a pragmatic approach to the conceptual and engineering challenges of the field.

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interactors will use our systems, and our repertoire of tools and resources often dictate the shape of our final design. These intellectual commitments shape and define the possible design space in which we work, which means that, more broadly speaking, these intellectual commitments describe the limits and possibilities of interactive narrative.

In this paper we propose a loose framework for exploring a wider IDS design space. This framework highlights the range of potential interactive narrative experiences that remain undeveloped and proposes them as new frontiers for this growing medium. Each of these design spaces emerges out of a combinatorial set of intellectual commitments—commitments about the nature of story, about the desires and abilities of our readers, and about the technological systems needed to articulate these positions—which gives rise to new models for both the analysis of existing interactive narratives and the design of new interactive narrative experiences. The goal of this work is to expose the fundamental constructs that drive the design of IDS systems and to illuminate a range of new possibilities for the field. To illustrate how this framework can be applied we briefly describe two design case studies intended to explore new IDS design spaces by reimagining digital narratives with a different set of fundamental commitments about the nature of story, interactive pleasure, and system authoring.

2 New Design Spaces for IDS: A Framework for Design

We propose a framework of three constructs that are fundamental to the design of interactive narrative systems: *narrative model, interactor model,* and *system model.* It should be noted that this is not a "design framework" in the traditional sense of the term. Design frameworks are comprised of a "collection of coherent design guidelines for a particular class of design challenges" [2]. The framework presented here is not of that type. Instead, we propose a framework *for* design: a meta-framework that exposes new classes of design problems. As this is a first iteration of this framework we make no claims as to its exhaustiveness; the constructs outlined in this framework

Table 1. A Framework for the Design of Interactive Narrative

Construct	Description
Narrative Model:	What constitutes a narrative? Is it a sequence of causally linked events? Is it a cognitive process for making sense out of phenomena in the world? Is it a simulation of dramatized human behavior? Is it an emotional journey for a character?
Interactor Model:	What does the interactor desire and how does she pursue those desires within the narrative? Does she want to explore? To tell a story? To be a hero? To take on a character role? To figure out how the system works?
System Model:	What tools exist to realize the above two models, and what tools still need to be developed? What authoring processes are needed to support the creation of the desired experiences? What technological processes are needed?

should not be taken to be a complete set of principles for expanding the design space of IDS. However, we believe that these three constructs reflect fundamental frames for the design of interactive narratives; they are necessary but may not be sufficient.

Table 1 shows the three primary constructs for this framework. As should be evident, these are general principles that lead to questions about the conceptual and pragmatic commitments required to design an interactive story. These questions may appear too broad or too fundamental at first glance, and certainly they do not provide the specificity required to move from loose concept to design strategy. Nor is it our intention to exhaustively catalogue every strategy and approach that has been undertaken by theorists and designers of IDS systems. Instead we aim to provoke a conversation about *what* is being theorized and *why*. In doing this we hope to redirect discourse in IDS research back toward broad questions of fundamental experiences, and away from narrow, solution-oriented, approaches.

It is our contention that these broad principles shape the different possible interactive stories that can be conceptualized and designed and, furthermore, that only a narrow range of constructs are addressed by current research and design in interactive narrative.

2.1 Construct 1: Narrative Model

The first construct, *narrative model*, asks questions about what constitutes a narrative in the mind of the designer. Design driven research in IDS has only rigorously explored the implications of a small subset of possible narrative models. IDS research often subscribes to simple conceptions of narrative, with numerous systems informed by Aristotelian narrative ([3] as cited by [4]) and the formalist systems of Vladamir Propp [5-6]. One important exception to this is research into "emergent narrative", as exemplified in the FearNot! project [7]. All too often, however, the model of narrative employed in the design of IDS systems is left implicit and unarticulated. This failure to articulate the narrative model could have several causes: the narrative model in use may simply be something that is taken for granted in the design of the system. Alternatively, there may not be any narrative model in play in a given research system. We argue that these ambiguities around the approach to narrative that is being taken in IDS have obscured ways in which research in the field is becoming fixated on a narrow set of the possible approaches to interactive narrative.

In truth there are a wide variety of formal and informal narrative models that have not been explored in IDS. These various models of narrative may be used to provide a wide range of insight into the design and analysis of digital narratives. Most widely used is Bordwell and Thompson's cinematic notion of a "sequence of events in time and space connected by cause and effect"[8] however the last decade has seen a popularization of a wider assortment of models for digital narratives, ranging from Ryan's formal narratological systems [9] to more open and informal models, such as Pearce's narrative operators [10] and Bizzocchi's framework of narrative for games [11].

2.2 Construct 2: Interactor Model

The second construct, *interactor model*, asks us to examine our understanding of what our readers/players/interactors expect from the interactive narrative experience.

Design as a practice is constantly evolving, and the role of the designer has been steadily shifting away from someone who creates *physical things* to someone who creates *opportunities* for a user or interactor to construct personal meanings through *engagement with processes and systems* [12]. In his recent book on *Semantic Design*, Krippendorf argues that one of the key roles of the designer is cultivate a form of *second-order understanding* [12]. By this, he means that it is crucial for designers to be able to imagine their designs through the eyes of their users: to anticipate and design for the desires of a user and to structure their designs to accommodate these desires. Central to this notion of second-order understanding is to design for *specific users* rather than taking a "one-size-fits" all approach to design.

Building new models of interactors for IDS means engaging with the existing expectations and literacies of our interactors in order to better understand how they will behave in our systems, but it also means engaging with our own ideals and expectations. We must thus ask two questions: first, what do our interactors expect and desire from this system; and second, what do we expect and desire from them? This construct is poorly articulated in current IDS research, in spite of a rich parallel tradition within the digital games literature on player preferences, player models, and player psychology [13-18]. When IDS *does* engage with interactor modeling, it is often to inflect a generic set of assumptions about player preferences with a set of stereotyped play styles [19-20]. In our previous work we challenged this approach to interactors, first by conceptualizing them as improvisational performers in a scene [21], and later by challenging the notion of unrestricted agency as a fundamental pleasure of play [22-23]. Different interactor models lead to dramatically different design possibilities, and it is here that we see the greatest challenges and opportunities for growth in Interactive Digital Storytelling.

2.3 Construct 3: System Model

Our third and final construct, *system model*, represents the area most researched within IDS. The system model is dependent on the previous two constructs, as it represents a set of design commitments intended to express a particular model of narrative and engage a particular type of interactor. Unlike the first two constructs, which deal with how we imagine and conceptualize the final shape of the experience, this construct deals with how we realize those concepts through design.

The system model asks questions about the practicalities of the design process, and entails design decisions that inevitably reflect the designer's ideas about story and about interactors. Research into different system models leads to new techniques and technologies for IDS, including new authoring methodologies and new software tools. At the same time, new system models allow for a wide variety of techniques for expressing the same fundamental narrative and interactor constructs. We can thus understand the system model as the juxtaposition of technological infrastructure and design commitments.

In many cases, it seems that innovation in IDS research is primarily interested in improving technological infrastructure (cognitive modeling for agents, story planning systems, generative animation systems, etc.) often to the exclusion of the other two models. The limitations of a conference paper prevent us from doing a full survey of IDS research over the last decade, however we believe it is reasonable to assert that the majority of publications and projects in the field undertake innovation at the level of the *system model*, often without articulating or questioning the model of narrative in use, or the model of the interactor. In many cases, research is driven by a desire to develop new system models, in hopes that new technologies will produce new insight into narrative or produce new interactor experiences.

These three constructs represent a starting point for expanding the design space of IDS. New understandings of interactive narrative can arise from an exploration of any one of them individually, or by combining them in new ways. They are not wholly independent: a new interactor model, for instance, will occasion a need for new system models and possibly for new models of narrative.

3 Two Design Case Studies

In this section we use the lens of the framework proposed above to examine two interactive narrative systems that we have designed. The purpose of this analysis is to demonstrate how different intellectual commitments can lead to very different designs.

3.1 Case Study 1: Scarlet Skellern and the Absent Urchins

The first system we will consider is "Scarlet Skellern and the Absent Urchins" (SSAU), a macabre, flash-based illustrated story which attempts to infer an "affective preference" from the reader's interactions and modulates the visual and auditory presentation of the storyworld in response [24-25]. The story follows the adventures of Scarlet Skellern, a bitter and sarcastic skeletal girl who divides her time between mad science and tea parties. Scarlet is accompanied by two companions: Errol, a relentlessly upbeat skeleton with no arms and Petri, a guinea pig who wears a Hannibal Lector mask to prevent unwanted chewing of everything. When the local street urchins and orphans of the town begin to disappear, the three heroes must embark on a perilous journey to rescue them.

In SSAU, as the interactor explores the environments within the frame of the storybook (by clicking on areas of interest with the mouse) the system builds a simple model of her preferences and adjusts the color palette, ambient sound effects, and musical orchestration of the world to match.

Fig. 1. A Screenshot from Scarlet Skellern and the Absent Urchins

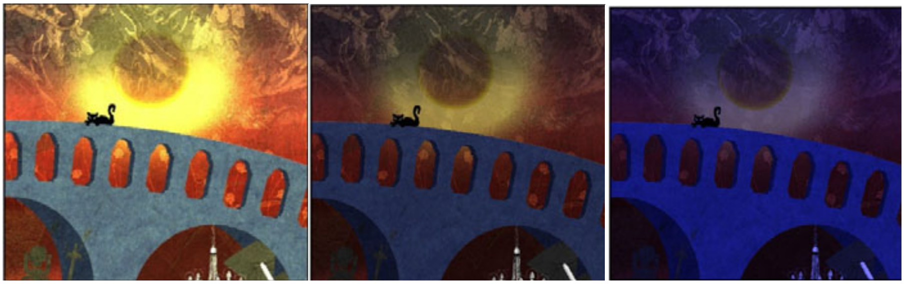

Fig. 2. Three different moods for the same scene

SSAU was an early attempt to create an interactive narrative that disconnected the choices of the player from the unfolding of the plot. Scarlet Skellern and the Absent Urchins directly addresses the interactor as a *reader* of the story rather than as a *character* within the narrative. As designers we hoped to provide the reader with opportunities to express an affective preference to the system (i.e. "what kind of story am I in the mood for?") with the expectation that the pleasure of interaction would come from reading a story that attempted to mirror and respond to the mood of the reader.

The design of SSAU is the result of the following intellectual commitments regarding the three constructs:

- **Narrative Model:** We argued that narrative meaning emerges out of style and context as much as character and plot. Thus the interactor was not able to change the outcome of the story, but was able to inflect the telling of the story with particular emotions and moods by making choices about the context and presentational style of the story. This was partially informed by Seif-El Nasr's work on intelligent lighting in interactive narrative [26].
- **Interactor Model:** We treated interactors as active readers rather than as players. We did not specifically identify a character for the interactor to control. Instead, the changing context of the narrative implicitly privileged different characters' perspectives over time.
- **System Model:** We argued that user modeling and personalization had unexplored potential for new interactive narrative experiences. The idea here was to think of storytelling systems that personalized themselves to the reader, much like a human storyteller might adjust her telling depending on the reactions of the audience. This system was implemented in Flash Action Script, using a combination of hand drawn illustrations and collaged backgrounds that lent themselves to parametric control at the level of hue, saturation, and brightness. Audio levels were also parameterized, so that the system could change the mix of musical instrumentation, and ambient sound in the background (such as weather effects and street noises).

This analysis is not meant to imply that we had fully articulated each of these commitments during the design process. Instead it is presented to demonstrate how this framework can be used to break down and interrogate the intentions of a designer.

3.2 Case Study 2: The Reading Glove

The second system we will consider is "The Reading Glove", a tangible, wearable interactive narrative in which the reader pieces together a non-linear story by exploring a collection of physical artifacts [27-30]. The story follows the exploits of a British spy who works undercover in French-occupied Algiers at the turn of the century. The hero (who is never named) discovers that his cover has been blown and has to go on the run, while trying to solve the mystery surrounding his betrayal. As with Scarlet Skellern, we designed the Reading Glove system to isolate the authored plot and character events from the choices of the interactor. Readers wearing a glove with an

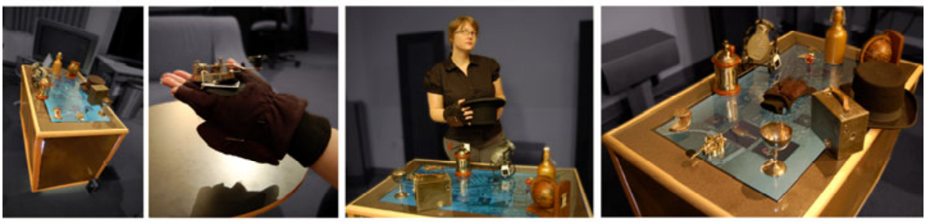

Fig. 3. (from left to right) The tabletop display, the Reading Glove, an interactor using the system, and the collection of narrative objects

Fig. 4. The collection of narrative objects assembled for the Reading Glove

RFID reader in the palm interact with the story by selecting from a collection of physical objects. When picked up, a piece of auditory narration is triggered that reveals a fragment of the story associated with the selected object.

The physical objects and the gamelike challenge of trying to piece the puzzle of the narrative together were designed to engage the readers in the narrative. To explore this we ran a series of formal mixed methods user studies of the system [30]. One thing that surprised us when we asked readers of the system to describe their experience is that many reported a strong sense of connection and identity transformation with the main character. Using our framework to break down the intellectual commitments that informed the design of the Reading Glove, we see:

- **Narrative Model:** The narrative model of the Reading Glove is a traditional Aristotelian arc, but due to the nonlinear nature in which the story is designed to be read, we chose to greatly increase the density and redundancy of narrative details. We coined the term *cognitive hyperlinks* to describe the web of interrelated details that we wrote into the story [28].
- **Interactor Model:** We initially conceptualized the interactor as a sort of “psychic detective”, using the metaphor of psychometry or object-reading to inform the interaction model. Our work was informed by theories of embodied cognition [31-33], and it was important that the interactor be incorporated into the experience in a bodily way.
- **System Model:** In order to create a bodily experience of the narrative, we turned to theories and techniques from Tangible User Interface (TUI) research. Our system incorporated wearable RFID technology, a large horizontal display, and a collection of interactive physical objects. The computational underpinnings of the system used an ontology driven expert system written in Java Expert System Shell (JESS) to track the interactions of the reader and provide support for untangling the narrative.

Our initial model of the interactors was designed to support an investigative or forensic approach to the story, however the actual experience of holding objects that the main character held had a more dramatic effect on many of our interactors. Many interactors reported feeling as though they had *become* the main character in the story. We regard this as a positive outcome, but we can see from this example how easy it is for the interactor models of a system designer to fail to fully anticipate actual interactor experiences. Our intellectual commitments can inform new design spaces, however it is crucial that we move beyond design and actually assess how interactors experience our systems. It is in the relationship between the system as designed and the system as experienced that we will reveal the poetics and design vocabulary of Interactive Digital Storytelling.

4 Conclusions: Challenges and Opportunities for IDS

In the paper we have proposed a framework for interrogating the intellectual commitments of the IDS community. To illustrate this we have described two different IDS systems that have resulted from adopting different intellectual commitments about the nature of interactive narrative. In doing so, we hope to illuminate a broader design space for interactive digital storytelling as a design and research practice.

We believe that this approach has broad implications for the future of IDS, as it challenges researchers and designers to examine their designs from a new perspective. By examining the underlying agendas driving design in interactive narrative, we hope to broaden the scope of questions being asked in the field. One important next step for this approach is to apply this framework to a wider range of IDS systems. This may be undertaken through an analysis of the systems (when available) and of the published works around those systems, however we suggest that the work of articulating the intellectual commitments of IDS research should fall squarely on the shoulders of everyone within the community.

At the moment many of us are asking questions about the "*how"* of IDS: "How do we build better agents?" "How do we incorporate natural language?" "How do we respond to unanticipated interactor choices?" "How do we plan for unexpected outcomes?" "How do we generate stories with dramatic tension, foreshadowing, and coherence?" With this framework we challenge the field to dedicate more time to asking the "*what"* questions. Most importantly, we contend that the three categories in our framework lead to essential questions: "What do different narrative models offer us as designers?" "What kind of experience do we want interactors to have?" "What kinds of systems and solutions can we imagine for new IDS experiences?"

We believe that this framework also can prompt a broader examination of how we frame the concerns of IDS research in the context of other approaches to interactive narrative. How do IDS practitioners set an agenda for their inquiry? Is the field driven by a shared vision of an imagined interactive storytelling experience? Is it driven by a set of computational problems and puzzles that need to be solved? Have we articulated a clear agenda for interactive digital storytelling as a field and have we grounded that agenda within the broader interdisciplinary concerns of interactive narrative research as it is framed in electronic literature, game studies, and other fields concerned with the intersection of computation and story?

If we imagine IDS research as one territory within the broader media landscape of interactive narrative (along with electronic literature, locative media, tangible and ubiquitous computing and games) then it becomes important to identify the design strategies and intellectual commitments that define this territory. We believe that broadening the design space of IDS will reveal new frontiers for the growing medium of interactive stories.

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A Method to Check the Satisfaction of Continuous-Time Constraints by Nonlinear Stories*

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Abstract. Within an interactive storytelling context, stories are essentially nonlinear, i.e., they correspond to multiple alternative sequences of events and each event can usually have multiple different outcomes. In this context, branching-time logics tend to be a coherent option to handle the possible states of an interactive story. In addition, important properties of the stories, such as the emotions they generate, continuously vary over time. In this paper, we describe an implemented method to check whether (parts of) interactive stories satisfy continuous-time constraints specified by means of a temporal modal logic, assuming that the time is continuous and branched. The method was applied to a story context with variants of the Little Red Riding Hood fairy tale.

Keywords: Interactive Storytelling, Constraint Programming, Temporal Logics, Continuous Change, Branching Time.

1 Introduction

Emotions and other properties of the stories, such as levels of violence and suspense, continuously vary over time. We can usually observe peaks in the intensity of emotions and a cumulative overall tension that reaches a climax before the end. This behavior is essential to catch and keep the audience's attention [1]. Moreover, story genres usually have constraints on the emotions caused by the sequences of events that may occur within a narrative and there also might be constraints related to users' preferences. Within an Interactive Storytelling context, where stories are automatically generated, it is then interesting to provide means to verify whether a story satisfies such constraints. In this paper, we propose a model for specifying the way continuous properties vary and a temporal modal logic for establishing constraints on them. We also present a method to verify, in real time, whether a nonlinear story satisfies such

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constraints. The method has been incorporated to a new version of the system Logtell [2], which generates chapters of stories by means of nondeterministic planning in real time. Each chapter is a tree of events and each path from the root to the leaf corresponds to an alternative of the chapter. Given a tree and a formula imposing constraints on it, the method checks the satisfaction of the formula by the tree.

In section 2, we present the way we model continuous-time properties and the extension of CTL(Computation Tree Logic) [3] used to specify constraints on these properties within an interactive storytelling context. Section 3 describes the main concepts of the verification method, which is based on Constraint Logic Programming (CLP) [4]. Section 4 presents an example of its application, based on the Little Red Riding Hood fairy tale. Section 5 contains our concluding remarks.

2 Modeling Continuous Properties and Specifying Constraints

With continuous time, the number of states within any interval is infinite. As it is impossible to directly verify each state, we created a model for the specification of continuous properties, so that the CLP-based method described in section 3 could verify constraints on them. For each event, we explicitly specify the derivative of each continuous-time property. The derivative can vary during the event, but only as a sequence of constant values. Each constant value is assigned to a percentage of the execution time of the event. As a consequence, the value of the property during the story varies as a piecewise-linear function, i.e. a continuous function that can be divided in linear parts.

To specify constraints on the stories, we proposed a CTL-like logic using most of the CTL quantifiers, but adapted to the needs of an Interactive Storytelling context. A well-formed temporal modal formula is recursively defined by means of the following grammar (in which *a* and *b* represent linear combinations of continuous properties, which have specific values at each moment of the story, and α and β represent temporal modal formulas):

$$\begin{aligned}\alpha,\beta \rightarrow\ & basic\_constr \mid AF\ \alpha \mid AG\ \alpha \mid EF\ \alpha \mid EG\ \alpha \mid A\ \alpha\ U\ \beta \\ & E\ \alpha\ U\ \beta \mid A\ end\ \alpha \mid E\ end\ \alpha \mid \alpha \wedge \beta \mid \alpha \vee \beta \mid \alpha \Rightarrow \beta \mid \neg\alpha\end{aligned} \tag{1}$$

$$basic\_constr \rightarrow a = b \mid a \neq b \mid a > b \mid a < b \mid a \leq b \mid a \geq b \tag{2}$$

The semantics for the satisfaction of basic constraints and formulas with the logical connectives (∧,∨,¬, and ⇒) is defined as usual. The semantics of quantified formulas is the same of CTL, but extended to incorporate the notion that we are speaking about time intervals with infinite sequences of states. Path quantifiers *A* and *E* are used to speak about the satisfaction along all paths and along at least one path, respectively. State operators *G* and *F* are used to speak about all future states and the existence of a future state of the path, respectively. Operator *U* is used to force that a certain formula α holds until formula β holds. A new operator "*end*" is used to specify that a formula should hold at the final state of the path. This operator is important within an

Interactive Storytelling context because it is typical the need of constraining the way a story ends (e.g. we might want to force a happy end). Figure 1 graphically presents the meaning of the combination of path quantifiers and state operators.

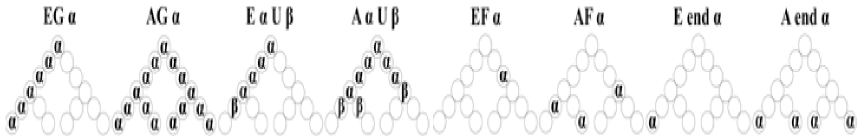

Fig. 1. Meaning of quantifiers and operators

3 Verification Method

As previously mentioned, the verification method is based on CLP. The key aspect of CLP is the tight integration between constraint evaluation and search. During program execution, the logic program incrementally sends constraints to the constraint solver, which tries to solve the constraints. The results from the solver cause a priori pruning of branches in the search tree spawned by applying rules in the program. When the constraints cannot be satisfied, the current branch of the search tree should be abandoned, reducing then the number of possible branches, i.e. choices, to be explored via backtracking. Using CLP, it is also easier to deal with numerical constraints, because they can also be declaratively specified. Most CLP platforms provide constraint solvers over rational and real numbers. The main limitation of these solvers is that they usually deal only with linear equations and inequations, because the cost of dealing with nonlinear constraints is usually too high in terms of computational time. Despite this limitation, constraint solving techniques have proven to be useful to solve many combinatorial problems. Our procedure was implemented using CLPR (CLP for real numbers) packages and runs both on SICStus Prolog [5] and SWI Prolog [6].

Our algorithm receives a formula specified in accordance with the grammar described in the previous section. The formula is initially transformed, eliminating conditionals and negative forms. Another initial step corresponds to breaking the events into intervals where the values of all the derivatives of the continuous-properties being verified are constant. During the process, the value of each property at the ends of each piece is represented by a Prolog variable and such variables are related to each other by means of constraints that calculate the values in accordance with the derivatives. A symbolic execution is then performed, calculating the values along the branches and adding constraints corresponding to the values at specific points in time, in accordance with quantifiers over the paths and the state operators of the formula.

Whenever a formula to be checked is universally quantified over all paths (quantifier *A*), we test all alternative paths to be followed and, whenever a formula to be checked is existentially quantified over the paths (quantifier *E*), we test the possible alternative paths using chronological backtracking.

If a formula α is existentially quantified over the future states (quantifier *F*), we need to find a state when α holds. For each piece of event, we check two possibilities: α either holds at a specific point in the interval or it holds after the interval. In order to impose that α should hold at some instant during an interval, fresh Prolog variables are used to represent a generic point in time and values of the continuous-time properties. This point in time is constrained to be between the start and the end of the interval. Constraints corresponding to the calculation of the values of the continuous properties at this moment are also sent to the constraint solver (notice that they can be described by linear equations, since all derivatives are constant within a piece). In addition, constraints in α are translated in terms of the values of the variables and sent to the constraint solver. Whenever a formula α is quantified over all future states of a path (quantifier *G*), the verification procedure is similar. The main difference is that α has to hold at every instant of every piece of the events. Differently from the case with quantifier *F*, the satisfaction of α has to be reinforced at every piece of the events. Due to the fact that the continuous-time properties have a constant derivative during the interval, a constraint like $a>b$ (where *a* and *b* represent linear combinations of continuous-time properties) holds along an interval if and only if they hold at the ends of the interval. To impose the satisfaction of α, constraints on the ends of the intervals are then sent to the constraint solver.

Whenever we have a formula $\alpha\ U\ \beta$ to be verified, we need to verify if α holds in all states until β holds. In order to do that, we mix the strategies used for the verification of formulas with quantifiers *G* and *F*. Formulas with operator "*end*" are verified only after considering the execution of the last event of a path.

4 Applying the Method to an Example

In our example, we modeled the emotions that are brought about by the events of the Little Red Riding Hood fairy tale. We used an adaptation of the work by Plutchik [7], in which a set of basic emotions is specified within a framework of 4-axis of opposite emotions *(Joy* x *Sadness*; Anticipation x *Surprise*; *Anger* x *Fear*; *Disgust* x *Trust*). We specified derivatives for these emotions for each event of the original story and some alternative ones. We do not have the intention of identifying the true nature of emotions, but this simple model was useful for the validation of our procedure. The events in the story and some alternative ones are presented in Figure 2. The original storyline corresponds to events EV 1… EV10, EV 17, EV 11, EV 13 and EV 15.

Assume that we would like to be sure that a happy end should be possible. This can be specified by a formula like *(E end (Joy > 0))*. The level of the emotion *Joy* is accumulated along the path. Chronological backtracking is used to explore all possible paths, interrupting the search when the condition *(Joy > 0)* is verified at the end of a path. In Figure 3, we can see that the original storyline is a path that satisfies the condition *(end (Joy > 0))*. The storyline Alternative 1, also shown in Figure 3, is similar to the original storyline until EV13 (*when Red meets the Hunter*), but has an unhappy end and would not satisfy the condition *(end (Joy > 0)).* Anyway, any tree containing the original storyline would satisfy the formula *(E end (Joy > 0))*.

A more complex situation occurs when we want to verify a formula like *(EF (Anticipation > Joy)* $\wedge$(Anticipation > *60.0)* $\wedge$ *(E end (Joy > 0)))*. In this case, we want to find a path in which there is a moment when the level of *Anticipation* is greater than the level of *Joy* and greater than *60.0*. From this moment on, there should be a path in which, at the end, the level of *Joy* is positive. The method tries to find a path and a moment *T* in this path when the condition *(Anticipation > Joy)* $\wedge$ *(Anticipation >

60.0) holds. When this condition is verified, the method has still to continue the process: condition *(E end (Joy > 0))* is then considered the condition that has to be verified in the tree that starts at *T*. Chronological backtracking is used to explore the alternatives. As shown in Figure 3, the condition *(Anticipation > Joy)* ∧ *(Anticipation > 60.0)* holds at a moment close to the end of the original storyline and, at the end of this storyline, condition *(Joy>0)* holds. In this way, the formula is satisfied by any tree containing the original storyline.

EV 1 – Mother Warns Red	*EV 2 – Red Leaves Home*
EV 3 – Red in Forest	*EV 4 – Red Meets Wolf*
EV 5 – Wolf Deceives Red	*EV 6 – Wolf Attacks Red*
EV 7 – Wolf Goes to Granny's House	*EV 8 – Wolf Eats Granny*
EV 9 – Red Arrives at Granny's House	*EV 10 – Red Interacts With the Wolf*
EV 11 – Red Escapes	*EV 12 – Wolf Eats Red*
EV 13 – Red Meets Hunter	*EV 14 – Wolf Gets Red*
EV 15 – Hunter Kills Wolf and Saves Granny	*EV 16 – Wolf Kills Hunter*
EV 17 – Wolf Attacks Red at Granny's House	*EV 18 – Wolf Eats Runaway Girl*
EV 19 – Wolf Eats Red at Granny's House	*EV 20 – Wolf Eats Red in the Forest*

Fig. 2. Events in the Little Red example

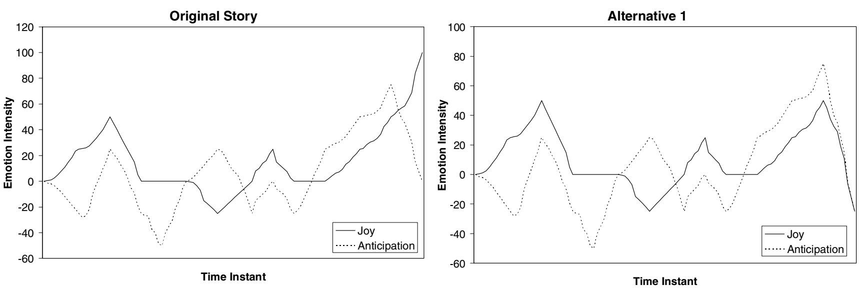

Fig. 3. Emotions in the original storyline and in an alternative

In order understand the selection of a tree, let us assume that the formula to be tested is *EF(Anticipation=75.0 and AG (Joy >= 0.0))***.** The formula says that there must be a path in which the level of *Anticipation* reaches *75.0* and, from this moment on, the level of *Joy* must remain positive in all paths. Looking at the graphs of both the original storyline and Alternative 1, we can observe the level of anticipation reaches *75.0* just at the end of EV 13. After that, the level of Joy is kept above 0.0 in the original story, but not in Alternative 1. As a consequence, the method detects that trees containing Alternative 1 but not the original storyline (or other storyline that satisfies the constraints) do not satisfy the formula.

The described verifications take between 14ms and 185ms in our system (a core 2 Duo running SWI Prolog on Windows). Notice that the size of the tested trees (around 20 events) and number of possible alternative paths (around 8) emulate the conditions we expect for a chapter of a more complex story.

5 Concluding Remarks

In the area of real-time systems, the verification of continuous-time properties is important to guarantee that systems work as designed [8], this is usually done by means of either the discretization of time or Model Checking procedures [9] with approximations. In our approach, as the numbers of events and branches to be considered are limited and we do not have cycles, we did not have to resort either to the discretization of time or to approximations, which could occasionally cause errors. We chose to perform symbolic executions using CLP and the strategy has shown to be viable even for verification at runtime while stories are generated and dramatized.

In the Interactive Storytelling area, our approach has an orthogonal relation with many issues. Regarding user modeling, as proposed in systems like PaSSAGE [10] and Mirage [11], an interesting future work corresponds to the incorporation of user models that describe constraints on continuous-time properties. Regarding models for emotions in interactive stories [12], there are many research directions to be explored, such as the development of mechanisms to reduce the burden of the author in the description of continuous emotions and the study about the relation between characters' emotions and the overall emotion brought about by the stories. In our approach, (parts of) stories are generated and then constraints are checked. A possible alternative to be explored is the generation of plots by planning algorithms that take into account constraints on continuous properties as goals to be fulfilled.

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Scaling Mobile Alternate Reality Games with Geo-location Translation

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Abstract. Alternate Reality Games (ARGs) are interactive narrative experiences that engage the player by layering a fictional world over the real world. Mobile ARGs use geo-location aware devices to track players as they visit real-world locations to progress the story. ARG stories are often geo-specific, requiring players to visit specific locations in the world and, as a result, ARGs are played infrequently and only by those who live within proximity of the locations that the stories reference. We present a solution to the geo-specificity problem called *location translation*, which transforms ARG stories from one geographical location to another, making them playable anywhere. We show that location translation addresses fundamental scalability challenges that arise from geo-specificity.

1 Alternate Reality Games

Alternate Reality Games (ARGs) have recently emerged as a new genre of games. ARGs are interactive narrative experiences that engage the player by layering a fictional world over the real world; as players act in the real world their actions influences the state of the fictional world. With the advent of geo-location aware mobile devices, ARGs make use of the actual, physical world as the environment for which the game plays out [5]. Typically, a *game master* runs the game and monitors players from remote in order to make adjustments to the narrative arc or trigger branching points as necessary. Many ARGs utilize *confederate actors* planted throughout the physical world to interact with players.

The ARG genre is limited in two significant ways. First, supporting an ARG is effort-intensive on the part of human game masters and confederates. Second, ARG stories can be *geo-specific*—they reference real world geographical locations and landmarks requiring visits to these places to advance the narrative. Consequently, a particular ARG story is fixed to a specific region of the real world; a story set in New York City cannot be played in London without substantial re-authoring. Taken together, the scalability limitations result in a situation where ARGs are played infrequently and can only be played by those who live within proximity of the region in which the game story is set.

How can one reduce the need for human confederate actors and game master? The use of virtual agents, exemplified by the tour guides described by Lim and Aylett [3], can replace confederate actors. However, such systems do not

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overcome geo-specificity limitations; agents can only perform in the vicinity of fixed landmarks. Efforts are under way to automate game mastering as well. The Spyfeet mobile ARG [6] uses a rule-base implemented in Inform7™ to control game progression. The Spyfeet story does not reference specific geographical locations and instead requires certain activities such as finding an NPC that has been mapped to an arbitrary geo-location. Likewise, the Backseat Playground [1] is a mobile ARG system that triggers story elements based on features of the local environment as one rides in the back seat of a car. Backseat Playground story content also does not make specific reference to location or landmark.

Location geo-specificity grounds the play experience by linking story content to physical space, but at the cost of limiting who can play. In this paper, we present an approach to overcoming the geo-specificity limitation through the use of *location translation*, an intelligent process in which the locations specifically referenced by a mobile ARG story are transformed to a new area so that any game instance can be played anywhere. Our location translation process is couched in the WeQuest ARG platform [4] that automates the game master and confederate actor roles. WeQuest allows ARG stories to reference *specific* geographical landmarks and uses location translation to make the game playable to people in other areas, thus directly resolving geo-specificity limitations.

2 Location Translation

In WeQuest [4], ARG stories are represented by a *dependency graph*, a directed, acyclic graph (DAG) where the nodes correspond to story events and arcs impose constraints on story event visitation order. Inspired by classic Role-Playing Games (RPGs), story events involve engaging in dialogue with virtual Non-Player Characters (NPCs) and using or acquiring virtual inventory items. Story event nodes reference specific GPS coordinates that a player is required to be within a certain radius of for the interaction to occur. Arcs between nodes represent dependencies that must be fulfilled for a particular event to fire. A dependency graph is a basic technique for managing lock-and-key style game play; for an event to occur, it must be "unlocked" by completing all other events it depends upon. Unlike finite state machines, dependency graphs can easily support branching stories, partial ordering of events, and parallel multiplayer events.

Location translation maps locations in the old game story to analogous locations in a new city where the user intends to play. To formalize the problem, consider an original story set in one area as a number of locations L derived from a dependency graph. For each location L_i in the original story, there can be n_i analogous candidate locations in the vicinity of the target area, denoted $M_{i,j}$ for $j = 1...n_i$. The goal of the translation process is to select one location $M_{i,j}$ for each L_i such that: (a) the analogical similarity between any locations in the original and translated graphs is maximized, irrespective of geography, and (b) the difference in distances between adjacent locations in stories is minimized when geography is considered. These requirements are often in conflict as the

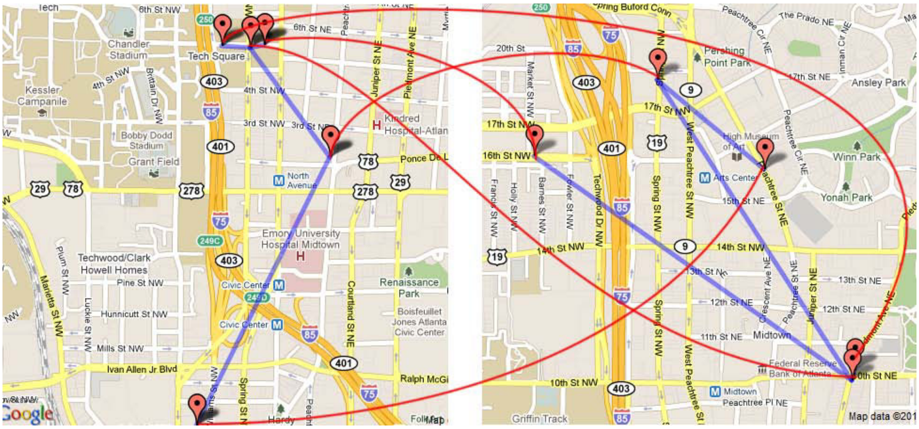

Fig. 1. An ARG story translated from one part of a city to another. Blue lines are dependency arcs. Red lines show analogical matches between locations.

most analogically similar locations may not be conveniently located relative to any neighboring locations. Figure 1 shows an example of an ARG story and its translation to a different part of the same city (disallowing self-matching).

2.1 Translation Search Algorithm

Our location translation process searches for the optimal candidate $M_{i,j}$ for each location L_i, given a dependency graph. Viewing game instance translation as an optimization problem, we solve the location translation problem with *dynamic programming*, an optimization algorithm specifically designed to exploit the optimal substructure property through an inductive process that runs in $O(n_{\max} * |L|)$. The solutions to subproblems are cached to avoid repetitious computation. Our dynamic programming implementation determines the suitability of any given candidate $M_{i,j}$ for original location L_i by computing the cost of $M_{i,j}$ given the optimal solutions for locations prior to $M_{i,j}$ in the dependency graph. Because dependency graphs can branch arbitrarily, we extend dynamic programming to account for multiple branching subproblems. See Figure 2.

A cost function evaluates a candidate location $M_{i,j}$ based on similarity of $M_{i,j}$ to the original location L_i plus the difference in distances between the candidate and its dependency graph predecessors as compared to the original dependency graph when locations are positioned geographically. Specifically, $cost(M_{i,j}) = \sum_{d \in Dep(M_{i,j})} \Big(\big| length(edge_{d,j}) - length(edge_{\text{orig}}) \big| \Big) + \frac{k}{sim}$ where $Dep(M_{i,j})$ returns the nodes that candidate $M_{i,j}$ are dependent on according to the dependency graph, $edge_{d,j}$ is a edge in the new graph between the current candidate location and the candidate selected as the solution to a subproblem, $edge_{\text{orig}}$ is the corresponding edge in the original dependency graph, and sim is the probability ([0..1]) that two locations in two different cities are similar. Thus,

Input: A list of locations L, origin and target cities $city_1, city_2$, and a set of similarity matricies.
Output: A list of locations S determined to be analogous to those in L.
let $S \leftarrow C \leftarrow M \leftarrow \emptyset$;
for *i = 1 to number of locations* $|L|$*, consistent with the dependency graph* **do**
  let $M_i \leftarrow$ `candidates`(L_i, $city_1$, $city_2$, `type`(L_i));
  for *j = 1 to number of candidates* $|M_i|$ **do**
    let $cost \leftarrow 0$;
    for *l = 1 to number of parents of* $M_{i,j}$ *in dependeny graph* **do**
      $cost \leftarrow cost +$ length difference of edge between $M_{i,j}$ and S_l;
    $cost \leftarrow cost + (k/$`similarity`($L_i$, $M_{i,j}$, $city_1$, $city_2$, `type`(L_i)));
    if $cost < C_i$ **then**
      $S_i \leftarrow M_{i,j}$;
      $C_i \leftarrow cost$;

Fig. 2. Modified dynamic programming for location translation

as similarity decreases, cost increases exponentially. The constant k is a tunable factor that penalizes dissimilarity relative to edge difference. The dynamic programming algorithm selects candidates in the target city that minimize cost.

2.2 Location Similarity

How do we compute the analogical similarity between locations in different cities? Our approach to finding analogies uses statistical correlations based on information about locations retrieved websites such as Citysearch™ and Yelp™ that allow their users to write reviews of restaurants, shops, and other landmarks. We make the assumption that the words people use to describe their experiences at these locations captures latent (e.g., hidden) salient features (cf., [2]) of the place and that natural language processing algorithms can analyze and compare word usage to derive similarity between places. When this assumption holds, term-frequency vector similarity techniques can be used to compute the distance between texts—in our case, texts containing user reviews of locations. Our approach to identifying similar locations based on reviews is most similar to the phrase-similarity computation technique of Sahami and Heilman [7], which compares term-frequencies vectors between documents retrieved from Google™. Our technique, however, uses web-retrieved reviews as a document corpus instead of the entire Web Wide Web, and compares locations instead of phrases.

Location translation begins with a pre-processing phase in which a *similarity matrix* is built that captures the probability that locations in disparate cities are analogous. We further specialize the similarity matrices by *type* of location (e.g., restaurant, park, salon, etc.). That is, each similarity matrix represents a combination of $City \times City \times Type$. For each location of each type in each city, we download all reviews from Citysearch™ through their API. Reviews are merged into a single document representing the location. We remove stop-words, words that are not nouns, (according to Wordnet), and common proper nouns (such as the names of credit card companies). Removing non-noun words from reviews avoids relating two places based on similar sentiment. While sentiment analysis is useful for product recommendation, we require an objective account; noun-only

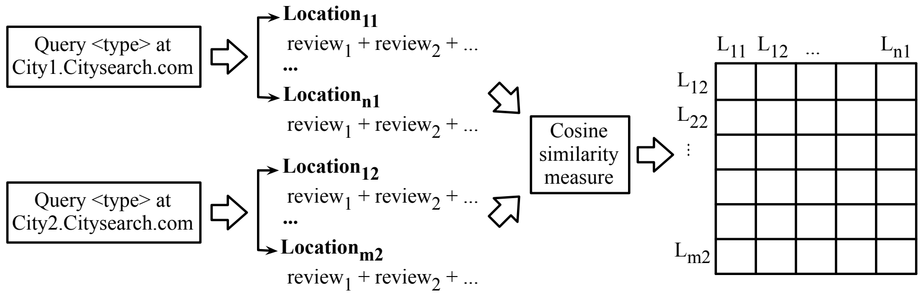

Fig. 3. Similarity matrix construction for a pair of cities and a type of location

similarity is thus a simple form of feature-only comparison under the assumption that nouns identify salient features of a place.

Review documents are converted into term frequency vectors where each dimension in the vector is a term and the value for each term is computed by Term-Frequency Inverse-Document Frequency (TFIDF), a common measure of term importance based on term uniqueness across documents. The Cosine similarity measure is used to determine similarity of document vectors by measuring the angle between each pair of vectors. Applied to all pairs of locations from two cities, the result is a similarity matrix with columns representing places in one city, rows representing places in the other city, and cells containing the probability that the two places are the same. See Figure 3. Repeating this process for all pairs of cities and all types of locations produces $|City \times City \times Type|$ matrices.

Reliable location translation requires reasonably accurate capture of semantic similarities between locations. To evaluate the quality of the similarity computations, we randomly sampled 10 *source* restaurants from our dataset of locations. For each source restaurant, we randomly sampled 10 *target* restaurants against which to evaluate similarity. We asked 5 participants familiar with the city to sort each list of targets based on their judgement of similarity to the source. From participant data, we computed a gold standard ranking as follows. Treating each participant's trial as a competition amongst target restaurants to be the most similar to the source restaurant, we use the ELO tournament rating method to determine a total order of target restaurants for each source restaurant. The ELO rating for a target restaurant is the aggregate number of other restaurants ordered below it by participants. We then used similarity matrix lookups to generate an ordered list of targets for each source (geography was ignored). Thus, humans and WeQuest performed the same ranking tasks.

To compare the WeQuest similarity matrix ranking against the gold standard, we used the Kendall's Tau rank correlation coefficient to assess the association between ranked lists. We calculated an average τ of 0.533 (where 1.0 indicates perfect agreement) across the 10 source restaurant comparisons, which is significant at $p = 0.0318$ indicating that that the gold standard and generated rankings tend to be highly associated. We note that, anecdotally, human participant ranking becomes increasingly arbitrary when actual similarity between locations is low, making the gold standard ELO values for low-similarity restaurants unreliable. Thus, looking at the tops of the rankings, WeQuest's top pick concurred with the gold standard's top-pick 60% of the time, was in the top two 80% of the time, and was in the top three 100% of the time. Thus, accuracy is highest when human-rated similarity is also high, which is significant considering that the optimization search must balance maximizing similarity with minimizing distances; it doesn't always pick the most similar location.

3 Conclusions

There is a lot of semantic knowledge to be harnessed from human-generated natural language that can be brought to bear for the purposes of automating creative tasks. Location translation is a form of analogical reasoning where we promote game play by computing probabilistic similarities between locations in different cities based on the words that people use to describe those places on the World Wide Web. In WeQuest we have applied location translation to automatically re-author ARG stories, making them playable anywhere, regardless of geo-specific references to locations. This allows WeQuest to overcome a significant limitation to the adoption of ARGs as a mainstream form of interactive entertainment: content geo-specificity. The ability to translate ARG stories from one area to another, combined with end-user story authoring [4], has the potential to scale up the amount of content available to players, making ARGs more accessible to mainstream audiences who desire real-world gaming experiences.

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Using Information Visualization to Understand Interactive Narrative: A Case Study on Façade

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Abstract. Video games increasingly take place in dynamic worlds with more autonomous characters and highly variable and moldable narratives. However, our tools for studying how players interact with these complex worlds are severely limited. In this paper, we propose different visualizations that can be used to more effectively analyze interactive narrative systems, and present a case study that applies these techniques to analysis of player logs from the interactive drama Façade.

Keywords: Information visualization, story analysis, game design.

1 Introduction

The future of video games promise highly interactive and flexible worlds which the players can shape to their desires and have a high degree of influence not only on the outcome, but also how each outcome is reached, how the story unfolds and how the player experiences the narrative. Metrics-based analytics is becoming a standard practice in game design, but has not yet had significant impact on interactive storytelling. One of the challenges for applying metrics to the design and analysis of interactive storytelling is developing appropriate visualizations to facilitate designers in developing insights about the player experience. In this paper, we propose different visualizations that can be used to more efficiently analyze interactive storytelling systems, and present a case study that applies these techniques to analysis of player logs from two different versions of Façade.

Façade is an interactive story in which player interaction can influence what topics the characters bring up, what they choose to reveal to the player about their problems and history, and ultimately what the fate of Trip's and Grace's (the two autonomous characters in Façade) marriage will be [10]. Parts of the story may also be enacted differently depending on player's past actions and affinity towards Trip or Grace. This flexibility results in a huge variability on how players experience the narrative of Façade – changes are possible not only on what is being told, but also how it's being communicated to the player. This level of variability makes Façade a good case study for the development of information visualization techniques for interactive story logs.

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This paper is structured as follows: In Section 2, we discuss the previous work in the literature that have explored using information visualization techniques for studying interactive media. In section 3 we detail the different visualizations we use in our analysis of Façade player logs and discuss our findings, and section 4 concludes the paper.

2 Related Work

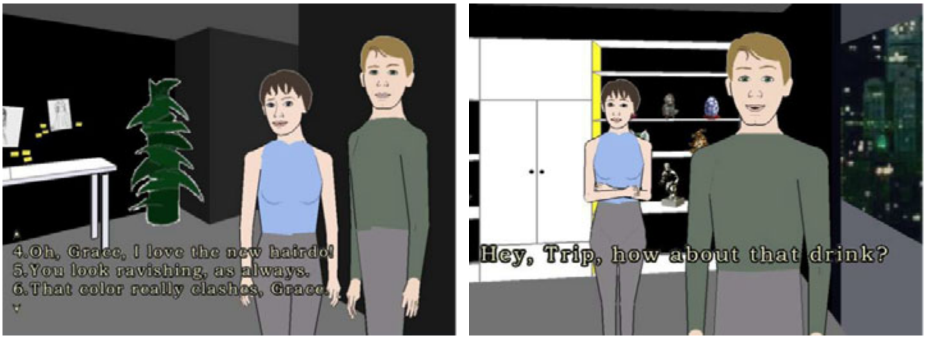
While information visualization techniques have been used as creative tools for input in some works of digital media [1,2,3], they are rarely employed as functional tools to study digital games. One example is the work on the Restaurant Game by Orkin et al. [4]. In The Restaurant Game the player can assume the role of a customer or a waitress, and try to achieve a simple goal such as earning money or having dinner. The authors collected sequences of actions and utterances from players' interactions with the Restaurant Game which they visualized via tree structures superimposing actions from many player logs. Another work that is focused on visualizing physical actions in virtual worlds is the work by Hoobler et al. [5] on visualizing team strategies and player behavior patterns in Return to Castle Wolfenstein: Enemy Territory.

The visualization of Choose Your Own Adventure (CYOA) books by Christian Swineheart is also a relevant work that uses information visualization techniques to gain insight into the evolution of these books over the years [6]. Swineheart produced visualizations of 12 CYOA books published between 1979 and 1998, focusing on desirability and number of endings and linearity of the plot. These visualizations focus on story structure visualization rather than player actions, appropriate since CYOA limits player action to a relative small number of discrete branches.

More general interactive story visualization tools must provide insight into both player action and story structure, as well as the relationships between the two. The visualizations presented here demonstrate our initial steps towards creating such visualizations.

3 Façade Log Analysis and Visualization Tool

As our case study, we looked at how different dialogue systems affect how players experience the story, and how their interaction patterns change. One of the interfaces that we used is Façade's original dialogue interface, which is a natural language understanding interface where the player can type in anything anytime to converse with the characters. The second interface is what we call a sentence-selection interface, similar to the interface found in games such as the Star Wars: Knights of the Old Republic or Monkey Island series, where the player is prompted with a menu whenever his or her input is required (**Fig. 1**). This choice of dialog system is representative of the types of decisions made by designers of interactive stories, where there is a complicated relationship between the player action space, the interface for taking actions, and the narrative trajectories experienced by players. While the focus of this paper is on the visualization techniques themselves, rather than the dialog system study, it is important that the visualizations were developed in the context of the kinds of real design questions facing interactive storytellers.



(a) (b)

Fig. 1. Different versions of Façade we used in our case study, (a) the sentence-selection version, where the player can only interact at fixed points and can only select utterances from a menu, and (b) the NLU version, where the player can type in anything anytime

We performed a small case study by recruiting 10 participants from an introductory game design class taught at UCSC. Each participant was required to play both versions from which we collected our gameplay logs. The visualization tool was developed using .NET in conjunction with the open source Graph# library [11]. The following sections describe the visualizations provided by our tool, along with the results we obtained from our experiment using the data from participants' gameplay logs.

3.1 Discourse Act Coverage

Façade maps each player utterance to a discourse act, which aims to capture the semantics of the line in the context of the game world. For example, greeting utterances like "Hi, Trip!" or "How are you doing, Grace?" get mapped to "Greet Trip" or "Greet Grace" discourse acts respectively. Façade's NLU version maps player utterances to approximately 30 main discourse act categories; each of those categories can have a varying number of parameters. The player's expressiveness is directly related to how many of those discourse acts they are able to employ using different interfaces when conversing with the characters. We designed a representation based on the squarified treemapping technique [8] to visualize the average percentage each discourse act is addressed over all gameplay logs. The treemapping technique is particularly space-efficient as it enables a compact and concise representation of many different possible player actions, as likely to be supported in NLU systems and rich interactive worlds, and it's also very effective when studying player behavior across different versions as it presents the information in a representation that makes more clear not only the relationships between differences in how players' behavior change across versions, but also how players employ different strategies in terms of discourse acts within the same version. While using regular treemapping techniques might result in many thin rectangles, the squarified treemapping technique attempts to mitigate this problem by using an algorithm which tries to adjust the dimensions of each sub-rectangle so that they approach a square in shape as much as possible. In our representation, the color of each rectangle is determined by the average percentage each discourse act is used. (**Fig. 2**).

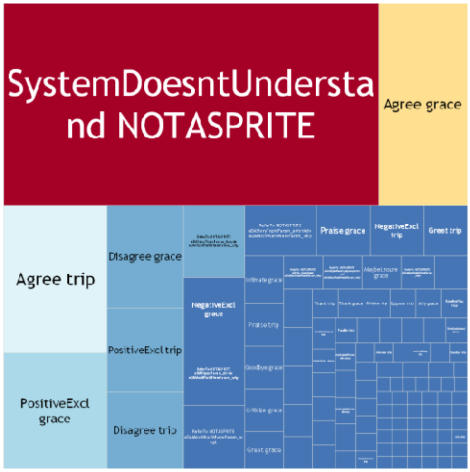


Fig. 2. Squarified treemaps for discourse act usage patterns for the NLU version

The most striking observation in the figure above is the relatively high percentage of the "System Doesn't Understand" category in the NLU version, which means the NLU module was unable to map the player utterance to any of the discourse acts it understands. However, it should also be noted that a previous study by Mehta et al [7] showed that the perceived failure rate of the NLU system was much lower since players were able to rationalize those failures in context when playing the game.

Another interesting point we noticed is how the players were inclined towards empathetic responses in both versions. Positive discourse acts such as Agree, Positive Exclamation, Support make up a much higher percentage of discourse acts employed in both versions than negative responses, especially when we look at the discourse act distribution without considering the parameters.

We also looked at how many unique discourse acts (including the parameters) the players were able to discover in a single playthrough. That number ranged from 14 to 35 for the NLU version, and 15 to 33 for the sentence-selection version, which is low given the huge set of discourse acts available to the players. However, given a large percentage of the discourse acts were not understood by the system in the NLU version as evidenced by the treemaps above, we can see that the average probability of each player utterance having a meaningful impact within the current context in the game is higher in the sentence selection version than in the NLU version.

3.2 Story Space Coverage

To visualize story space coverage we use a graph that we call a "story graph". The story graph uses a coloring scheme inspired by heatmapping, which is a frequently used technique in information visualization in which values are represented by colors

[9]. In our story graphs nodes represent story beats and edges connect beats follow one another in a gameplay log. Color corresponds to the number of incoming edges to a beat.

A close-up of the story graph from 10 logs from the NLU version is shown in **Fig. 3**. This map allows us to observe which story beats occur more frequently in story logs compared to others. In the example below in **Fig. 3**, we can clearly see that players were more likely to encounter the story piece where there's a discussion over which drinks to have (FASKDRINKT1NTPA) than the beat where Grace complains about the apartment's decoration (AAT1GPA).

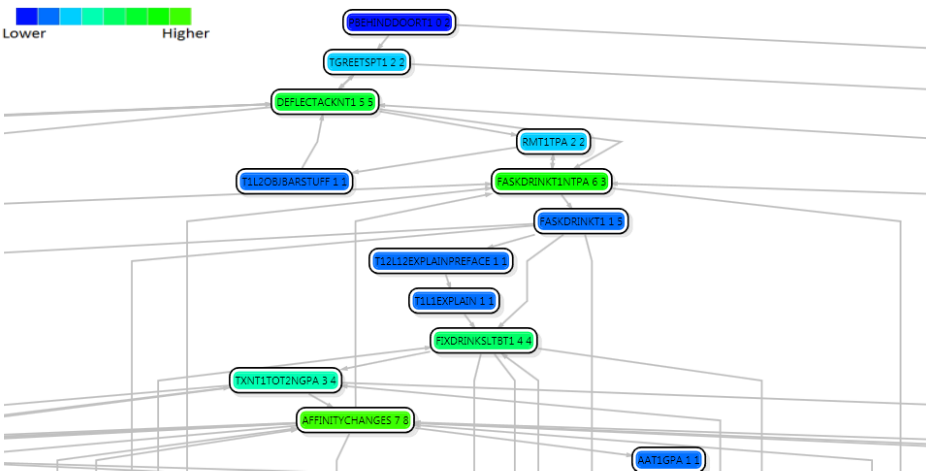


Fig. 3. A close-up view of the story graph

Players experienced more variety of story beats in the NLU vs. the sentence selection version – 57 different beats in total across 10 playthroughs in the NLU version vs. 43 for sentence selection. Thus players experienced greater story variation in the NLU version. This highlights an important design trade-off between menu-based and NLU interfaces: The sentence-selection version allows a higher degree of local influence, since the system is explicitly aware of what each utterance means. But since the number of options that can be presented to the player is limited, the NLU version allowed the players more global freedom in shaping and creating variations in the story by addressing various mixins, subtopics and objects. A look at the average in-degree of nodes also reveals that the sentence-selection version graph has slightly higher average in-degree (2.37) than the NLU version graph (2.2), which also indicates that player experience was more linear in the sentence-selection version than in the NLU version.

4 Conclusion

In this paper, we have presented a visualization tool that aims to enhance our current toolset for studying interactive narratives. We have also demonstrated the usability of our visualizations in a simple case study using two different versions of Façade. Our analysis shows that information visualization techniques have the potential to be useful in the field of game studies where highly interactive and flexible story worlds are poised to become a norm.

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Adaptive Art – A Shape Language Driven Approach to Communicate Dramaturgy and Mood

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Abstract. Graphic designers and visual artists express their narrative intentions using visual tools which essentially include the styling of shapes. In classic art forms design decisions are limited to the initial creation process. Although technical progress makes it possible to adjust content-wise dramaturgy in real-time, the graphical design process often still has static characteristics. In our current work we therefore study how dramaturgical non-linearity can be combined with a flexible visual shape language to conform content-wise narration to visual expressiveness in real-time.

Keywords: Interactive Cinematography, Environment and Graphical Effects, Real-time Techniques for Interactive Storytelling, Visual Narrative, Graphical Design.

1 Motivation

1.1 Graphic Styles and Visual Narratives

Visual design professionals use specific styles and composition principles to emphasize the content of a narrative and convey emotions to the viewer implicitly. The term "visual communication", which is used a lot in design industries such as the advertising business, implies that graphic design has not only aesthetic purposes but can be used specifically to deliver messages between two parties. In each case an attempt is made to reinforce the content of the message to be transported, for example by the additional application of psychological perception, and to guide the attention of the target group towards a specific objective. In [1] we already discussed such visual communication as used for in-game landscape design as well as character design for example.

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1.2 Adapting Interaction in Visual Design

Static visual media (painting, photography, film) are subject to a fixed dramaturgy. In consequence both the editor who compiles the contents of the narrative and the designer who builds visual footage must decide on a specific dramaturgy at a given point in time. In interactive media, however, the dramaturgy can change constantly and unpredictably according to the user's behavior. In order to respond to the changing dramaturgy in real-time, wouldn't it be more consistent to visually communicate the content-wise changes through dynamic visual design? There already exists some research on this topic: frequently, communication channels such as lighting and camera motion were taken into consideration, notably as they can be flexibly changed at runtime due to their dynamic and technology-related parameters. Any visual element portraying changes in the dramatic emotion at runtime shall hereinafter be referred to as "Adaptive Art".

Additional design features beyond the aforementioned camera and lighting effects may be experimented with, and we focus on shape language in particular. Its use is most evident in sculpture, where it takes on the role of the visual stroke and where it significantly characterizes, in interplay with light and shade, the visible contours and shape surfaces. The connection to the process of virtually modeling wire mesh models in three dimensions is obvious. Distinctive shapes can be used in several occasions. They are found not only in the content manifestation of bodies in space, but also for example in the frame composition as such which is a key principle of filmmaking as described by van Sijll [2] and others. Some research was done by Seif and Zupko [3,4] and by Olivier, Ha and Christie [5] on how different aspects of that area could be applied to gaming and interactive media. While they focus a lot on light and camera work, we present a scenario in which, at runtime, the *shapes of objects* adapt to dramaturgical values. A similar understanding of the meaning of visual shape was described by Halper et al. [6], for example.

2 Technical Interpretation

To implement our adaptive objects we store various mesh deformations using Shape Keys. In contrast to the facial animation our deformations intend to depict the dramatic "look and feel" more than change in content-wise meaning. In addition we use the Shape Keys not for obviously visible animations, but for soft and progressive deformations at the time of the change in the emotional mood of the scene.

Fig. 1 shows an example of the use of the Shape Key mechanism for implementation of a mood-dependent shape language. Therefore the model was initially shaped to have a positive emotional style (left) so that the tree appears in edgy shapes, but the overall shape draws a corpulent body to show vitality. In a second Shape Key (right image side) a contrary mood was created. Using the Shape Key mechanism it is not only possible to visualize two extreme moods, but also to realize flexible transitions. Dramatically this means in case of

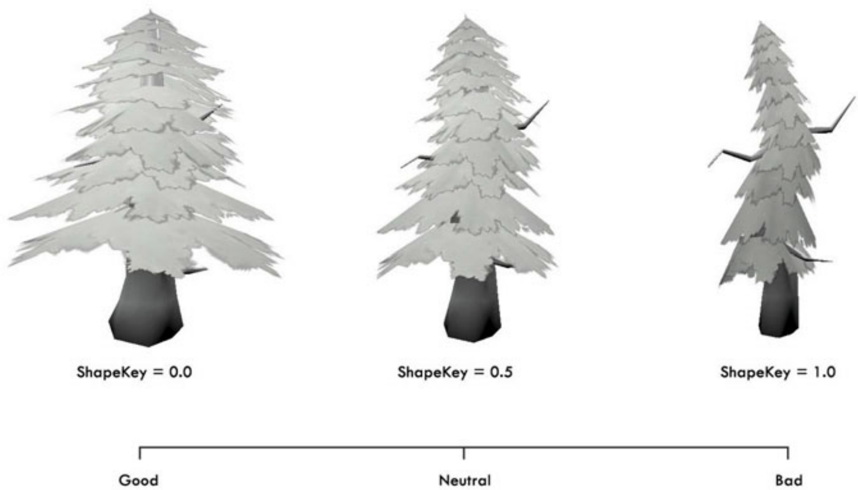

Fig. 1. Dramaturgically adjustable object at three shape-deformation steps

a simple positive-negative scale that the object shows a kind of neutral state in the middle of the blending range. If the dramaturgy changes towards the better or the worse mood, also the Shape Key factor is adjusted in one or the other direction. In this way the creative transformation is mapped to numeric values that can be then easily bound to data sources like an emotion model.

3 Reflection and Further Perspective

From feedback of players going through a test scenario we expect to get knowlegde about how far the efforts of creating adaptive image material are worth being made compared to static elements. It is conceivable that for atmospherically dense scenarios as they occur in interactive storytelling, additional channels like coloring and image editing effects are necessary to make the dramaturgy visually "perceptible" and to satisfy the high visual quality today's interactive entertainment customers are used to see, as described recently by Seif El-Nasr [7] for example. If graphical adaption succeeds, it may help to engage these users deeply emotional. Although some computer games that deal with moral decisions like "Black and White", "Star Wars" or "Fable" implement visual reflection of content-wise emotion and mood already, they often use a limited set of techniques like just changing texture colors. Reshaping objects at run-time as introduced in this paper, may help to extend the supply of visual feedback methods.

An ambiguous characteristic of our approach is the danger of substantive change. When an object deforms its content, its meaning also changes inevitably which in turn is the basis for the emotional assessment. Too extreme changes therefore might change the narrative meaning so much that potentially unwanted overlaps with the narrative content may happen.

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assimilate: An Interface for Collaborative Narrative Construction

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Abstract. This paper describes the interface component of a visual collaborative storytelling system that enables participatory narration by means of tangible user interaction. The essential feature of the interface is to incorporate participants' creative actions by embedding metaphorical schemes through its mechanics and from the visualisation of self-organising content to support collaborative narrative comprehension.

Keywords: Interaction Design, Creativity Support Tool, Interactive Digital Storytelling, Narrative Intelligence, Conversational Information System, Cybernetics.

1 Introduction

The assimilate interface (Fig. 1) is a component part of a collaborative storytelling system [1] that aims for narrative coherence in situated collaborative contexts. It consists of a multiuser touch surface that manages a collaborative environment and allows participants to visually construct narratives in an abstract virtual space using various sources of online content. The interface is an essential part of a storytelling system architecture that aligns participant themes from keyword search terms, with template narrative themes drawn from a database of mythology and folklore [2]. This is done through a collaborative process of self-organisation based on Conversation Theory (CT) [3], a generalised model of conversation and thematic sense-making. The following is a description of the interface and how it generates narrative coherence through amplifying the storytelling process involved during a group conversation.

Fig. 1. Assimilate interface

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The essential feature of the interface is to incorporate participants' creative actions by embedding metaphorical schemes through its mechanics to support collaborative narrative comprehension and by the visualisation of the system's self-organising feedback that attempts to arrange the themes coherently. This is done primarily through situated actions, where gestural acts drive the experience and support the conversational aspects associated with storytelling. Each gesture triggers physically modeled feedback that supports the intention behind the act, and may promote a conversation or a verbal response to clarify the action.

The assumption is the enactment of narrative, or the act of the telling through conversation, is the means by which mental models of narrative are formed and shared [4]. It is the process of enactment that embodies the creativity possibilities of metaphorical and conversational exchange. The interface attempts to regulate this conversation between the system's processes and participant intention by the visualisation the feedback of narrative sequences and participant non-verbal actions.

The general approach to the interface and its incorporation into the storytelling system architecture, looks to holistic paradigms of information retrieval and exchange. Meaning, the interface should provide expressive affordances that expose the system's processes [5], and open them to interpretation through collaboration. These affordances consist of embedded metaphorical schemes that enhance narrative comprehension in the minds of the participants, allowing them to dynamically switch roles as narrator or participant. Common gestures associated with storytelling are mapped to interface mechanics and help to reflect participant intention. Participants create 'rings' or spaces in the content area that represent a 'point-of-view'. These views scale or merge together purposely or inadvertently to generate dramatic or unexpected outcomes.

This paper will present an overview of the interface mechanics and how embedded metaphorical schemes convey intention with the conversational process. This is followed by a brief overview of the storytelling system with a focus on how the interface integrates with the systems processes, and finally a discussion on the general design criteria for holistic storytelling tools that support the generation of meaning for collaborative narrative construction.

2 Interface

The interface ring contains a physics model that responds to gesture inadvertent or intended, and allows for each participant to form a viewpoint by the creation of their own ring that resizes depending on the amount of visible media. Each participant begins the experience by entry of a keyword into a ringed space (Fig. 2) that is representative of a theme or idea that participants wish to bring to the collaboration. Media such as text, image, sound and video, are displayed as representations of the narrative events, characters or themes. These are drawn from online search of databases, based on the keyword entered, and aligned with the events of pre-existing narrative templates.

Fig. 2. Keyword entry

The interface ring expands or contracts dependant on the amount of media elements present. Elements are annotated with a descriptive keyword tag that offers some hints of visible context. Media tags are also seen outside the ring, and these provide the potential context dependent on their distance to the ring. Only salient media elements are visible within the ring space. Each element is animated with a set of behavioural features, such as colour, size, position and duration. Element behaviours drive the aesthetics choices the participants make as to the media they retain or eventually eject from the ring. They perform this by dragging in and out the tags to create and evolve the context, or the ring itself ejects them after sequences play out. Each ring can be physically merged together and the context of the media combined, thus modifying a participant's intention or otherwise steering the narrative in an alternate or unintended direction.

Tangible interaction is central to the systems relationship with its collaborators as it supports the role the participant wishes to enact through conversation by verbal, non-verbal or gestural means and allows for dynamic or shared narration. If we are to claim that storytelling, the act of telling through conversation, originates with embodied action [6], it follows a holistic interface design must account for how we assimilate narrative into our common experiences. Actions such as a conversational gesture, may be referred to as “image schemata” [7] and originate from embodied experience. An interface that supports primal embodied metaphors can assist participant recognition of the acts and intentions of others with respect to the feedback generated. These primal actions often relate to our bodily relationships with the world and the physical forces associated with it. With the assimilate interface, a touch surface is used to trigger responsive feedback that enhances the transfer of spatial schemes associated with narrative exchange.

The following spatial image schemas are identified to support the metaphors embedded into the interface mechanics:

- The *container* schema delineates what is inside the ring as coherent and salient, as opposed to outside, incoherent yet potentially relevant. Each participant ring may demonstrate some intention with the visible content.
- The *centre/periphery* schema places salience on current sequences within the ringed space by highlighting those elements above others. This also allows the participant to enact a point-of-view, essential to the narrative process in characterisation or narration.

- The *scale* schema deals with the physical size of the ring which scales according to amount of content visible. Participants may dominate narration by scaling their ring or reduce the size open to sharing or collaboration.
- The *merging* schema allows a participant ring to physically merge with another, thus merging conceptual arrangements. The merging of views may be purposeful or inadvertent through the interface physics, supporting possible dramatic outcomes.

Through identifying common gestures associated with the conversational process and storytelling. These embedded interface schemas seek to extend the space of meaning through visibility of non-verbal action with the output of the interface. In essense, the interface extends the metaphoric space into the collective participant space allowing narrative relationships to become more accessible and recognisable.

3 System

The interface is an essential component to the storytelling system that is constructed as a multi-tiered network architecture that includes, a database tier containing a pre-processed set of templates with recognisable narratives, the application tier that self-organises online content themes with templates, and the interface itself detailed in this paper. The following section presents a brief overview of the system architecture and the role of the interface plays in the visualisation of its narrative properties.

The architecture is based on a holistic design that centers on face-to-face group situations and emphasises how mental models and intentions are understood by others, and not necessarily by the system itself. With these general aims in mind, the model for story template representation should be flexible enough to allow a participant to take a particular narrative perspective and compare that to the other participants, globally or locally within a story world. This is done by modeling conversation relationships [8] with the aim of self-organising and negotiating an agreement surrounding several themes. Conversation Theory (CT), a 2nd-order cybernetic theory of learning and social interaction, can demonstrate how to maintain narrative coherence within a set of assembled themes, while taking into account the collective viewpoint and interpretation of co-collaborators. This places group conversation central to its process and outlines a formal method of conversation as a sense-making network or a negotiation of shared agreement surrounding several interrelated themes, that lead to eventual action or procedures that clarify the context.

The central feature of CT is the construction of the entailment mesh [9]. These are concept networks that embed interrelated knowledge, such that each concept that can be explained or understood by its relationship to at least two others. (Fig. 3) From the theory, entailment networks are said to achieve coherence, that is, a network of localised relationships that are considered 'operationally closed', or cyclic, in its dependency. The advantages cyclic relationships provide a rich set of possible narrative structures within the entailment mesh. This allows participants to procedurally adopt several viewpoints or perspectives within the network.

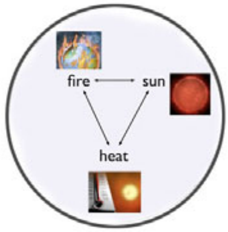

Fig. 3. Cyclic entailment relationship

The focal point of narrative coherence and viewpoint is the interface ring itself. Its role is to visualise these self-organising relationships within the 'coherent' ringed space, such that each annotated tag within the ring may be re-organised or ejected to collectively shape the network's meaning. Participants construct the narrative themes in this manner to form any arbitrary number of coherent networks that are assigned ratings dependent on the contextual strength of their associated theme relation. These themes are considered the fittest based on collective ratings (Fig. 4) and is a result of entailment relationships that have been retained with each conversational session.

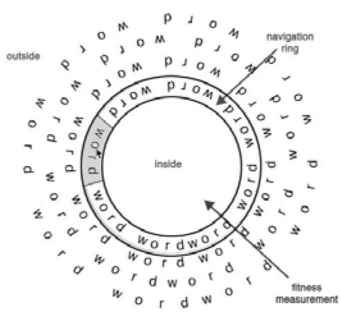

Fig. 4. Fitness measurement

The visualisation of narrative relationships with entailment structures, allows for a cyclic interpretation and may be suitable to a range of narrative styles in a domain independent and scalable way. The interface plays a central role in the system architecture by representing the cyclic properties of these entailments while maintaining coherence. The cyclicity inherent within the system is adaptive to collaborative input and potentially covers a range of narrative sequences and modes.

4 Discussion

The interface design and its integration into the holistic storytelling design places emphasis on metaphor as the basis of narrative accrual in the conversational process. Metaphor is essential to the storytelling process, and arguably a pervasive aspect of communication, however also found in primal embodied actions. An interface design that supports metaphor must begin with embodied action before any other external conceptual representation can occur. This assists with participant recognition of intention, enhancing meanings by the visibility of gestural actions through interface feedback. This feedback should have an expressive appeal that renders visible its inner processes, allowing the conversational relationships modeled in the narrative templates open to interpretation yet easily procedurally recognisable.

This paper has attempted to put forward an interface design for collaborative storytelling that adopts a certain epistemological view of knowledge generation [10], a holistic system that aims for maximising the creative possibilities by modeling a wide narrative context. The criteria for evaluating this design should come from a qualitative understanding of participant experience, as each would approach the collaboration in a unique way dependant on the intentions they bring to the group, their relationships to one another, and content generated. Such evaluation studies would point to a set of general design requirements for interfaces that generate narrative content with semi-automated systems.

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Calliope: A Portable Stage for Co-creative Storytelling

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Abstract. In this paper, we introduce Calliope, a portable paper-based platform for interactive story making that allows physical editing of shared digital media at a distance. The system is composed of a network of creation stations that seamlessly blend analog and digital media and documents the creative process with no need to interact directly with a computer. The system enables the use of any object to be used as material for creation. This offers opportunities of collaboration to peers who's expertise might not be in the same medium.

Keywords: Storytelling, User Interface, Long Distance Collaboration, Cross-cutural, Cross- generational.

1 Introduction

When we create stories we inhabit the illusory, treading between fantasy and fact. We give voice through externalization to our internal reality.A story then, is an artifact, and as an artifact we can share it, reflect upon it, or use it as a spring for further thought. When we tell stories, we exercise our memory; we recall experience; we make use of any expressive device to convey the desired message; whether it be dance, song, written, acted or drawn, telling a story is a creative, mental and physical activity that demands a space and a time where one can let the full expression of oneself come through. The design of a tool for storytelling thus, should endorse both facilitating diverse means of creation as well as propitiate the space and time where this can happen.

2 Background

Calliope is the second iteration of the NeverEnding Drawing Machine (NEDM) , a system meant to bridge cross-cultural and generational boundaries by offering the opportunity of collaboration to people who’s expertise might be in different mediums. While the system was successful in many ways, it also offered a world of possibilities that were worth trying. Among them was the improvement of the design to make it a portable and capable of documenting the process of co-creation. Calliope is a portable stage which hopes to bring together people who otherwise would not meet to do things they would otherwise would not do. Taking storytelling beyond the oral and written means, it offers the user’s environment as a source of inspiration and creative material, allowing the creation of contextualized, personalized work. The design

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considerations taken when building Calliope emerged from a user study ran on the NEDM and from the obvious limitation that having a system constrained by its price and size imposes over the initial motivation of cross-cultural collaboration. Calliope was also designed to avoid the calibration issues the NEDM presented by limiting the number of cameras and making the projection to sketchbook mapping automatic.

2.1 Design Considerations

We based the design of Calliope following a user study on the NEDM. In this study, it became clear that co-creation was actually a fun activity and that creating a contextualized narrative was a natural outcome deriving from the system's ability to incorporate objects. While linear narratives where not the most common, they non the less occurred though users were more interested in the collage possibilities presented by the merging of analog and digital media. Cross-generational collaboration happened seamlessly, as well as bringing people from different cultural backgrounds together. This prompted the design of a personal, portable system that could be launched virtually anywhere. The most common problem the NEDM presented was related to calibration issues given the use of two cameras.

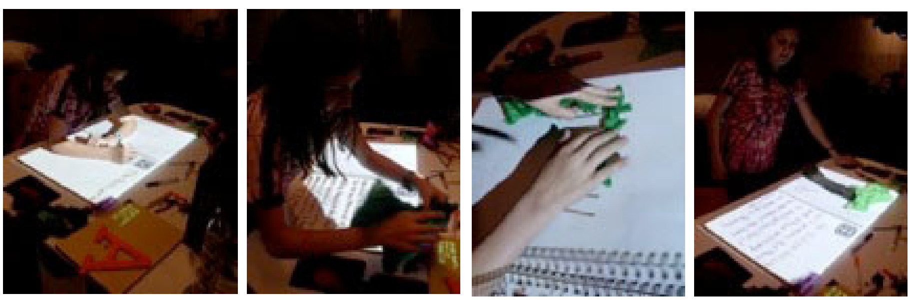

Fig. 1. User creating a collaged story on the NEDM

3 System Design

Calliope blends pre-made digital media and newly captured analog content onto specific pages in a sketchbook permitting co-edition of the same page simultaneously or independently. Captured images are layered and displayed on any other networked Calliope. The user can choose to upload any kind of digital media and to map it to specific pages of the sketchbook, this though, cannot be accomplished unless interfacing directly with the computer. A status bar at the top of the page lets the user know what page their collaborator is on. The system was designed to interface with the user by using costume made human readable tags that allow sound recording, history display and layering of images. Calliope lets the user record sound on each page, opening limitless possibilities both for creative output and inspiration. Additionally, the system automatically re-sizes the projection to fit any size sketchbook by placing corner tags onto the corners of the sketchbook.

Fig. 2. Calliope's front and back view

3.1 Calliope: Hardware

We wanted the physical design of the box to reflect the merging of analog and digital media. While the technology is not hidden, it is also not over emphasized.

Calliope is a wooden box which interior conceals a computer, a speaker and a micro-controller.

The upper layer of the box contains a pedal and an attachable camera, the rest of the space is intended for the user to be able to store whatever material or objects she wants.

The front compartment conceals a pico projector which bounces off a mirror attached to the lid and projects down to the sketchbook.

A small box containing a camera attaches to the lid with magnets to minimize any possible errors in calibration.

The fiducial tags are made into magnets that attach to the box surfaces that have been painted with magnetic paint.

3.2 Calliope: Software

The current system is coded in openFrameworks.

There are three stages of the system- getting inputs and extracting information, media storage and alternating internal states, and output generation.

We use Dropbox for data sharing between users with the update usually taking less than 4 seconds. Accessing the collaborators data is the same as accessing any file in their file system.

There are three input sources: camera, microphone and pedal.

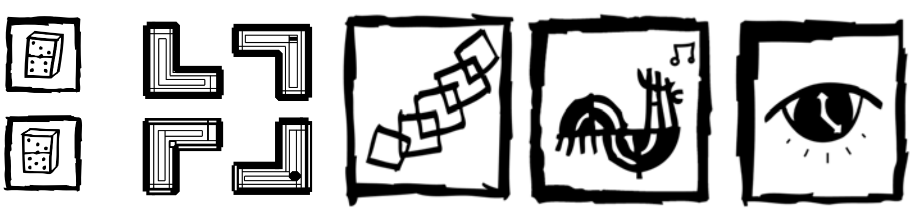

Fig. 3. Costume made fiducials: Page tags, Corner tags and Action tags: layers, sound recording and history

Camera Inputs: Fiducial Tags

Fiducial markers communicate with the system through the ofxFiducialFinder toolkit.

There are three types of fiducial tags used: action tags, page tags and corner tags:

- Action tags play, record, change the display of layers or show the history of the page.
- Page tags associate the content to be projected to the page number, this way the sketchbooks can be synchronized.
- Corner tags are used to auto-pin the projection to fit the sketchbook.

If something from the camera input is recognized by ofFiducialFinder, the index of the tag's digital string is exported and categorized as pages, actions, or corners, changing the system's internal states based on the inputs.The internal state functions as a switch, deciding which input sources and media files will be fed, processed and what the output will be and is composed of three major parts: action states, user states and display states.

Action and display states are user specific, exist only in memory, are not shared nor stored and are determined by the action of the user. User states configurations, on the other hand, are shared between users. These decide what media file, snapshot and audio streams should be fetched. The user states are displayed on the status bar of the sketchbook.

4 Discussion

Calliope can be taken and installed anywhere provided there is power and a network. As a self-contained portable system, it allows people who might be in two remote locations to either synchronize and work on the same content, or to share each others work asynchronously. This means that Calliope could serve as a platform to collaborate with peers form different cultural backgrounds and to get a glimpse of how does their environment affect the work they produce. Like the NeverEnding Drawing Machine, Calliope blends author and reader into one role making them both creative agents. By allowing creators to use incorporate any object, either for it's sensorial qualities of emotional value, Calliope opens a whole new way of personalizing stories. Calliope proposes that the external reality we live in is full aesthetic potential if we decide to look at it from a creative approach. It's multimodal point of entry, small learning curve and capacity for asynchronous collaboration intends to let the user take it's time, allowing them to focus on the creative act and not necessarily on the fast delivery of product. Drawing provides a record of thought; Calliope preserves the history and gives the user immediate access to the though process and decision making that the creative act entails.

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Computational Model of Film Editing for Interactive Storytelling

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Abstract. Generating interactive narratives as movies requires knowledge in cinematography (camera placement, framing, lighting) and film editing (cutting between cameras). We present a framework for generating a well-edited movie from interactively generated scene contents and cameras. Our system computes a sequence of *shots* by simultaneously choosing which camera to use, when to cut in and out of the shot, and which camera to cut to.

Keywords: Camera planning, Virtual Cinematography.

1 Introduction

In interactive storytelling, it is useful to present 3D animation in a cinematic style, which means selecting appropriate cameras and appropriate inter-cutting between cameras to properly convey the narrative. We propose an optimization framework for selecting shots and cuts while the narrative unfolds, based on a relatively simple scoring scheme driven by working practices of film and television [3,6]. We cast the problem of film editing as selecting a path inside an *editing graph* which consists of a collection of evolving film takes (a take is a continuous sequence of images from a given camera) and precisely deciding when to cut in and out of film takes. In contrast to related work, we also account for a precise enforcement of pacing (rhythm at which cuts are performed). We propose an algorithm suitable for online editing which uses an efficient best-first search technique. The algorithm relies on short-term anticipation to improve quality in cuts and produce movies consistent with the rules of cinematography and editing, including shot composition, continuity editing and pacing.

The paper is organized in two parts. The first part describes the score functions used to evaluate shots, transitions and pacing illustrated by a number of examples. The second part explains the search process for exploring the editing graph during the storytelling process with a very minimal lookahead.

2 Film Grammar Rules

In our system the score of a movie is built up incrementally as the sum of the scores of its shot fragments and transitions. The cost per fragment (a fragment

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Fig. 1. Action costs. Left: Three shots of a drinking action. Right: Three shots of a pouring action.

is a part of a take of duration Δt) is evaluated as a weighted sum of all violations of the rules of frame composition $w_k \times C_k^S$. And similarly, the cost of a transition (or cut) is evaluated as a weighted sum of all violations of the rules of editing $w_l \times C_l^T$ (see equation 1).

We compute a complete sequence s as a sequence of shots s_i of durations d_i and cuts between shots. Each shot s_i is processed as the concatenation of fragments $f(t)$ where t is a time interval of length Δt. We then assume that the cost of s is the sum of the costs for all of its fragments and cuts, plus a function C^P of the durations of shots:

(1)
$$C(s) = \sum_t \left(\sum_k w_k \times C_k^S(f(t), t) + \sum_l w_l \times C_l^T(f(t), f(t+1)) \right) + \sum_i C^P(d_i)$$

2.1 Shot Composition

The cost of a shot fragment integrates the violation of three terms: action, visibility, and composition. The action term $C_A^S(t)$ measures the amount of the scene action which is missed in the given fragment, computed as a sum over all actions a occurring during the fragment:

$$C_A^S(t) = \sum_a imp(a) \times M_A[type(a), size(a), angle(a)] \quad (2)$$

where $type(a)$ is the type of action, $imp(a)$ its importance in the narrative, $size(a)$ the screen size of its protagonist and $angle(a)$ the profile angle of its protagonist. The action matrix M_A contains empirical preferences for shot framings as a function of action types. Figure 1 illustrates the preferences for shot sizes and profiles for the special case of two actions types: pouring and drinking.

2.2 Shot Transitions

A transition between shots causes a visual discontinuity. The art of the editor is to minimize the perception of discontinuity by selecting appropriate shots and moments for cutting [1,2,5]. In this work, we compute the cost of a cut as a sum of terms measuring discontinuities in the screen positions, gaze directions and motion directions of actors. Moreover, we weight each term with the screen size $size(i)$ of each actor i, so that continuity in the foreground receives a larger reward than in the background.

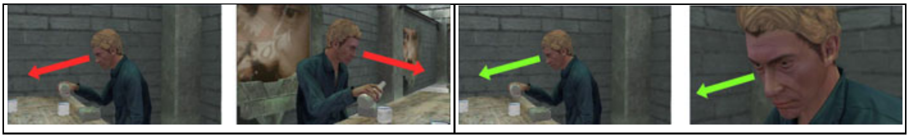

Fig. 2. Gaze continuity. Left: the gaze direction of the main character changes, resulting in a poor cut. Right: keeping the gaze directions consistent results in a better cut.

Screen continuity. Screen continuity prevents actors in successive shots to appear to jump around the screen. Because the actor's eyes are the most important center of attention, we favor transitions which maintain the actor's eyes at the same screen location.

Gaze continuity. When watching a movie the gaze direction of actors should not change. We thus use a cost function that penalizes camera changes that cause apparent reversals in the actor's gaze directions.

$$(3) \quad C^T_{GAZE} = \sum_{i \in screen(f_1) \cap screen(f_2)} size(i) \times \delta(sign(x^G_{i,f_1}) - sign(x^G_{i,f_2}))$$

where $screen(f_k)$ represents the actors that project on the screen during fragment f_k, x^G_{i,f_k} is the horizontal on-screen coordinate of the gaze direction for actor i in fragment f_k and δ is the Kroneker symbol. Figure 2 shows two cuts with increasing gaze continuity scores.

Motion continuity. The motion direction of actors in two successive shots should not change also. We thus use a cost function that penalizes camera changes that cause apparent reversals in the actor's motion, defined as:

$$(4) \quad C^T_{MOTION} = \sum_{i \in screen(f_1) \cap screen(f_2)} size(i) \times \delta(sign(x^M_{i,f_1}) - sign(x^M_{i,f_2}))$$

where x^M_{i,f_k} is the screen motion of the actor's eyes in fragment f_k measured in the horizontal on-screen direction, and δ is the Kroneker symbol.

2.3 Shot Durations

To control the pace of the editing, we introduce a duration cost per shot, measuring the deviation from a log normal law, where d is the duration of the shot, μ and σ are resp. the mean and the standard deviation of the log normal law:

$$(5) \quad C^P(d) = \frac{(\log(d) - \mu)^2}{2\sigma^2}$$

The log-normal distribution is a compact and discriminative representation of shot durations in movies as well as sentence lengths in natural language [4] and its two parameters can be used as a signature of film editing or writing styles.

3 Film Editing as Path Finding

The computation of an optimal sequence of shots consists in searching the path of least cost in our editing graph. Exact and efficient algorithms exist for computing a solution offline. For interactive storytelling applications, we instead describe an approximate method that chooses shots and cuts incrementally as the story unfolds and runs at interactive framerates. At a given depth in the search process (i.e. advancement in time over the fragments), a decision needs to be made whether to stay within the current shot or perform a cut to a shot in an other take. We use a short observation window over the next W fragments to compute the best moment for transition. Given the current shot is s_c, for a given time t in the observation window and for each shot $s_i \neq s_c$, we compute the cost C^{CUT} of a possible transition from shot s_c to shot s_i, and we compare it to the cost C^{NOCUT} of staying in the current shot.

If $C^{NOCUT}(s_c) \leq min_i\, C^{CUT}(s_c, s_i)$ (i.e. the cost of staying in s_c is the minimal cost), we extend the duration of s_c by Δt and the observation window is shifted a fragment ahead. If there exists a shot s_i such that $C^{CUT}(s_c, s_i) < C^{NOCUT}(s_c)$ at time t, we need to know whether to cut at the current time t to shot s_i, or to wait for a better moment. To implement this, we scan successive fragments at $t + \Delta t, t + 2\Delta t, ..t + W\Delta t$ in the observation window until a cost lower than $C_{CUT}(s_c, s_i)$ is found. In such case, the best cut occurs later and the observation window can be shifted a fragment ahead. Otherwise, t represents the best moment for a transition and a cut is performed towards shot s_i. Results are presented here http://sites.google.com/site/christophelino/work/film_editing.

4 Conclusion

We have introduced a novel framework for virtual cinematography and editing which adds an evaluation function to previous approaches. Preliminary results demonstrate that our approach is efficient in separating correct from incorrect shot sequences in complex narratives with many actors and actions, and is thus appropriate for future research in film-mediated interactive storytelling.

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HIP-Storytelling: Hand Interactive Projection for Storytelling

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Abstract. We have created an interactive storytelling system for public spaces that is collaborative, easy and entertaining to use, and allows for a natural interaction. The system consists of a table, a ceiling mounted projector that projects onto the table, and a 3D camera for tracking hands and for object recognition. The main feature of the system is the projection on top of the palm of the hand of the users; thus, the hand becomes also a viewing surface. This allows for very natural gestural interaction, such as holding and passing objects between users. For example, in the course of narrative, users can hand over a story character or object to each other. We also employ projection based augmented reality to animate real objects on the table. Apart from entertainment, the system shall be employed for concrete educational interactive storytelling applications in public spaces.

Keywords: Interactive Storytelling, HCI, Natural User Interfaces, Augmented Reality.

1 Introduction: Interactive System at Public Spaces

What is the best way to employ interactive storytelling for practical, fail-safe applications in public spaces, possibly with educational goals, e.g. for kids? We have created an interactive storytelling system for public spaces such as museums or shopping malls where interactive storytelling can be presented in an innovative, funny and engaging way, and where users can collaborate with each other. Our system shall also enable to transmit knowledge in an entertaining way, e.g. in museum contexts. In place of the widespread "point & click" interfaces and of touch surfaces, in our system, the user interacts with the narrative through natural hand movements and gestures. Using the recent of-the-shelf 3d cameras and computer vision algorithms, we track objects and hand palms, and project narrative elements onto the hand and the objects, enabling gestures such as picking up some virtual object or dropping it, and specifically collaboration, e.g. handing over a virtual, projected object to another user.[1]

[1] Another practical advantage of the system is that it is hygienic, since interaction can be completely touchless, which is an important consideration for public spaces.

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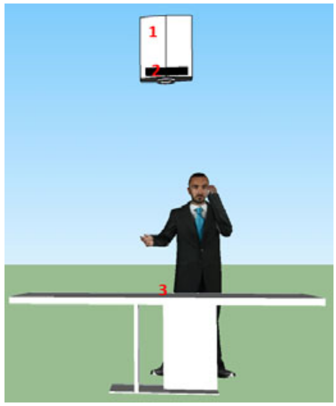

Fig. 1. Configuration of the system (1-projector, 2-3D camera, 3-projection surface, e.g. table)

2 Related Work

Most interactive systems for public spaces today are based on touch or multi-touch screens. With this project we aim to design interactions that are more natural and appropriate for the content and for intended usage. Ishii and Homura have presented the artwork “it’s fire, you can touch it” [1] in which the palm of the hand is employed as projection surface for poems. This system was a major inspiration of our work. We take the concept further by transforming this palm-projection idea into the main mode of interaction, allowing for collaboration through natural gestures. In future, more types of gestures shall be allowed for.

There are several examples of previous work merging augmented reality systems that project directly on a table top with the manipulation of physical objects placed on that surface, in the authors opinion a particular interesting example is the OASIS project [2] as it recognizes a variety of objects placed on the table and where the virtual objects react to the physical objects.

The Responsive Multimedia System (RMS) [3] is an example of a tangible system designed for interactive storytelling. Users can interact with tangible objects to experience a personalized interactive story. The table in RMS is used as tangible user interface consisting in a semi-transparent display screen. A camera tracker is placed under the table to recognize objects and touch.

Another previous work coupling tangible interfaces with a storytelling system is the project "Tangible Viewpoints" [4]. It explores a multimedia storytelling system that uses a tangible interface to represent different character perspectives for the story. The interaction surface on which the objects are placed is complemented by a LCD screen with speakers where the action is presented.

The HIP system here presented consists of a table, a ceiling mounted projector that projects onto the table, and a 3D camera for tracking hands objects. Objects placed on the table can be augmented while the users’ hand serves both as a localized display and as an interaction mechanism. Multiple users can interact simultaneously with the scene or in-between users allowing for example to grab and exchange objects. Given the naturalness of the gestures and movements we believe this provides for a quite intuitive and immersive interaction since the virtual character and objects are not confined to a screen; users have informally reported that a tactile sensation is invoked when an image of an object is projected onto the surface of their palm, which adds a tangible presence to the virtual thing (Cf. [1] for a similar report).

3 *HIP-Storytelling*

We have currently implemented and tested the hand recognition and projection of *HIP-Storytelling*, and our first successful test case has been a fish tank. Users can grab fishes from it, carry them on their palms, and hand them over to other visitors, cf. Figure 2. We are currently working on an interactive storytelling prototype for edutainment in museums. It shall transmit an important event in the history of Portugal. The story logic is not in focus at this moment, and we will employ a simple “string-of-pearls” approach (cf. [5]), where users have a certain level of freedom to solve some tasks at certain times during the narrative, but it still follows a linear storyline.

Story characters will be projected onto the table; users will interact with them with the hand, picking, dropping and carrying them, and handing them over to others.

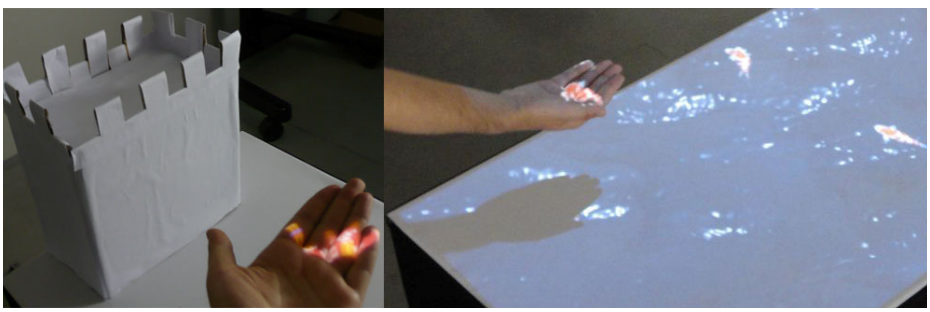

Fig. 2. First test case with fish tank and a current working on test with a real object (castle)

Our prototype shall tell an interactive story based on the history of Portugal and the city of Guimarães, about a battle that Dom Afonso Henriques fought against his own mother (and which he won). Users must accomplish tasks to progress within the narrative. For example, placing armies on the battlefield, helping Dom Afonso Henriques to fight or to climb into the castle; users can also grab enemies and throw them to another location. Some tasks are easier to cope with if several users collaborate, e.g. an easy way to hide the mother from the son is for one visitor to hold her in his hand, while the other user carries the son to the castle. It shall also be possible to interact with real objects, such as the castle and catapults; these tangible elements will be recognized by computer vision algorithms, they shall be part of an Augmented Reality setting, in the sense that the objects will be augmented will be projected by projections on top of them, for instance fire on the castle or bullets on the catapults.

4 Conclusion

At first informal tests, some users reported a series of tactile sensations when viewing objects (fishes) projected into their hands. This phenomenon of synesthesia is compatible with Biocca et al. [6] findings, and contributes to a sensation of immersion and liveliness. We believe that *HIP-Storytelling* is an important example of how interactive storytelling can be employed in public spaces, where immediate understanding of the interfaces, collaboration, and a sense of fun and involvement are important.

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Interactive Non-Fiction: Towards a New Approach for Storytelling in Digital Journalism

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Abstract. The development of digital journalism, an important area of storytelling, has focused primarily on incorporating interactive multimedia components to traditional linear news stories. In this paper, we propose a new approach that places central focus on text, the core of journalism, based on insights from fictional interactive digital storytelling. Drawing upon the convention of interactive fiction, we present our preliminary work on *interactive non-fiction*.

1 Introduction

Interactive digital storytelling (IDS) is a multi-disciplinary area that extends traditional storytelling techniques and conventions through digital media. So far, most efforts in IDS have been focused on fictional storytelling — imaginary story worlds that can take multiple shapes based on different parameters as a new mode of storytelling. In this paper, we explore the expressive affordance and potential issues of "multi-plot" storytelling in the setting of fact-based journalistic reporting.

It is true that digital technology has shaped journalism in multiple ways. However, a majority of such attempts focus on how to integrate multimedia content (e.g. images, animation, video) as a *complement* to text. The way we think about text, the core component of journalism, has remained fundamentally unchanged. In this paper, we propose a new way of integrating computation and journalism based on insights from fiction-based IDS systems. In particular, our current experiment draws from the convention of interactive fiction (IF), a genre primarily based on text. Our initial inquiry raises questions about the variability of text in the context of "journalistic truth," "balanced" reporting and reader agency. Our ultimate goal is to steer digital journalism from an "additive" formulation [6] into a more mature expressive form. In the rest of the paper, we present relevant background, introduce *interactive non-fiction* through a comparative reporting case study and conclude with discussions.

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2 Background and Related Work

Experiments utilizing digital technology for journalism purposes can be traced back to the early 1970s[3]. The prominent approach of contemporary digital journalism centers around various ways of incorporating multimedia into traditional reporting. For instance, McAdams's "Flash journalism" practice[5] calls for using multimedia platforms such as Adobe Flash to produce interactive, multimedia stories that enrich readers' experience and better explain often convoluted information through a collage of photos, sound, video, animation, infographics and text. By and large, text, the core of journalism, is still structured and consumed in ways resembling traditional newspaper [1].

The specific IDS tradition that we draw upon is interactive fiction (IF). Sometimes referred to as text adventures, IF is an interactive storytelling form that mixes elements from literary fiction and computer games, typically using text as its primary medium. A typical way to interact with an IF piece is through text commands. A user types in various commands, often in the form of verb-noun combination such as "pick up the key" or "go west." Through a text parser, the system analyzes the input and returns appropriate textual response. Depending on user interaction, each run-through of an IF system can yield different stories.

Although we are not aware of any IF-based interactive journalism practice, several simulation-based systems are related to our approach, such as Columbia University's *News Simulation: A fire scenario* project [2] and what Bogost et. al. call "news games" [1]. However, many existing projects emphasize editorial commentary rather than presenting neutral and balanced reporting and require high production cost. By comparison, our focus is on journalistic reporting and a scalable model that can be explored by many journalists in their daily practice.

3 Interactive Non-Fiction

Interactive non-fiction (INF) offers a different approach for rethinking the role of text in the context of digital journalism. We use the term to refer to text-based news stories presented using conventions borrowed from interactive fiction. A reader of INF interacts with the news story through an IF-like user interface, exploring viewpoints from different sources in the order and level of depth she desires. Whereas an IF piece may produce drastically different stories, INF is geared towards reflection of real-life events and requires multiple versions of the story to converge. This hence imposes a different set of constraints on how various story components can and should be composed together.

In our current work, we conducted a case study INF reporting and compared it with the equivalent story in the traditional form. Our source material comes from the comprehensive interview notes of a reporter who already published the story *"Thermography Claims 'Misleading': FDA"* in the traditional form on *www.healthnewsflorida.org.* The story covers a recently released Federal Drug

>ask everyone about mammography

Carol Chandler, licensed acupuncture physician who sells thermograms:
"There are a lot of women who don't even have mammograms."
RELATED POINTS: **CONTROVERSY** OVER THERMOGRAPHY, **SAFETY** OF MAMMOGRAMS

Linda Brateman, physicist at the University of Florida:
"The probability of x-ray mammography causing cancer is much less than the risk of not having a mammogram."
RELATED TOPICS: MAMMOGRAPHY AS A **TOOL**, MAMMOGRAPHY AS A **STANDARD**

>what is mammography

Mammography is the process of using low-dose amplitude-X-rays (usually around 0.7 mSv) to examine the human breast and is used as a diagnostic and a screening tool. The goal of mammography is the early detection of breast cancer, typically through detection of characteristic masses and/or microcalcifications. Mammography is believed to reduce mortality from breast cancer.

>ask chandler about mammography

"There are a lot of women who don't even have mammograms. They just don't personally choose to do that. It's a woman's choice, and some woman choose not to. Usually, one, for some women it's very painful—that's probably the number one reason women don't have it done. The other reason is radiation exposure," Chandler says.

Fig. 1. Screenshot of an Interactive Non-Fiction Reporting

Administration (FDA) warning against thermography as an alternative to mammography in breast cancer testing, reporting arguments against and for thermography. We chose this story because it contains a wide array of opinions on a controversial topic. Our initial design of an INF news story on the same subject is mocked up using the Inform 7 System, whose natural language-like programming language, multiple extensions, and an active support community offer a reasonable platform for journalists working under tight deadlines.

Unlike the established news structure in the original story, our INF reporting (Fig. 1 shows an excerpt) is framed with a format we call *Round Table.* Here, all available sources (interviewees) participate in a non-linear round table discussion with the reader on pre-defined topics. After the traditional "nutgraf," summarizing the news value of the story, the reader is presented with a list of sources: their names, titles and a small quote relating their positions on the main topic. There are three central navigation functions: "ask everyone [topic]," "what is [topic]," and "ask [NPC] about [topic]." The first function yields responses from all sources, each represented as a non-player character (NPC). Brief responses present each NPC's basic view on the subject. The second function supplements user's knowledge on basic subjects foundational to the story that may be taken for granted by sources in their interviews. The last function, which allows users to address specific NPCs, yields a source's extended opinion on a topic and, in some cases, elicit additional "related topics" recommending similar or opposing viewpoints from other sources. In addition, we also allow easier access to the main story for time-strapped readers. Several ways of doing this are the "list topic" command, which shows all of the topics in the story, the "what is [topic]" command, and the "glossary" command, which lists all of the key words related to the story.

A straightforward advantage of INF is that it allows a news story to be better tailored to individual readers. More important, it offers new opportunities for both news consumers and producers to engage news media more critically. Gilmore [4] argues that journalists often misrepresent the strength and popularity of minority opinions in an effort to achieve "balance." For example, in the case of global warming, one side is supported by substantial amount of scientific evidence while the opposition is small and presents little beyond their skepticism. Still, the majority of news stories mention the anti-global warming argument, fearing the criticism of cheerleading one side. Our proposal for INF starts to address the two-sides fallacy primarily by providing more levels of presentation beyond in/exclusion. A minority opinion, depending on its nature, may be accommodated in the main source responses, or as an optional branch that are multiple levels of interaction away from the main story.

4 Conclusion

In conclusion, our initial exploration of interactive non-fiction indicated that insights from fictional interactive narrative research are valuable for further transforming journalism in a more interactive and critical way. Through a comparative case study of reporting, we illustrated some of the differences between INF and traditional news stories as well as how INF may offer a model of journalistic balance that addresses the individual concerns of news consumers. For our future work, we plan to expand our Round Table concept by further exploiting IF's procedural nature such as the ability to model economic or political systems and track predefined NPC emotional responses. Levels of details of different viewpoints may also be modified procedurally based on the arguments that the user has already encountered.

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Multi-user Interactive Drama: The Macro View - Three Structural Layers

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Abstract. Narrative is generally crafted around a Three Act structure that dates back to Aristotle's Poetics. This paper asks to what extent the beginning, middle and end of a linear story remain relevant in interactive environments where drama can result as much from the interplay of rules and multi user participation. In this context drama appears to build through short, yet ongoing cycles of variable engagement. This allows for an alternative, structural approach to the application of Aristotle's Poetics in multi-user interactive environments involving three component layers, rather than three linear acts: The Source Drama, The User Drama and The Multi Drama.

Keywords: Interactive Drama, Interactive Narrative.

1 Introduction

Literary theory divides narratives into two types, telling and showing [1], but interactive environments afford an additional narrative mode, doing, or action. Whilst users can enact learnt behaviors as a form of text [2] action also involves discovery. This paper seeks to modify the application of Aristotle's *Poetics* [3] to multi-user, interactive environments where the drive for discovery, added to the need for multiplicity, appears to make linear plot structures redundant. Whilst Laurel's analysis of human computer interaction as a medium that "formulate(s) potential in the same way that drama does – as a progression from possibility to probability to necessity [4:71]" is a core theoretical contribution, its application is dogged by the fact that multiple users disrupt any hope of a unified linear beginning, middle and end plot. Given this, it is proposed that "procedural authors" [5] sculpt open-ended encounters marked by three variable layers of interaction**:** The Source Drama, The User Drama and The Multi Drama.

This paper continues a two part preliminary poetics for multi-user interactive drama. The structural analysis considered here is partnered with an additional paper included in this volume that explores the user drama in process [6].

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2 The Three Layers of Multi-user Interactive Drama

Layers can usefully illustrate concurrent and inter-related components. In such a layered structure, the source drama refers to the source system, whilst the user drama refers to the user's subjective experience of an encounter with that system and the multi drama refers to the unfolding, dramatic relationships between multiple users and media networks also party to that system (see Fig. 1). Multi-user interactive drama appears to evolve through the interplay of these three, networked layers.

Layer 1:
The Source Drama
The event space created by a script, or media object

Layer 2:
The User Drama
The subjective drama that a single user experiences when they engage with that script, space, or object.

Layer 3:
The Multi Drama
The collective drama that exists between multiple users and multiple systems.

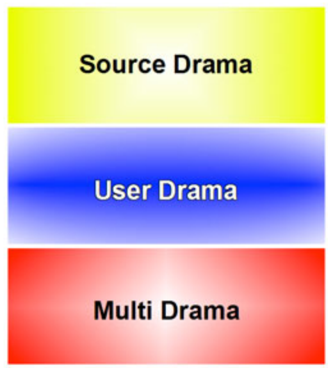

Fig. 1. The three tiered macro structure of multi-user interactive drama

2.1 The Source Drama

This sort of 'plot' more accurately refers to a shared field of material resources [7]. "The play- wright's influence on the shape of the plot becomes indirect; he (she) must predispose the interactor to make choices and take actions so that the interactor's experience has a pleasing shape [7: 260]," but when the plot is in fact a field this begs the question: What shape? Laurel's model emphasizes progressive links between authorial drives (the formal cause) in collaboration with the audience's (material) causation on the other [4: 41-50]. For authors, these causal chains develop through plot (action), character, thought, language, melody (pattern), through to the final spectacle [4: 50]. Mateas argues that single user agency adds two new causal chains to this model, one formal and the other material that slot in at the level of character [8]. In *Façade* [9], a prototype for single user interactive drama, Mateas and Stern staged variable subplots and end points to create the *feeling* of user agency within an overall dramatic arc. Multiple users create more layers of causation again. Multi-user dramas emerge as a result of a combination of forces that include competing subjectivities, media networks and their surrounding cultures of usage. This reinstates the importance of all four causes originally identified by Aristotle, including the purpose of the event (which involves discovery as much as representation) and the efficiency of its multiple makers. Rather than present an intricate web of multiple causations, the aim here is to suggest a simple, but useful alternative to help guide future design efforts. In essence, a source system becomes dramatic when it evokes a subjective drama.

2.2 The User Drama

Active users participate in real time, intensified engagements with staged encounters. This engagement that links user to source is intensified yet again by the users' investment in that drama and/or the extent to which it challenges their perceptions, abilities, or life stories. The *fee*ling that they can impact and reinvent that dialogue is crucial. This combination of links and tension points powers the drama (informed by user motivation and agency). Thus, a multi-user interactive event is dramatic because it affords a real time and potentially transformative encounter. Users are drawn into this sort of encounter by a variety of factors that include narrative elements, the application of rules, the interplay of relationships and sensory stimulus. When multiple users engage with an overall context through these sorts of sub-elements the results can be felt, enacted, consumed, discussed and thought about. This process recalls Douglas and Hargadon's discussion of the core pleasures of interactive narrative: "The pleasures of immersion stem from our being completely absorbed within the ebb and flow of a familiar narrative schema. ... Our enjoyment in engagement lies in our ability to call upon a range of schemas, grappling with an awareness of text, convention, even of secondary criticism and whatever guesses we might venture in the direction of authorial intention [10]." This sort of engagement might be experienced as an internal psychological event, but it can only be shared when it is also expressed, ideally in a mutually meaningful way. Meaningful action in this context recalls Salen and Zimmerman's [11] articulation of the need for discernable and integrated action paths. It emphasizes personal identity and self-validating expression linked to a broader sense of community.

2.3 The Multi-drama

Here the source drama extends to incorporate multiple, emergent user dramas. These relationships can be molded, but in practice emergent dramas also collaborate with a mysterious form and lack of control. This recalls the beauty of the lyric [7], evocative of natural rhythms. It also demonstrates another cause, which Aristotle identified as separate to the others: Chance, or spontaneity. The element of chance points to the drama inherent in the knowledge that there is much that can't be controlled, such as other players. Dramatic dialogue supports this collaboration as it shifts between the pleasures of personal mastery and relationship, sometimes by design and sometimes just as much, by chance. Given this, procedural authors do well to stage dramatic, but variable dialogues that individual users can relate to and be a part of. In this context, causal networks are directed towards the universal actions, such as sharing a secret, rather than the particulars of the text. Participation in that dialogue can be both prompted and constrained, but as long as users can *feel* like they make a meaningful contribution to that shared drama then they can also feel a sense of participatory agency. This impression distracts users from their desire to control a particular dialogue and instead position them towards a desire to be part of it. With this in mind one can speculate on what implications might emerge for the writer or creator of such dramas and other associated professionals and participants. Faced with the demands of providing interactive experiences for the participants the writer must now concentrate on different tasks. Instead of scripting stories they now need to create open-ended experiences that engage users in an emotive and also exploratory dialogue, promote sharing of personal data, provide opportunities for self-validation, test and explore their emergent identity, build connections between them and further explore their differences. Participants who are attracted to this type of experiential drama may find that it offers opportunities to engage in a more flexible and humanist manner. It also builds new skills and stages new developmental experiences that can expand networks. Additional challenges for producers, though of a comparatively lesser magnitude, will be to stage social play that is both enriching, entertaining and profitable. While the full range of future impact is yet to be investigated, the aim of this paper is to explore these possibilities. It is hoped that this discussion will stimulate procedural authors to a) add social play into dialogue and b) expand the level of interpersonal engagement in interactive play. Both foreseen possibilities and as yet unforeseen consequences may ensue. Another paper in this volume [6] further explores the subjective experiences that can face those who elect to participate in such programs.

3 Conclusion

This structural analysis suggests that computer-mediated multi-user dramas can evoke a variety of user responses to prompt an overall dialogue, or pattern of engagement. These sorts of co-creative, collaborative encounters negotiate between what is already known, and what can only emerge when control is relaxed and the forces in play are allowed to spontaneously emerge. In terms of procedural authorship, as long as the source, user and multi drama are linked in a way that also allows for individual challenge, reinvention and self- validating expression, or in other words as long as users can *feel* like they can engage with the overall dialogue in a personally meaningful way they will be able to enjoy the pleasures of being part of a dramatic dialogue that is outside of their control. In this way multi-user systems can be designed to generate dynamic and dramatic, humanist encounters.

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Performatology: A Procedural Acting Approach for Interactive Drama in Cinematic Games

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Keywords: performatology procedural agent acting character AI.

1 Introduction

We define a Performatology approach as combining performing arts theory with AI to design Performative Embodied Agents (PEAs) that simulate skilled acting. Our position is that NPC characters for interactive drama, in the traditions of theater and cinema, should be animated by agent behavior modeled on the physical acting of live performers. We propose that agent behavior problems related to generating embodied fictive characterizations are at least in part gestural acting problems that have been addressed in the arts domain. Actors, puppeteers, and animators have successfully portrayed fictive characters that are both believable and appealing to audiences, and therefore similar agent generated characters should attempt to simulate their techniques. Our research has two main motivations:

1. Improve real-time agent characterizations by simulating actor gesture style.
2. Provide skilled performers with procedural acting tools for interactive drama.

Several machine learning techniques have been used to isolate gestural content from style in motion capture data [1][2], with the capability of modeling, predicting and synthesizing new motion data in a consistent style [3].Our methodology uses a similar process to study the virtuosity of live performers in offline data, to translate their methods into procedural acting parameters, and then to generate online agent characterizations in a similar style. To this end we are currently conducting data driven training of a neuro-evolutionary algorithm, HyperNEAT [4], on the gestural rhythms of skilled performers to model general acting principles and specific actor preferences for a characterization. The concept of procedural acting treats an agent as a target actor's apprentice, analogous to a star's understudy or double who learns to do an impression of the star's characterization in case of their absence. The live actor trains the agent offline through improvising on a mocap stage in the intended role or persona, with similar testing data serving as a fitness function for simulated agent mimicry. The process, consisting of gesture modeling, recognition, prediction, and synthesis, is designed to increase the amount of recognizable acting presence displayed in online PEAs behavior.

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2 Performatology Influences

Performatology draws on the subset of performance theory that studies skilled performance for enacted entertainment. Most game related research has been focused on performance as play or as non-skilled performative behavior, with some noting that skill is not relevant to such performance [5]. However, our position is that professional actors in theater and cinema are in the business of producing meaning through their virtuosity, with dramatically enacted characters being a direct product of their artifice. Performance studies show that trained actors employ extra movements in their gestures not displayed in the naturalistic behavior of non-actors [6], and gesture studies have also found notable differences between professional and amateur performers [7] [8]. Performance theorists have described everyday gestures as utilitarian and efficient to minimize energy expended in reaching a stated goal, while trained actors have the hidden goal of creating maximum drama in a scene by adding subtle codified movements that require extra energy to perform.

In performance studies these extra gestures have been classified as pre-expressive attributes that form the foundation of semiotic acting technique by regulating the actor's choices that affect posture, balance, and rhythms [9]. Skilled actors traditionally embody these meta-acting codes by imitating the genre content displayed by other actors as part of the actor apprenticeship process. Pre-expressiveness makes the performer more readable as a character type, allowing them to better capture and direct audience attention. For instance, an attribute often exhibited by live performers is anticipation, where the performer moves slightly in the opposite direction before moving towards a final goal. Disney animators classified many of these attributes when studying live actors during the production of early animated films like Snow White [10], and then incorporated them into their animation principles. Performance studies have closely identified pre-expressive attributes with an actor's stage or screen presence, related to projecting a persona that is believable and appealing to audiences. We hypothesize that pre-expressive techniques can be isolated in the gesture data of skilled performers, and then modeled as meta-acting parameters to improve acting presence in agent behavior.

3 Procedural Acting Tools

Although procedural tools for animators have been developed by Perlin [11], and story generation tools have been a strong area of research and development related to interactive narrative [12] [13], to our knowledge other researchers have not taken a similar approach to developing procedural acting tools for embodied performers. The difference between our performing arts approach and literary performative approaches is we don't consider enacted drama to be a subset of narrative, but contend that embodied performance and character acting are at least partially created by the live performer. Theorists have dubbed a literary fallacy the idea that enacted performance is entirely generated out of the text, because the script is always underspecified in theater and cinema [14]. Actors are given the freedom to improvise and develop a character within authoring and directorial constraints, and in some forms of enacted entertainment there is no script. There are many examples of scenic business, bits, and gags in theater and cinema that are dramatic but also unrelated to the greater narrative of a story. Expanding narrative to encompass performance is the equivalent of using the 'All the world's a stage' argument to expand acting to encompass story, which lacks useful boundaries for designing cooperative micro-agents that generate creative artifacts based on collaboration.

Our Performatology research is influenced by classical acting theory on full-body gesture, where the actor is treated as a black box, rather than modern internal acting methods. Consequently we are focusing on simulating physical technique, deferring psychological motivations to other areas of research related to emotions [15] High-level story motivation and mise-en-scene direction can be input as constraints on PEAs acting from authorial agents. By modeling actor preferences that drive low-level gesture patterns, we are exploring 'how' a good performer acts, not 'why' or 'what' they do. For instance, we are interested in how a character moves when directed to walk across a room in a specific context. Every good actor will perform such a maneuver in a unique way, and the same actor will perform variations in multiple performances, but also display general content and style consistencies that define their persona. Since PEAs training features a target actor exploring the character space, simulated improvisation as well as mimicry is central to our process. Other performance oriented research on the improvisation of skilled actors has been done, finding basic principles for improvisation, and developing non-gestural improvisational micro-agents [16].

Our Performatology approach differs from other methods that employ mocap blending or avatar control [17] [18]. Avatar control functions like puppetry with the performer directly manipulating the real-time character's behavior. While natural user interfaces like the Kinect sensor may allow an avatar to reflect some of a performer's virtuosity, the resulting performance is subject to puppeteer errors. Our method addresses behavior not directly controllable through avatar control, but could be used for avatar enhancement. Parametric motion blending requires the use of edited sequences and transitions from a mocap library, providing refined motion but lacking real-time flexibility. We find artistic advantages in taking an indirect procedural acting approach, treating the generation of character motion as an AI acting problem rather than a graphics animation problem. Additional information on the formulation of our Performatology approach can be found in [19].

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Situating Quests: Design Patterns for Quest and Level Design in Role-Playing Games

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Abstract. The design of role-playing games (RPGs) is very complex, involving an intricate interweaving of narrative, quest design, and level design. As an important means for conveying the game's story, quests dictate the setting and contents of levels. Levels provide challenges for the player to overcome in the service of completing quests, and their structure can invite the inclusion of certain kinds of quests. This paper presents an analysis of design patterns present in existing RPGs that aims to better understand such relationships. These patterns identify common design practices for quests and levels at many different levels of granularity.

Keywords: quest design, level design, design patterns, game analysis.

1 Introduction

Quests are the primary mechanism for narrative progression in most role-playing games, providing the player with objectives that guide gameplay and choices that can influence the story; we call such games "quest-based games". However, level design plays an equally important role as quest design; well-designed spaces situate quests in an immersive world and provide challenges for the player to overcome while fulfilling their goals. Aarseth defines quests as being intricately tied to a player's movement through space [1], while Howard describes level and world design as the "first step" for creating quests [2]. He states that the goal of level design in quest-based games is to provide the player with direction towards the quest goal, while also challenging the player with "disorientation". Though the first step in designing a quest may be to build the level it inhabits, the design of a level can also inform quest design; quests are constrained by the existing, physical structure of the world. Due to this tight integration of level and quest design, we argue that any analysis of one of these aspects of the game is incomplete without an analysis of the other.

We have performed such an analysis through the creation of a library of design patterns for role-playing games. Our work has been heavily inspired by Christopher Alexander's identification of an architectural "pattern language" for cities and buildings [3], especially how his patterns span many different layers of abstraction. Like other design pattern libraries for games [4-8], our patterns are largely descriptive in nature. We have aimed to be more formal than existing game pattern libraries; each

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pattern has variables describing how its use can differ across implementations. We also strive to exhaustively define relationships between patterns, and understand how patterns across different layers of the hierarchy work together.

We present our library of design patterns and examples of how this library can be used to describe a complete quest and level pairing. The pattern library provides an improved theoretical understanding of how levels and quests are related to each other, and allows for a common vocabulary for discussing the design of quest-based games.

2 Design Patterns

Each pattern is identified as a quest or level design pattern, and placed into a category in the hierarchy we have defined. This section describes these categories and provides an example pattern. For space reasons, not all of the identified patterns can be described in this paper; a full listing is available online.[1] At time of writing, there are 33 quest design patterns and 57 level design patterns drawing from an analysis of over 20 RPGs. References to patterns and pattern categories are denoted in italics.

There are five different categories for quest design patterns that range from patterns of player behavior to common methods for storytelling through quests: *Quest Action, Quest Objective, Quest Structure, Quest Superstructure, and Purpose.* The first four form a containment hierarchy: the overall quest superstructure for a game contains a set of quest structures, each of which are made up of quest objectives, which the player fulfills by taking quest actions. Patterns in the *Purpose* category describe the gameplay reason for a quest being given.

There are six categories for level design patterns, covering both configurations of level geometry and patterns of NPC behavior. *Physical Element, Physical Area, Level Structure, and Level Superstructure* patterns form a containment hierarchy similar to that of the quest design patterns. There are also *NPC* and *NPC Encounter* patterns that describe common kinds of NPCs and how the player might interact with them.

2.1 Example Design Pattern: Arrowhead Questing

Arrowhead Questing refers to a chain of quests that begin with broad *objectives* that narrow down to specific *objectives* of great significance. A common instantiation of this pattern has the player *kill* progressively smaller numbers of stronger units, from simple *standard encounters* all the way to a *boss battle* at the end of the chain.

The style of arrowhead questing is a common pattern for teaching the player how to perform increasingly difficult tasks, and may make the player's actions in the world feel more significant as each step in the quest chain typically affects the next quest. In terms of story, this pattern gives narrative a framework for progression.

Variables and Affordances. Arrowhead Questing is a *quest structure* pattern that contains multiple, smaller *quest objectives*. The pattern has a starting quest and ending quest, and a variable number of middle quests. This pattern also varies in how related each stage in the quest is to the other; some arrowhead quest chains involve

[1] The RPG pattern library is available at http://rpgpatterns.soe.ucsc.edu. A complete description of every pattern mentioned in this paper is available on the website.

simply killing progressively more difficult enemies in an area, while others may incorporate a story by having the player perform a series of different tasks that are all thematically related. An arrowhead quest structure that has little internal variety may be considered a *contextualizing quest*, as the repetitive objectives can teach the player how to perform particular actions or how to use specific strategies.

Examples. The *Fallout 3* [9] quest chain "Blood Ties" fits into this pattern. The player is first asked by someone in Megaton (the starting town) to deliver a letter to their family at a different settlement. Upon arriving the player finds out that the person who was supposed to receive the letter has gone missing, and the people of the town blame raiders for the kidnapping. The player is now tasked with the less general but more significant objective of hunting down said raiders. Upon finding them there is an option to either kill them all, wiping them from the game world, or to converse and convince them to not attack the town anymore. This final task has the greatest impact on the game world of any tasks in the quest chain.

Quest-Level Relationship. On a large scale, arrowhead questing can be a subplot that exists within a *city* or an *uncharted area*. On a smaller scale, it might involve the player progressing through a *gauntlet* of increasingly difficult enemies. The conclusion of an arrowhead quest chain is frequently a *boss battle*.

3 Worked Example

Below, we show how the patterns we have identified (denoted in italics) can be used to describe a quest and its associated level in the "Scan the Keepers" quest from Mass Effect [10]. This is a small-scale *side quest* that the player receives early in the game.

After the player's first visit to the council, one of the *companion* party members points out a Salarian (*interactive NPC)* examining a Keeper (*non-interactive NPC)*. If the player initiates *dialog* with the Salarian, he'll discuss his work scanning the keepers of the Citadel (*city*) and mention its questionable legality. He then asks the player for assistance, initiating a quest to search and scan all the keepers, which has both *search* and *collection* as objectives. Since the player is not required to complete this quest, it is considered a *side quest*.

There are 21 keepers scattered throughout the different districts of the Citadel; some are hidden down *hallways*, while others are operating in plain sight in different *nuclei* of the *city*. The player is given a scanner (a *quest-tied item*), and.each time the player finds and scans a keeper, she receives credits and experience. There are bonus credits (*money*) and experience if all of them are scanned. The player can instead make a *choice* to encourage the Salarian to discontinue his research.

This quest rewards the player for fully exploring the citadel, through the search for Keepers. The Citadel is a very large space that is the starting area for the game, and the player must complete a number of main-plot quests in the area before reaching a *bridge* to a new section of the game. It could also be considered a *contextualizing quest*, as it indirectly introduces the player to the city's rapid transit system, which *warps* the player to different districts. By encouraging the player to fully explore the station, the quest introduces the player to areas where more *side quests* can be found.

4 Conclusion

This paper has presented a collection of quest and level design patterns for role-playing games. These patterns were found through an analysis of over 20 different quest-based games, and span many different layers of abstraction, from small items found in a level to broad, game-wide quest structure. The patterns we have identified help us better understand the relationships between level and quest design, and how exactly levels situate quests in a space that the player can explore and conquer. The formal pattern definitions and their relationships are currently being used in the creation of a procedural quest and level generator that can assist human designers. We anticipate expanding our pattern library over time to include many more patterns and detailed examples, as we uncover further patterns during the development of this tool.

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Specification of an Open Architecture for Interactive Storytelling

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Abstract. This article introduces OPARIS, an OPen ARchitecture for Interactive Storytelling, which aims at facilitating and fostering the integration of various and heterogeneous Interactive Storytelling components. It is based on a modular decomposition of functionalities and a specification of the various messages that different modules exchange with each other.

Keywords: Interactive Digital Storytelling, Interactive Narrative, Architecture, Narrative Engine, Behaviour Engine, Animation Engine.

1 Motivation for an Open Architecture

This last decade, a significant number of Interactive Digital Storytelling (IDS) systems have been implemented [1]. In order to provide the end-user with influence on the storytelling process, these systems include a core narrative engine, that is responsible of choosing/generating appropriate actions during the experience, and various peripheral yet essential technologies: menu-based interfaces text recognition/ generation technologies, behaviour engines, camera engines, light engines, etc. Most systems above integrate their own set of technology, within an in-house architecture, but there has been limited integration *between* these systems to date.

This lack of integration is problematic because it limits the ability of each research team to experiment/validate/demonstrate their core contribution. Furthermore, with limited integration, the spectrum of available technologies ready for applications remains limited. More precisely, our motivation is twofold:

From an engineering point of view, it is desirable that, within a given architecture, a module could be replaced by another one with limited effort. Furthermore, a well-defined API enables modules to be easily distributed and supports the development of new compatible modules.

From a more theoretical and narrative viewpoint, our goal is to formalize the dependencies between the narrative level and the medium, by studying which narrative phenomena can be described within the Narrative Engine, which one cannot and finally which information needs to circulate between modules to generate these

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phenomena. More generally, an open architecture gives the opportunity to formalize what circulates between the architecture's components in narrative terms, rather than in raw Computer Science terms, without being confined to a specific theory of IDS.

2 General Design of OPARIS

2.1 Design Principles

Flexibility: OPARIS aims at both creating new IDS modules and integrating existing ones. Therefore, a key principle of OPARIS is to provide several levels of integration, from an ideal case, where each module works according to the documented API, to cases where modules have followed different specifications.

Simplicity: our users are not system engineers but researchers in IDS and advanced media designers. Therefore, the architecture specification must remain simple, avoiding too much abstraction and not be over-constrained.

Narrativity: We aim at fostering a narrative point of view on IDS via the architecture. Therefore, OPARIS uses an existing set of already defined IDS concepts [2] to specify and name the data circulating between modules.

2.2 Modular Decomposition

The modular decomposition is inferred from the various existing IDS architectures developed within each system [3,4,5,6]. This decomposition cannot be unique. The granularity of modularity varies between systems. This implies that *modules* should be differentiated from *functionalities*. Modules are isolated software components that perform one or more functionalities (Table 1).

Table 1. Modules in the proposed architecture, with the associated typical functionalities. The two last modules are composite modules.

Module	Functionalities
Narrative Engine (NE)	Calculates actions that must be displayed to the end-user.
Behaviour Engine (BE)	Transforms behaviours into series of elementary animations.
Animation Engine (AE)	Animates a 3D or 2D model of a character and displays other information to the end-user.
User Interface (UI)	Takes input from the end-user.
Music Engine (ME)	Plays background music according to the unfolding of the story.
Theatre (TH)	Displays the story events and descriptions and manages the end-user's interaction.
Small Theatre (ST)	Displays the story events and descriptions and manages the end-user's interaction. In case of 3D, it excludes the BE.

2.3 Physical Implementation

Each module is an independent software component that communicates with the rest of the architecture with TCP sockets. Data circulating within the architecture are coded in XML. The specification of the API for each module is supported by an XML schema (XSD), which is provided to the users of the architecture.

In the architecture described so far, each module's output must be compatible with every other module's input. However, this is not always the case when working in a real integration case. In particular, the NE outputs narrative actions, which do not necessarily match the behaviours of the BE. A conversion must be performed at the NE or the BE level, specifically for each integration. This hinders the interoperability of the whole architecture. To solve this issue, a new module is introduced, the **Director**, which follows the design pattern of a *Mediator*. It performs three functions: (1) It receives all messages from the other modules and redirects them to the proper module(s), based on the content of the messages; (2) It performs a semantic conversion between modules (e.g. it translates the scenario-specific vocabulary outputted by the NE to the behaviour's catalogue terms in use by the BE); (3) If a module is not compliant with the API, it can perform a syntactic conversion of data from and to this module. The Director plays a role of both routing and conversion. For the conversion, taking advantage of the XML framework, the Director uses an XML transformation language, XSLT, dedicated to transforming an XML document into another XML document. A single ".xslt" file enables to manage all the conversions needed. This enables the building of a specific architecture in an easy manner, without entering into the Director.

In numerous situations, data from one module to another does not need to be transmitted directly as a command but rather should be shared in a central place, accessible to all modules. Therefore, a module called the ***Shared Narrative States Repository*** **(SNSR)** is introduced. It enables any module to store narrative data that is useful to one or more other modules. These modules can either take these data when they need it (pull method) or subscribe to certain data and receive notifications when it changes (push method). It is recommended that the shared data follow the conceptualisation of IDS concepts mentioned above [2].

To further increase the openness of OPARIS, an optional module is introduced, an **adapter**, that is inserted between a module and the Director, to cover cases where a module does not use XML and/or is a TCP server itself. Several adapters can be used within the same specific architecture.

3 Modules' API

Each module described in Table 1 is specified via its API. Since OPARIS is language independent, the API is not described in a specific language (Java, C#, etc.). Instead, it focuses on communication protocols, i.e., all messages sent and received by modules are specified, first in a reference document, then via examples of XML messages and the corresponding XML schema. The specification is accessible online [7] and specifies 15 types of messages. Here follows an example of a message from the NE to the BE:

```
<?xml version="1.0" encoding="UTF-8"?>
<message>
    <ACTION_TO_PERFORM>
        <act>
            <id>34</id>
            <actionType>talk</actionType>
            <actor>Amanda</actor>
            <actionParameters>
                <actionParameter parameterName="addressee">John</actionParameter>
            </actionParameters>
        </act>
    </ACTION_TO_PERFORM>
</message>
```

The above message corresponds to an action named “talk”, with the character *Amanda* as actor and the character *John* as a parameter of the talk action, the parameter being named “addressee”. (See [7] for the corresponding XML schema).

4 Conclusion

In order to foster the collaboration between researchers, we have proposed OPARIS, an open architecture for IDS. While not yet tested at a large scale, OPARIS has been used to connect one Narrative Engine (IDtension [5]) to four different Theatres.

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StoryFactory – A Tool for Scripting Machinimas in Unreal Engine 2 and UDK

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Abstract. As part of our broader initiative on promoting the education in the field of computer science and ICT at high schools and universities, we have created the StoryFactory tool, which enables students to script short movies in a 3D virtual world. In an engaging way, StoryFactory introduces challenges posed by scripting 3D virtual characters and screenwriting. The tool is supposed to be used in ICT and/or media education classes. Here, we present the tool along with first results from its evaluations.

1 Introduction

With rapid advancements in computer science and ICT, the task of teaching these subjects at high schools becomes increasingly challenging. Today's children grow in stimulating ICT-rich environments, surrounded by computers, cameras, social networks and so on, all of which did not exist a couple of years ago.

Because our department runs a summer school for high school ICT teachers annually, we have the opportunity to learn how teachers cope with this rapidly changing ICT world. Our experience is that while above-average teachers do their best to familiarize themselves with innovations, they can hardly become experts on everything: their knowledge is often fragmented. Students' knowledge of ICT is also fragmented (and, in addition, often superficial), but due to ubiquity of modern technologies, the students often understand some aspects of the ICT world better than the teachers. In general, this undermines students' confidence in teachers' ability to teach them something valuable, which is particularly troublesome concerning talented students, who may become frustrated and lost for further ICT and media studies.

Our working hypothesis is that to overcome this problem, it may help to teach students only some engaging ICT topics in detail (after covering compulsory basics). This would lessen the requirements on teachers' knowledge. In our opinion, virtual reality, virtual characters, films, and virtual storytelling are examples of such engaging topics. Still, teachers need some support.

As a part of a larger project, called Robotomie (www.robotomie.cz), we have developed a freely available tool called StoryFactory (www.storyfactory.cz). This tool—we believe—can attract attention of technology-interested high school students yet be simple enough to be easily usable by high school teachers. In a nutshell, StoryFactory enables users to develop silent machinimas in a large virtual town with modern architecture, employing several teenage characters and a creature (Fig. 1). The characters are equipped with animations for the real world interaction, including

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dating. The graphical content has intentionally strong social aspect that is meaningful to teenagers. This, we believe, can further increase the students' interest.

The educational objective is to familiarize students with basics of 3D animations, virtual characters, screenwriting, and film editing. The teaching methodology is as follows: StoryFactory should be used as a supplement after an expository lecture on these topics. The goal of the student is to produce a short (up to five minutes) silent machinima employing two or three main characters. The machinima should feature a simple narrative arc. Then, the machinima is to be exported to a movie clip and either dubbed or subtitled.

In fact, several tools for producing machinimas already exist (see, e.g., [4]). However, they are often not tailored for our target audience (this requires, for instance, very simple user interface) and/or for usage in computer labs at high schools (i.e., simple installation, executable on outdated hardware etc.).

Short stories can be also developed in Storytelling ALICE, which can be used, in addition to teaching basics of 3D animation and screenwriting, to teach basics of programming [3]. However, while ALICE's target audience is middle school students and the graphics is tailored to that audience, we target high school students. Even though the procedural model underlying StoryFactory may be considered to be a subset of ALICE's procedural model, the surface representation in StoryFactory—dating teenagers—makes our tool more suitable for our target audience. In other words, we claim that the content is very important (see also, e.g., [1] concerning this point).

Fig. 1. The content of StoryFactory in Unreal Engine 2

2 Technical Details

StoryFactory runs on a freely available version of Unreal Engine 2 (UE2) [2]. This engine is 7 years old, making it more likely that the applications will run on usually slightly outdated school hardware (we also have an Unreal Engine 3 (UDK) version). The virtual city is about 500 x 500 m large. Five virtual characters are equipped with about 50–200 motion captured animations each and their surface textures may be alternated (e.g., color of their t-shirts, etc.). We developed most of this content ourselves.

The user controls the movement and animations of characters using a bird's-eye view map of the city and timelines (Fig. 2). The user can also use two cameras.

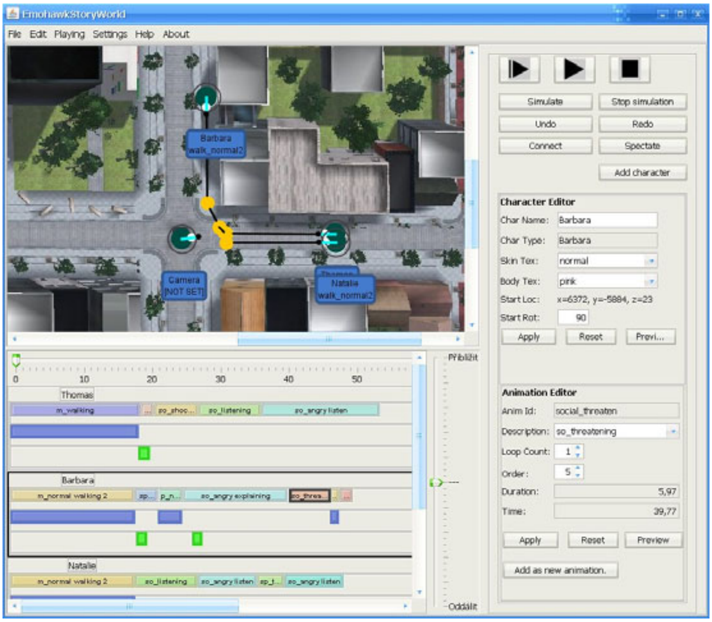

Fig. 2. The StoryFactory's graphical editor. Notice the bird's-eye view of the city in the upper left corner and the animation timeline for each character and camera below.

3 Evaluation

We have already made four small scale evaluations. First, we have informally evaluated graphical content with high school students during several lectures we had at high schools about 3D virtual characters during 2010. Results suggested that the graphical content was largely accepted by this usually very critical audience. Second, we conducted a more formal evaluation with high school teachers as part of our summer school in August 2010 (29 teachers participated). The results suggest that a) the background knowledge of Czech ICT teachers of 3D graphics and animations is minimal, but b) can be substantially improved in one 90 minutes long lecture and one 90 minutes long practical seminar with StoryFactory, and c) the acceptance of StoryFactory is positive (in several evaluative questions, the majority of teachers chose one of the two most positive scores on 5-point Likert scale). The third evaluation was conducted in November 2011 with high schools students (2 ICT classes, 24 participants altogether). The results indicate that a) the students are able to use StoryFactory effectively after a 90 minutes long tutorial, b) the acceptance of the tool by the target audience is positive, including the graphical content (one of the two most positive scores on 5-point Likert scale were chosen by the majority of students). Finally, in spring 2011, we ran a StoryFactory competition for small teams of high school students and teachers. The goal was to create the best short movie (up to three minutes) using StoryFactory running on Unreal Engine 2. The competition itself was successful with 20 short movies received (16 of them submitted for the competition). The feedback from both students and teachers was positive in general. Notable comments are that a) even UE2 does not run smoothly on some school/home computers, yet some students would prefer to work with the UDK version, which is even more hardware demanding, b) students complained that they are missing some animations, but missed animations were surprisingly few. We are currently scheduling a new round of the competition for autumn 2011.

4 Conclusion

We have presented StoryFactory, a tool in which students develop short movies in a 3D virtual world using virtual characters. The main audience of StoryFactory is high school students and the tool is supposed to support teaching basics of 3D animations, virtual characters, screenwriting, and film editing. On a more general level, the objective is to help teachers to elaborate on these topics in detail using the tool, possibly attracting students to further ICT/new media studies. In this regard, we do not claim that StoryFactory is a silver bullet: students should be involved in other engaging and meaningful ICT-based activities beyond developing machinimas.

Our tool differs from similar tools in that its content and the usage methodology are explicitly tailored to the high school audience. To our knowledge, a tool for that audience was lacking. The tool, including the graphical content, was positively accepted by both students and teachers, as demonstrated by our evaluations.

StoryFactory was also used in spring 2011 in a new media class for undergraduates, who developed machinimas similarly to high school students.

The tool is freely available in Czech language at www.storyfactory.cz, where the students' movies submitted for the spring competition are available too. The English version is available upon request.

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Structuring Narrative Interaction: What We Can Learn from *Heavy Rain*

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Abstract. Designing interactive narrative has been focused intensively on creating "smart" storytelling systems that react intelligently to players. Such systems, however, take a lot resource to develop and, as a result, rarely produce a full-scale narrative experience. This paper studies the structure of the interactive narrative game Heavy Rain and reveals some economic design strategies that address the problem.

Keywords: Heavy Rain, interactive narrative, narrative design.

1 Introduction

Despite their heavy focus on narrative intelligence, interactive stories developed through research projects generally create much shorter and less intense narrative experience than story-centered commercial games do. For example, playing *Façade* requires about 20 minutes and playing *Mirage* 10-15 minutes [1, 2]. With bigger investment, commercial games certainly can produce more narrative content with better representation; however, this does not mean that they have no design strategies to be shared with small-budget projects. *Heavy Rain* is a good example that employs strategies to simplify the computational process while maintaining the ostensible complexity. Developed by Quantic Dreams, *Heavy Rain* delivers a critically and commercially successful interactive story to its players with rich content and realistic graphics. The gameplay generates remarkably varied narrative outcomes with its surprisingly heavily prescribed narrative structure—a structure that many AI based interactive stories are trying to avoid. This paper investigates how narrative interaction is structured in *Heavy Rain*. By studying the narrative design of the game, the analysis aims to bring some insights on the practicality of design strategies taken in the development of an interactive story. In this paper, narrative interaction refers to player choices or actions that result in a change of the direction of the story progression and/or the ending of the story.

2 The Interactive Narrative Structure of Heavy Rain

The plot of *Heavy Rain* revolves around finding the Origami Killer who has committed a series of murders of young boys. The game takes a third-person point of view and grants players the sequential control of four characters, one at a time: the

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victim's father Ethan Mars, the journalist Madison Paige, the FBI profiler Norman Jayden and the private investigator Scott Shelby.

Many games and interactive narratives employ a two-tiered structure to accommodate narrative interaction at various levels of influence. Mateas and Stern made distinction between local and global agencies: the former being the moment-by-moment agency experienced at an intermediate level and the latter allowing the player to influence the overall story arc in longer term [1]. This distinction can be clearly seen in *Heavy Rain*. Resembling films, the game/story of *Heavy Rain* is presented in a series of scenes, or game chapters. A situation *within* a chapter can be considered as a local situation at an intermediate level of the narrative structure. Similarly, a situation *between* chapters can be considered as a global situation.

2.1 Local Situation

At the local level, *Heavy Rain* maintains a complex interaction structure. In total, there are three types of chapters in the game, which forms three levels of player influence on the plot. In the first group, players cannot vary the story unfolding at all; they can only follow the prompts and move the scene forward, or watch the cut-scenes. In the second group, players can choose from several options so that the story unfolds differently, but there is only one ending situation of this type of chapter, meaning player choices and actions have no global influence on the overall story. In the third group, things are the same as the second group, except that player choices can lead to the change of one or more global states, which will be factored into the unfolding of future chapters. In the game segment illustrated in **Fig. 1**, for example, Madison's chapter is the second type whereas the other two are the third type.

Obviously the third group is of most interest where players directly affect the global situation. **Fig. 2** shows the flow of a chapter of the third type—"Mad Jack", where the playable character, Norman, can die at three different times and venues in this intense fighting scene. If he dies, his state will be changed in the game system and as a result, any future chapters or sequences with him will be removed. At the end of the chapter, his state can be either killed or alive. There are five ending situations as shown in **Fig. 2**. Interestingly, while the character state serves as a global variable whose value will determine the future story trajectory, the local outcome of each chapter does not really matter at the global level.

2.2 Global Situation

If the local branching structure helps provide a local agency that most interactive narratives can produce, the global agency offered by the game is more impressive yet with minimal logical complexity. Unlike in the local situation, the story at the global level does not branch out. Narrative varies based on character states and conditions stored in a set of global variables. In addition to the changes of story trajectory, these states and conditions will also have an impact, direct or indirect, on the final ending. For example, if Ethan succeeds in all five trials, he will get the address where Shaun is trapped. Otherwise, he will get an incomplete address and have to guess the address before he drives to the location to save Shaun. This guess will be an added obstacle for him, which potentially can cause him to fail. Hence, in these trial sequences, actions of the player, as Ethan, have an indirect impact on the ending. As previously mentioned, main characters have the potential to die. If death occurs, subsequent chapters and sequences with the dead character will be automatically removed. This, too, causes the change of story trajectory as well as the final ending.

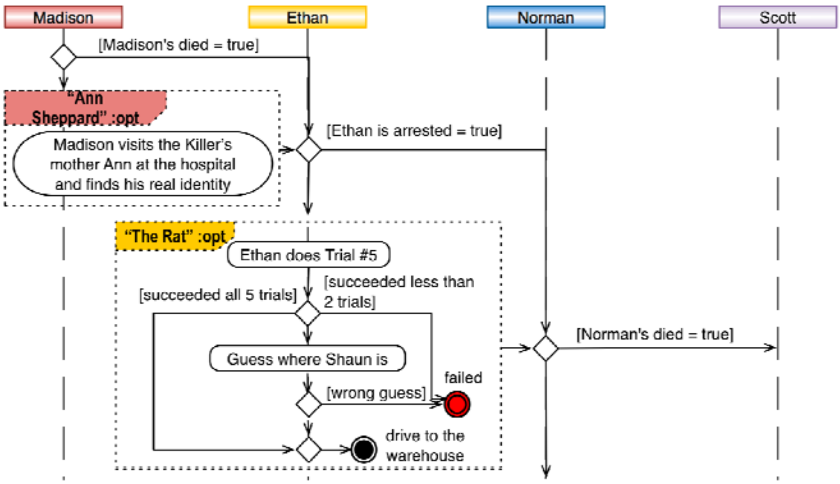

Fig. 1. A segment of *Heavy Rain*'s narrative flow

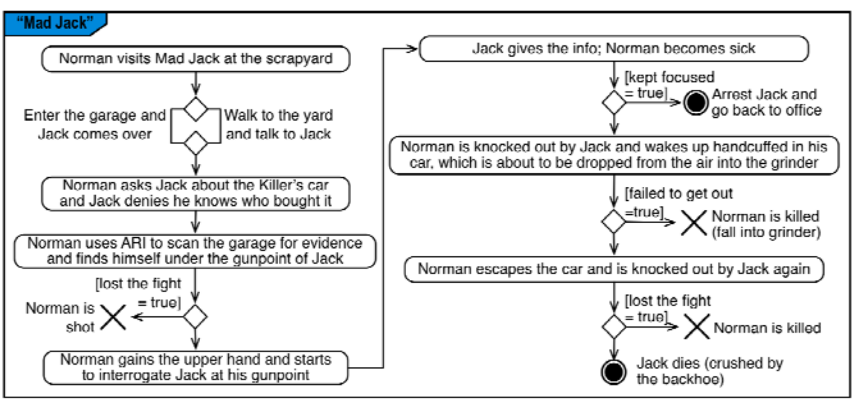

Fig. 2. The "Mad Jack" chapter with local branching and variable ending

Fig. 2 illustrates a segment of the narrative interaction flow. As we can see, some chapters, marked by ":opt"—meaning optional, are contingent upon the character states, which are carried via curvy arrow from previous chapters. Player choices and actions cause changes of these states, which in turn change the story. The following table summarizes the main character states that have global effect. Three types of effects of these states are: removing future relevant chapters, character not showing up in the last chapter, or bringing the state into the last chapter.

Table 1. Main character states in *Heavy Rain* that have global effect

Character state	Effect
Alive	Story goes with the “master plan”
Dead	Future relevant chapters and/or events are removed and the character will not show up in the old warehouse where Shaun is trapped (in the last chapter)
[Ethan only] Arrested	Future relevant chapters are removed and Ethan will not go to the warehouse
[Ethan only] Failed a trial	Missing letters in the address given to Ethan before the warehouse scene
[Ethan and Madison] Kissed	Alternative cut-scene epilogues will be shown after the last chapter
[Norman and Madison] Failed to obtain the clue	The character will not show up in the old warehouse
[Madison] Obtained the clue and called Ethan	Ethan will show up in the old warehouse
[Madison] Obtained the clue and called Norman	Norman will show up in the old warehouse

3 Design Lessons Learned

The structure of *Heavy Rain* manages to maintain a good balance: the story engages players and possesses a certain degree of variability for them to replay, but it also stays at a manageable size for designers to craft each branch to secure coherency. Three strategies are used to achieve this: 1) simple but ostensible branching; 2) multiple playable characters; 3) simple design of character states and their effect. Except for the last interactive chapter, all local branching is structured with a binary tree where at all levels only one of the two children nodes carries on the storyline and the other is simply the ending node of a chapter (see **Fig. 2**). In this way, the number of story nodes to program is reduced to minimum while still maintaining a tree.

Riedl et al. points out that while player agency of existing interactive stories is “typically very high at the action level,” at the plot level it has typically been “restricted to a single storyline or a small number of storyline branches” [3]. The design of *Heavy Rain* succeeds especially in global agency using a set of economic strategies. It fulfills what Ryan suggests about interactivity: “The ideal top-down design should disguise itself as an emergent story, giving users both confidence that their efforts will be rewarded by a coherent narrative and the feeling of acting of their own free will, rather than being the puppets of the designer” [4]. The narrative design of *Heavy Rain* is all about disguising its prescribed narrative structure and giving players the control that is just enough to feel critical to the narrative experience.

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Surround Vision – A Hand-Held Screen for Accessing Peripheral Content around a Main Screen

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Abstract. This paper describes a system that situates the viewer at the center of a surrounding video space. The system proposes that the main program on an ordinary television screen be augmented with content that is accessible through an orientation-aware hand-held viewing device.

Keywords: Television, User Experience, Virtual, Augmented, Narrative, Immersive TV.

1 Introduction

This paper discusses Surround Vision, a system that transforms the TV-watching experience into an immersive activity and allows the viewer to explore and construct a more complete picture of what is happening "off screen" or on the "other side" of the screen. The main interface to this system is a handheld device that gives the viewer a way to access this extra content so that he/she may choose the point of view with relation to the content on the main screen and the viewer's position relative to the screen. When the TV experience is split this way into two spheres of usability (shared and personal), the field of TV entertainment suddenly derives new potential for interactivity and social/shared construction of a story. The long-term vision for the proposed system is that it will not only change the viewer experience, but will also increase the story creation opportunity and encourage directors (or storytellers) to invent new methods and conventions, possibly constructing their stories using parallel synchronous actions with the intention of engaging the viewer in an active exploration to discover the whole story.

2 Developing the System

For an initial deployment we chose an Apple iPad since it has the array of sensors we needed and additionally, the size, weight and screen size of the iPad are well-suited to our purpose. Other mobile devices now on the market are similarly suitable for this application and we expect that a commercially-deployed version of the system would work with numerous platforms.

The iPad was a good hardware choice, but not the best choice when it came to software. In order to work, the Surround Vision system needs two main things. First, more than one video must be shown in the screen and second, the videos must be

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located inside a virtual 3D space so that the user can interpret the moving of the screen as a way of exploring this 3D world. To handle the graphic part we use HTML5 for its video tag and took advantage of its 3D transform capabilities to create the perspective views that guide the user. We then used an Objective C code to handle the sensor data. Finally, to get around the iPad's inability to play multiple videos in one screen we use VLC to read a video file from a server and export MJPGs to the browser in the iPad. The result is multiple streams of videos shown simultaneously in one screen with accurate control through the sensors in the hardware.

3 Content

For content we used initially a custom video that served to prove the concept of the project. We then acquired professionally made footage from different sources.

Fig. 2. The Quiz Show footage as seen on the iPad when looking at the left and right of the screen

WGBH Quiz Show. WGBH's "High School Quiz Show", is a game-show taped in front of a live audience in which two teams compete against each other in answering general knowledge questions.

The program is shot with four cameras, three that were each dedicated to the host and the teams and a fourth that would giving general views of the set as well as of the audience. When using Surround Vision, the viewer is able to see on the main screen the final show as it normally airs, while the handheld device allows exploring between the cameras showing the teams (one on each side of the TV) and the general panning camera in the center (Fig. 2). This way the users could follow the show as they would at home while complementing it with the new camera angles that were offered.

Fox Sports NASCAR. Another example of professional footage that we were able to use was a NASCAR race given to us by FOX Sports. We received an assortment of camera footage from various angles. One of the cameras followed the race going from the first car to the last and showing the action; we used this footage on the main TV. The others focused more on specific groups of cars, for example the two leaders and the cars in third and fourth place, etc. Thus the viewer can follow a particular car throughout the race, or just pan through the views of all cars and see details that would have been impossible to catch before.

4 User Studies

The user studies conducted for this project were set up in a space at the Media Lab, arranged to look and feel similar to a living room in which the subjects would be able to feel comfortable while trying out the system (Fig. 4). The subjects would get a briefing about how the system works and operates. Then they were left to enjoy the programming and use the system. Four different types of programs where shown: a sports event, two action movies and a show taped in front of a live audience (Quiz Show). The users were allowed to change back and forth through any of the shows as they preferred in order to explore the possibilities of Surround Vision.

Fig. 4. Shots of the user testing environment

5 Influence on the Narrative and Other Uses

5.1 Parallel Narratives

In many ways a story can be separated into parallel narratives. Every character can display a different take on a given story. With Surround Vision these different versions can be accessed independently from the main narrative and from the other viewers. In a similar way, when one of the characters walks off the screen, some of the viewers might focus on the main screen while others focus on the SV screen to follow the character that walked off. This way the viewers will hold different clues to the overall narrative that can come out through discussion transforming the viewer experience into a social experiment.

5.2 Viewing Metaphors

An interesting use of the SV screen is when it takes on a different metaphor than simply spatial exploration. The hand held device can act as binoculars or the microscope through which a character is looking at something. A group of friends who are watching a crime show can each have a device enabled with Surround Vision. When the detectives on the main screen enter the room where a crime was committed, each of the SV screens can reveal different clues. One device can be used as night vision goggles, another will show finger prints, yet another might reveal blood splatter, and so on. Here each of the participants will have knowledge of a specific clue. When the show cuts to commercials, the participants may then discuss what they witnessed and try to piece together the crime.

6 Conclusion

We have discussed the Surround Vision project and its possibilities. It enables the viewers to explore the spaces around a main screen in order to find additional content that can expand on the experience of watching the program. Technologically, this project is easily attainable. That is why the most important and interesting aspect is to study the effects that a new interface like this will have on the overall viewer experience and on the story creation process.

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The Reading Glove: A Non-linear Adaptive Tangible Narrative

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Abstract. In this paper we describe The Reading Glove: a non-linear adaptive tangible narrative system in which interactors piece together a narrative puzzle by interacting with a collection of physical artifacts. The Reading Glove uses an adaptive system to assist the reader in making sense of the complicated web of narrative information.

Keywords: Interactive Narrative, Tangible User Interfaces, Wearable Interaction, Adaptive Systems.

1 Introduction

The Reading Glove system consists of a wearable glove-based interface and tabletop display surface that provides an interactive narrative experience grounded in a set of physical objects. Interactors pick up RFID-tagged objects to activate audio story fragments associated with that particular object. The tabletop displays recommendations on which objects to select next using a knowledge-based reasoning engine to guide the interactor through the non-linear narrative. As a research project, the Reading Glove explores how interactors experience the adaptive components of the system, as well as their understanding of the narrative and the impact of the tangible and wearable interaction.

Fig. 1. The Reading Glove System

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2 The Reading Glove System

The current Reading Glove system is version 2.0 of an earlier iteration of the project. The first version, discussed in [1-3], consisted of a glove-based reader and a set of tagged objects used to access a non-linear story. The current version adds an intelligent recommender system and tabletop-display to assist interactors in navigating the narrative[4]. Analysis of this system is currently ongoing.

2.1 The Glove and Objects

The central component of the system is the Reading Glove itself, a soft fabric glove containing an Arduino Lilypad microcontroller, an Innovations ID-12 RFID reader, and an Xbee Series 2 wireless radio. Interactors pick up objects associated with the story, each of which has been tagged with an RFID chip. When the RFID reader in the palm of the glove detects a tag, the tag ID is communicated wirelessly via the Xbee radio to a second Xbee unit connected to the serial port of a laptop. The serial data is read into a java program in Eclipse which processes the tag activation and triggers the audio playback of a specific "lexia": a pre-recorded story fragment associated with the object.

Fig. 2. The glove components

2.2 The Table and Recommender

In addition to generating audio feedback, picking up an object also triggers the reasoning engine to generate a set of recommendations that will be shown to the interactor when the audio clip nears its completion. The reasoning engine is a rule-based expert system written in the JESS language. The reasoning component relies on an OWL (Web Ontology Language) ontology that encodes semantic knowledge about the story content, such as thematic connections between lexia and rankings related to the chronological order or the overall importance of specific lexia. The JESS rules use this knowledge base to recommend a set of three objects that will be most likely to advance the interactor's understanding of the story.

Fig. 3. The tabletop screen in neutral (left) and recommendation (right) states

Thus the recommender system acts as a kind of "expert storyteller", leading the reader through the narrative. There are two versions of the recommender that can be activated. The first version is a story-content based recommender that relies on knowledge of the story and the current lexia being listened to. The second version augments the story content with a user model, adding sensitivity to the individual reader's history and patterns of interacting with the system. The recommendations appear on the table several seconds before the end of the lexia. This delay is intended to focus attention on the story and objects rather than the display. During most of the lexia playback, all ten objects are visible on the screen in small, semi-transparent boxes. When the recommendation system kicks in, the pictures of the recommended objects grow in size and become fully opaque.

2.3 The Reading Experience

Interaction with the Reading Glove system is straightforward. The "reader" puts on the glove and begins picking up the objects sitting on the table. When the palm of the glove comes in contact with the tag on the object, a segment of recorded audio narration is played back over the speakers. Several seconds before the clip ends, the tabletop display delivers a set of recommendations on which object to pick up next by enlarging and brightening photos of the objects. The reader can choose to follow the

Fig. 4. Individual and small group interaction

on screen advice or not. Each object has two clips of audio narration associated with it, so the reader must engage with each object multiple times to uncover all the story fragments. The story embedded in the Reading Glove system was developed based on the objects, which were picked to fit a certain historical aesthetic. Other aspects of this aesthetic are echoed in the background image of the tabletop display and in the table itself. The plot of the story revolves around a British spy operating in French-occupied Algiers around the turn of the 20^{th} century. The narrative traces the spy's discovery that his cover has been blown and his unraveling of how this came about. The uncovering of facts in the narrative mimics the uncovering of story fragments that the readers perform with the objects. Thus the puzzle-like nature of the story and the interaction support and reinforce each other. The story can also be experienced in a small group, with one person wearing the glove and the others assisting in untangling the narrative and selecting the next objects to engage with. Further details on the task of authoring the narrative to support this experience can be found in [2].

3 Closing Thoughts

The Reading Glove provides interactors with a uniquely embodied experience of an interactive narrative. By connecting the body of the interactor to the world of the fiction through a collection of tactile objects, the Reading Glove provides opportunities for the reader to imagine herself into the fictional world. The system also represents a first exploration of a new design space for IDS research.

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Values Impacting the Design of an Adaptive Educational Storybook

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Abstract. We present an adaptive educational narrative that combines an interactive storybook with drama management. By understanding our underlying value system, we are able to create an adaptive narrative that provides features adequate for the target context. Our value system and design needs invite a reexamination and reapplication of interactive storytelling systems, and results in an adaptive narrative framework that is both feasible and extensible to a wide range of experiences.

Keywords: Interactive narrative, drama management, design values, early childhood education, design process.

1 Introduction

Storytelling, especially in early childhood, combines learning techniques with fantasy play and artistic expression. In emergent literacy, when children are just learning to read for the first time, parents are the first educators, guiding their children through shared reading behaviors to introduce them to story, art, and print [3]. Parents are observant guides, providing responsive and intelligent encouragement and demonstration in the learning process for their children. We have designed and implemented storytelling software to assist in this learning process, as an assistant that unobtrusively prompts the readers to engage in storytelling practice [1]. The criticality of learning at this young age however, compels us to examine our presentation of material to children [4]—in our case, this is manifest in the nature and choice of interactive narrative framework.

In this paper, we lay out a vision for a learning tool and our values (informed by principles in early childhood education) that guide our design choices.

2 Vision

We envision interactive storybooks that grow as their authors continue to expand their materials (cloud storytelling) at the same time that they learn from their usage patterns to improve their performance for individuals (adaptive storytelling). Our vision is inspired from fiction, especially the illustrated primer from Stephenson's *The Diamond Age* [5], yet it builds upon prior work.

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Fig. 1. Parent-child discussions prompted by TinkRBook

Cloud TinkRBook is a project building upon TinkRBook [2] and Dramamatic, an interactive narrative engine we are building for use in Cloud TinkRBook and other projects. A TinkRBook is an interactive storybook that allows users to explore how text changes in response to user interactions with story elements within a story context. The system is designed to promote parent-child discussion, as in Figure 1.

We envision a system that draws its resources from the cloud (that is, its authors, who may be many, continually expand its body of story resources) with the intention that it has an ever growing body of resource from which to tell stories. As such, it will need an intelligent system to help each person find the story that is relevant to them. As this intelligence is fundamentally an interactive narrative system, Cloud TinkRBook is an adaptive educational narrative that combines an interactive storybook with drama management.

3 Values

By explicitly articulating the *values* for our design, we constrain the problem of designing an adaptive educational narrative[1]. Obviously, designing explicitly for children requires awareness of the cognitive abilities of young and beginning readers. Other considerations arise from empathizing with the other stakeholders in developing the experience, such as parents and story creators. Parents are usually the mediators for the book, and we are interested in providing some benefit to them for reading an adaptive narrative to their child. Story creators, who may be educators, artists, or authors, need to have a way to express their ideas to accomplish their educational and experiential goals.

We use the aesthetic values summarized in Table 1 to guide our design of an interactive storytelling system (outlined in the same table).

4 Discussion

Our design criteria, including our vision for Cloud TinkRBook and our values, present interesting challenges for interactive narrative systems and their

[1] Our decision to articulate values stems from a movement in the Interaction Design and Children (IDC) community to make values underlying design explicit [6].

Table 1. Impact of values on design choices

Value	**Design Choice**
Leveraging existing ritual	– use of explicit page turning buttons – use of tablet form to promote physical proximity – semantic highlighting in response to strumming of words
Developmental Appropriateness	– avoiding text in menus and complex HCI interaction paradigms (e.g. checkboxes, sliders, double-click) – concise and simple text – choice (decision points) are explicitly offered through narrative text layout or interactive graphic elements – multisensory interaction: every touch on an active story element responds with sound or animation – modular scene-based story structure – small world containing educational objective within each scene – immediately observable (short) causal links in the narrative
Addressing the Dual Audience	– providing demonstrable swapping of words to demonstrate narrative flexibility – customization of narrative and story presentation over repeat readings

interfaces. In particular, we needed our educational concepts to prevail over interactive narrative structure, and existing systems did not fit our value system. In our review of systems, which we do not present in this paper, we found our work has a few notable differences from other systems.

Interactive storybooks may treat time as an explicit decision. How do we represent time? What does "going back" mean? In TinkRBook, when the user goes back a page, they are not going back in time as they would with a paper storybook. The state of the world and character remains consistently in the now, with the pages providing spatial distance between scenes. Choices made in a frame are generally reversible, meaning that the user can usually change a decision by revisiting the appropriate scene, and the implications of the change will propagate to other frames. For example, a child can revisit a frame where he or she can change a character's color, altering the character's presentation in all other frames.

Causal chains do not have to be long. In many interactive narrative systems, having large causal chains or complex puzzles can be enjoyable. Because we have chosen to use modular self-contained scenes, the overall narrative experience can distract from reading a story. Creating cohesion among different story scenes is an interesting challenge. Our answer so far is to use small chains of causality, such as making most choices immediately demonstrable within a scene and at most looping over only two frames. In the Babdyduck story for TinkRBook, instead of letting the protagonist advance to a bed time scene while covered in mud, the protagonist is sent back to a scene with a pond and a mud puddle to bathe.

The narrative experience can adapt to the user's development. We intend to keep beginnings and endings consistent and mostly change the content in the middle. Having different educational lessons sandwiched within a story framework can be enjoyable and useful for pedagogical purposes, as children learn to care for a reoccurring character and become familiar with the story world. However, too much variation between each scene can be narratively distracting.

An interactive storybook that creates a cohesive storytelling experience for a dual audience will need to adapt the narrative over a history of readings, and seek ways to foster fresh dialogue between people of different abilities. This brings up interesting idea of long term interaction with interactive narratives. How can the narrative experience adapt to the user's development?

The state of the story changes over successive readings. We have to explicitly decide which aspects of the world are persistent from the last time it was read. Our system must judge how many times users have to read a particular sequence before changing the narrative structure. For example, we can save the color choice for a protagonist and have it persistent each time the story is read. Over time the color selection scene may disappear if children don't use that scene.

5 Summary

In this paper, we presented an articulated need for adaptive narratives in the domain of educational storytelling. From there, we showed our vision for an interactive educational storybook along with a value-based approach to designing an interactive storytelling system that could realize our vision. In this process, we questioned basic assumptions, like how time should flow in a storybook.

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Voodoo: A System That Allows Children to Create Animated Stories with Action Figures as Interface

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Abstract. Dolls, employed as tangible interfaces, have the potential to provide an easy to learn interaction device that allows children to animate virtual characters in an intuitive way. We assume that dolls and action figures are more compelling, easy to use, and immersive for children than standard interfaces to create movies. We present Voodoo, a prototype of a system where children take over the role of a movie director, animating virtual characters with action figures. Voodoo translates the action figures movements into animations, based on movement patterns and on the narrative context of a well-known story. We maintain that our approach will easily and joyfully empower children to create animated stories.

Keywords: Virtual Characters, Tangible Interfaces, Affective Interfaces, Toy, Children, Action Figures, Dolls, Computer Animation, Storytelling.

1 Introduction

The doll is a companion to the child during many years and regardless of gender. Playing with dolls provides children with the opportunity to build imaginary worlds that express their thoughts, feelings and fantasies. While playing, children create stories that are related to their experiences and to other stories. The fact that it is fundamental for children to tell stories with dolls is the motivation to our work: What if it were possible to empower children not only to invent stories with dolls, but also to use the dolls to create a movie, that they can watch over and over again, and show to peers and parents? If playing with dolls would result in animations of virtual characters (VCs), inserted into a story context? *Voodoo* is the system that is currently under development, and that shall enable this.

Two major open issues that our prototype shall help clarifying are "disambiguation" and "learning balance". The first major open issue, *disambiguation*, refers to the necessity of disambiguating underspecified input: Assuming that the animation system is capable of producing a vast amount of different, fine grained animations that much outnumbers the possible movements that a child can be sensibly expected to make: How can then the doll be nevertheless employed to create, in a controlled manner, these animations? E.g. a system may have the capacity to animate

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a Little Red Riding Hood (LRRH) VC that is suspiciously talking to the Wolf. With plastic action figures, it is impossible to deduce from the movement of the LRRH figure alone that LRRH is “talking”, or even that this talking is “suspicious”. Understanding how to best disambiguate input is currently the main focus of our work.

The second major issue refers to the *learning balance* between system and user. This is the question as to who is expected to adapt more in order to enable a fluid interaction – the user or the system? Doll based systems need not necessarily have a very powerful, adaptive system for recognizing the doll’s movements. If the child knows that the system will take into account contextual information about the narrative role of the animated character, then he/she can adapt the doll movements to the expected interpretation, thus easing the recognition and interpretation task.

Further research questions relate to: The inclusion of possibly complex actuators into the doll (cf. [1] and [4]), in order to reduce the boundary between virtual and digital; Further unfolding usage metaphors, in order to promote the usability of the system; Enhanced computer vision or sensor networks, in order to improve the recognition of doll movements; The integration of research on Computer Graphics for animating of VCs, in particular the question of appropriate control parameters.

2 Related Work

Other groups have already employed dolls for the manipulation of VCs [5], also having in mind children as users ([1], [3] and [4]). Within this paradigm, children manipulate some kind of doll, and the computer system detects the movements and alters a VC´s state, resulting in some animation. Our system presents a new approach for the input disambiguation, and contextualizes this kind of user interface in the field of animated stories creations. In order to cope with the ambiguity and underspecification, we allow our system to recur to additional context information. This includes (i) the story role that the doll embodies, the (ii) relationship between the story persons, and (iii) the reference to a scene, either of a well-known story, or of an implied, typical context.

3 Integrating Story Context into Input Interpretation

The doll metaphor is even more powerful in the particular case of action figures, because these are based upon characters of a film or comic book, and therefore have a role context associated to them. This can be an excellent aid for the system to decide about which action the VC shall perform, based on the figures’ movements, because the story context constraints the interpretation of the movements that the child makes. For example, choosing and playing with the action figure of Bauer from the TV series 24 will result in a specific animation appropriate for this character. If a child enacts a scene where the character Bauer has to open a door in a combat situation, probably Bauer will not rotate the doorknob, but kick it open.

The interpretation of the movements of a particular action figure will be influenced by the associated story as well [6], including information about the personal relationships between the characters. For example, in the story of Hulk, much information can be extracted from the character Bruce Banner and his relationship with other characters and with the story environment: when angry, Bruce Banner is transformed into a wild and powerful creature, and this transformation is more likely to happen when General Ross is nearby: Bruce Banner will show an affectionate behavior when he is close to Betty Ross, but the transformation into Hulk can again occur when he is enclosed in a prison. Thus, the interpretation of the movements of the action figure can take a schemes of a story into consideration.

In order to provide this context to the child, we employ a DIN A4 paper map where the action figures can be placed upon (**Fig. 1**). The map contains areas with drawings that evoke a story context. Depending on the area of the map where the figure is above, the movements will be interpreted in a different way.

Fig. 1. System scheme and Screenshot of a *Voodoo*-made animation

We are developing a prototype that implements this idea of animating according to context: *Voodoo* (**Fig. 1**). Our current test case is inspired by the well-known story LRRH[1]. It targets at a single child tentatively of age six to ten, who can play with up to two figures at the same time, one in each hand. *Voodoo* relies on a computer vision module to determine in real time the environment that surrounds the action figures, the spatial relationships between them, as well as the kind of movements the child is making with them. The recognition is based on a color blob tracking of the actions figures and on the detection of markers printed on a paper map. These markers allow detecting the areas of the map; the areas correspond to story contexts, e.g. the house of the grandmother. The placement of the figures above some area of the map is determined through their color blob points. The movements of the doll generate in real-time specific animations of VCs on the screen. To recognize movements of the figures, we employ a simple movement recognition dichotomy: a gesture is either

[1] Prior to the implementation, in a first round of participatory design, an informal Wizard of Oz study with two eight years old participants of both sexes was conducted, with the result that the kids had no usability problems. We also learned that a rigid laptop webcam would not be appropriate if the animation were to be watched at on the laptop's screen, since the camera needs an inclination of approximately 45 Degrees to the paper map.

vertical or horizontal; additionally, the speed of the gestures is calculated. Thus, all of the animation details are determined by the aforementioned story contexts: (i) the action figure that was chosen, (ii) the area of the map above which the figure is placed, and (iii) the typical narrative relationship between the figures that are in this same area.

4 Conclusion and Future Work

We believe that tools that facilitate the interactive creation of linear stories, in particular for children, have an enormous entertainment and pedagogical potential. A major question regarding such tools is how to deduce complex animations and stories from simple input of intuitive input devices. We presented an approach where we integrate the contextual constraints of a story to enable a child to create animated movies with action figures as input devices. With *Voodoo*, it shall become easy for a child to reinvent a well-known story and eventually to create new stories. The stories that the child makes result in a computer animated movie. We do not know yet if it is mandatory to enable the child to somehow post-edit the animation. Later, even user emotions could be taken into consideration in order to choose the appropriate animation, as well as some automatic interpretation of what the child is saying. The collaborative use of the system is easily possible; for this, the size of the paper map must be increased, and larger displays would be required.

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Arithmetic Methods in Personality Modeling

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Abstract. This workshop demonstrated how to use arithmetic methods in personality models for characters in interactive storytelling. We began with the selection of personality attributes and the relationships between first person, second person, and third person attributes. The mathematics of "bounded numbers" was explained. We then worked on modeling and behavior problems suggested by participants.

Keywords: Interactive storytelling, personality models, arithmetic methods.

1 Workshop Objectives

Personality modeling is a fundamental component of interactive storytelling; it provides the basis under which characters in the storyworld respond to events. Quite a few personality models have been developed,[1] most of which are designed to address the personalities of real people [1]. For purposes of interactive storytelling, such personality models yield behavior that is insufficiently dramatic. Participants in this workshop learned how to develop personality models using numeric attributes for characters. In particular, they learned how to establish properly orthogonal attributes that span the vector space of dramatic behavior. Orthogonality [2] is important because a personality model with overlapping personality attributes is difficult to use: the user must choose between competing closely-related attributes in calculating behavior. Spanning the vector space of dramatic behavior is important to insure that all appropriate behaviors can be mathematically addressed.

Participants also learned how to extend first-person attributes into second-person and third-person versions[2] [3], and to understand the advantages and disadvantages of doing so. A first-person attribute is an intrinsic personality attribute, such as integrity. The associated second-person attribute is another person's assessment of the first person's integrity –in other words, how much the second person trusts the first person. The third person attribute is the perception a third party has of the second party's perception of the first party's integrity. While this may seem overly indirect there are a few cases in which third-person attributes have utility in influencing behavior. Participants also learned how to create simple formulas for calculating changes in

[1] For a full discussion of personality trait theory, see Matthews et al. *Personality Traits*. Cambridge University Press (2003).
[2] A description of multi-dimensional traits can be found in Crawford, C: Chris Crawford on Interactive Storytelling, pp 186-188. New Riders, Berkeley, 2005.

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second-person attributes as a result of observed behavior, and how to make behavioral decisions for characters based on their personality attributes.

Finally, participants learned how to use bounded numbers in personality models. Bounded numbers are a special mathematical system that is easier to use and less error-prone than conventional numbers.

2 Workshop Description

The first hour covered basic personality modeling issues and each participant designed a personality model to address an interactive storytelling topic of their own choice. Participants then compared and discussed the different personality models they created.

The second hour addressed second-person and third-person attributes and the circumstances under which they are useful. Participants decided how to extend their first-person attributes, then an explanation of how to write formulas to alter second-person personality attributes in response to observed behaviors was presented, which participants then implemented

The third hour turned to the problem of calculating behavioral choices. The concepts of roles and options were presented, and participants were shown how personality attributes permit definition of roles as well as calculation of option inclinations. Participants then wrote a set of formulas for determining roles and selecting options.

The fourth hour was devoted to the concept of bounded numbers. Personality traits and relationships pose computational difficulties because they behave in some cases like boolean variables ("Darth Vader is evil, Princess Leia is good.") and like continuous arithmetic variables ("Princess Leia is more good than Luke Skywalker who is more good than Han Solo who is more good than Darth Vader."). Treating a personality trait such as "goodness" with boolean variables cannot tell the difference between Princess Leia and Han Solo, while treating the same trait as an arithmetic variable runs into normalization problems: Is Princess Leia ten times more good than Han Solo? A million times? The solution to this problem is an arithmetic system called "bounded numbers", not heretofore documented in the literature. Bounded numbers define a personality trait in terms of normal and extreme values. Participants defined bounded number systems for their personality models and revised their formulae to take advantage of the useful properties of bounded numbers.

The fifth hour was dedicated to the use of blending functions to take best advantage of bounded numbers. Blending functions are unique to bounded number systems and greatly simplify many calculations. The participants revised their formula to utilize blending functions.

The remainder of the workshop was devoted to a group discussion of the entire system.

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Towards a Unified Theory for Interactive Digital Storytelling – Classifying Artifacts: A Workshop at ICIDS 2011

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Abstract. An important step towards a theoretical understanding of interactive digital narrative is a classification system for existing artifacts. Many artifacts in Interactive Digital Storytelling provide a challenge to taxonomies derived from literature or film. The lack of a thorough classification system is also a serious hindrance to theoretical work, as it precludes a mapping of the overall field and a comparison of artifacts along categories shared by many researchers. In order to minimize confusion and misunderstandings in the academic discussion within the field and with outside disciplines, the workshop explored ways towards a shared taxonomy for Interactive Digital Storytelling.

Keywords: Interactive Digital Storytelling Theory and Practice, Classification System, Taxonomy, Artifacts, Digital Media.

1 Overview

Interactive Digital Narrative is not only a form of artistic expression that has produced many diverse artifacts, but it also shares significant features with other genres. While some IDN works belong to specific traditions like Hyperfiction (HF), Interactive Fiction (IF), or Interactive Drama (ID), many other artifacts cannot be located so easily. Is Cadre's Photopia [1] an IF work, or rather HF told by means of an IF engine? Can we count Bookchin's Intruder [2] as an IDN and if so what group can it be associated with? What about Textrain [3], news games [4], mixed-media locative games [5] or blockbuster games such as Half-Life [6], or LA Noir [7]?

This workshop aimed at moving towards a unified theory for IDN. As part of an ongoing investigation, we emphasized a tight coupling between theory and practice. Possible taxonomies such as Ryan' s classification [8] or the SNAPS group proposal

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[9] were put to test, pointing out strengths and weaknesses and proposing concrete ideas on how to improve early attempts at a descriptive framework for IDN.

The workshop was a follow-up to two prior workshops at ICIDS 2009 and ICIDS 2010. The first workshop presented different theoretical perspectives on interactive digital storytelling based in semiotics, meta-narrative, game studies and an independent theory of digitally mediated interactive narrative. The second workshop explored the potential of advances toward a shared vocabulary as well as existing obstacles. The recent workshop continued the project towards a unified theory for IDN along the same trajectory, this time with a particular focus on the classification of artifacts using proposed taxonomies and subsequent evaluation of the taxonomies.

2 Workshop Format

The workshop was a full-day workshop in order to allow ample time for discussion of these complex topics in terms of theory as well as practice.

The workshop started before the conference with the organizers sending out classification schemas, and a list of artifacts so that participants could familiarize themselves with the subject. Participants were asked to compile a list of issues and also suggest additional artifacts for review. The workshop started with an introduction of issues in IDN classification and existing schemas, followed by an initial round of "early thoughts" by the participants.

The next step of the workshop was to look at a body of artifacts and discuss their properties and consequent location within a particular classification system. Additionally we discussed issues of suitability of a specific taxonomy. After the lunch break, the workshop was split-up in groups led by the organizers and we discussed possible avenues for establishing a shared taxonomy. This session revisited the examples presented earlier and attempt to find common ground amongst the different approaches or argue for a new taxonomy. All participants gathered again after a coffee break and the results of the groups' discussions were presented to all. Next, a panel of invited experts reacted to the results and presented their take on the problem. Finally the organizers wrap-up the workshop.

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The User Experience of Interactive Digital Storytelling: Theory and Measurement

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Abstract. This workshop has been dedicated to discussing the user experience of Interactive Digital Stories (IDS) and the empirical measurement of it. Although technology development has made substantial progress, theory and empirical studies on the user perspective have not received much attention in the community so far. The workshop has introduced a measurement toolkit for testing user experiences of IDS software, gives hand-on insight and stimulates discussion on conceptual as well as methodological issues in user-focused research on IDS.

Keywords: Interactive storytelling, user experience, methods, measurement.

1 Workshop Background and Objectives

While technology development in IS has made substantial progress, the audience perspective has received less attention in the IDS community. System creators certainly have implicit or explicit assumptions about how users will experience their interactive story; however, not much theoretical or empirical knowledge has been developed in this regard [1]. This workshop was intended to stimulate a focused discussion on the user perspective and proposed user experience dimensions derived from theoretical foundations of entertainment media research and expert interviews.

We introduced a standardized measurement toolkit to provide an easy-to-handle application for system creators that allowed conducting rapid user studies with new prototypes and comparing a system's performance with data obtained from other systems [2] and [3]. The toolkit comes as a set of self-report measures to be applied immediately after users finish exposure to an Interactive Digital Story. It includes scales on various dimensions of the user experience, including fundamental issues such as perceived usability and character believability, affective-motivational processes such as efficacy, suspense and curiosity, and evaluative dimensions such as user satisfaction and enjoyment. Moreover, flexible components are included that can be customized for specific study purposes. The toolkit is available as a software application that enables mostly automatized data collection and analysis.

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Benchmarking data were obtained with different IS systems (e.g. Façade [4], EmoEmma [5]) and narrative rich commercial video games and allow comparing results from new studies with data obtained from published reference systems.

The workshop served to make interested IS researchers familiar with the measurement toolkit, to demonstrate its application in prototyping studies and to illustrate how findings from testing one's own IS prototype can be compared to data from reference systems. In addition, methodological issues related to the user experience were discussed with participants. Key questions were:

- Which cognitive, affective, and motivational processes need to be addressed in empirical studies on IS system users? Does the current IRIS measurement toolkit cover all relevant facets?
- In addition to self-report measures, which other methods of user research are promising for future studies in IS?
- How can data from user tracking – such as user decisions' on story progress or users' individual style of handling the system's interface – be exploited for understanding the enjoyment of IS?

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"Making Interactive Stories Meaningful" Workshop on Story and Character Development through Theatre Games

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Abstract. The aim of this half-day participatory workshop was to explore new tools for interactive story generation through the playing of theatre games. The expected outcome of this session was the creation of an interactive role-playing game that could be presented at a conference luncheon or final wrap-up. The theme and characters of the gameplay were determined by the participants at the workshop and dealt with a current social or political issue, enabling conference attendees to contribute alternative solutions for a serious global issue. The take-away for game developers was a new tool to tap into theatre's innate ability to represent real life conflicts, allowing participants to construct and animate scenarios to test out different solutions from within.

Keywords: Theatre Games, Performance, Improvisation, Social Issues.

1 Introduction

In this half-day workshop, participants explored new tools for interactive story generation by playing of theatre games with the eventual outcome being an interactive role-playing game that would be presented at a conference luncheon or final wrap-up. The theme and characters of the gameplay were determined by the participants at the workshop but dealt with a current social or political issue, enabling conference attendees to contribute alternative solutions for a serious global issue. The take-away for game developers was a new tool to tap into theatre's innate ability to represent real life conflicts, allowing participants to construct and animate scenarios to test out different solutions from within.

1.1 Inspiration for the Workshop

The primary inspiration for the workshop material comes from Augusto Boal, Brazilian theatre visionary and developer of Forum Theatre. "A dynamic place of interactivity. An environment where spectators becomes 'spect-actors.' A forum for direct action and social change." Although these are descriptions of Boal's potent political theatre, they might also apply to serious videogames where social impact is a component of the experience.

2 Description

In this lecture and participatory workshop, activist theatre art and game developer Lori Shyba set out the principles and facilitated basic exercises of Forum Theatre,

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thereby familiarizing serious video game designers with techniques that can liberate creative ideas for videogames and interactive media of all kinds. Recognized by UNESCO as a "tool for social change," Forum Theatre harnesses theatre's ability to represent real life conflicts through the art of interactive storytelling. In this presentation and hands-on workshop, participants firstly got a short theoretical overview of the philosophical and ethical principles of Forum Theatre, and then went to work constructing and animating scenarios that posed questions of social and environmental significance. In addition to games and techniques of Augusto Boal, this workshop utilized character analysis techniques of acting coach Uta Hagen, and principles and practices of improvisational theatre guru Keith Johnstone.

The Preliminary section included warm-up exercises and games to prepare for the physical work; setting out the principles of Forum Theatre and setting goals and objectives of the games; introduction of techniques that opened participants up to the political aesthetics of this form of game-making; monitoring contributions from participants about social and environmental issues of concern; and a vote on the issues that they wished to explore. In the Collaboration and Performance section, a series of movement and rhythm exercises led up to the construction and animation of scenarios that posed questions of social and environmental significance; a facilitated shaping of the physical, visual, aural and emotional texts; development of the interactive narrative, and qualitative discussion and rehearsal to wrap up the workshop and prepared for the conference performance.

At the gathering of conference attendees, the scenarios would be performed twice. The first time the audience saw the situation and the problems presented; the second time they became "spect-actors" where they may have stop the action and replaced a character they saw struggling with social conflict, taking the story in new directions. Ideally, all conference participants, whether in the performance workshop or not, discovered new ways to plan interactivity in games and, at the same time, embraced their potential to initiate social change.

3 Workshop Organizer, Lori Shyba

In no particular order, Lori Shyba has been a theatre impresario, videogame and web designer, video producer, magazine publisher, advertising art director, TV talent, digital art curator, sports car enthusiast, and cowgirl among other things. Her doctoral case study was the forum theatre event *Spies in the Oil Sands,* and its spin-off computer game *The Pipeline Pinball Energy Thrill Ride Game* which, as she puts it, "mixed live improvisational drama with screen-delivered intermedia and games, peppered with audience participation, and served on a bed of subversive humour." She currently works as an assistant professor of interactive media at Montana Tech of the University in Montana, is research director of "The Pod" Media Lab and co-founder of the Game Development Option in the Department of Computer Science. One of her current creative collaborations is *5000 Dead Ducks, Lust and Revolution in the Oilsands,* co-written by C.D. Evans, published by Durance Vile Publishing Ltd.

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Sharing Interactive Digital Storytelling Technologies

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1 Workshop Objectives

The Interactive Digital Storytelling (IDS) field has produced numerous research prototypes over the last years [1]. These prototypes cover several different technological domains, including: drama management; human computer interaction; language understanding and generation; behavioral modeling; 3D rendering, modeling and animation. Research in the field usually focuses on one specific area. However, it is often the case that other dimensions need to be integrated with one's core contribution to provide the end-user with a whole experience that can be assessed. As a consequence, researchers in IDS tend to become "one-person bands" trying to unite being scientists in multiple fields; engineers in an array of domains; and developers at home with many technologies and processes. Game technologies aim to simplify this challenge by providing, in particular, sophisticated game engines. But since game engines do not cover all IDS needs, important development/integration efforts still remain to be addressed beyond the central scientific investigation itself. This workshop aimed at helping IDS researchers to identify and adopt existing IDS-relevant technologies, for them to be able to deliver prototypes that are more varied - or better tailored to their needs and goals - with less effort.

More precisely, it can be observed that:

- There is very limited reuse of software components between research teams;
- Existing IDS architectures have typically not yet been deployed outside their original research labs;
- There exist some available IDS-related components that would deserve to become better known and utilized across the field.

Extending previous related efforts [2], this workshop aimed at moving the field towards more sharing of technologies, first by increasing the community's awareness of this issue and second, and more importantly, by gathering key players around the table to develop concrete strategies to share their technologies. This has enabled participants to:

- Become aware of existing IDS-related components and middleware available for them;
- Share technologies that have been developed in their research labs or companies;

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– Identify key obstacles and discuss the best way to organize the scaffolding for and the actual sharing/integration of IDS technologies within the research community.

2 Workshop Description

Based on the software and conceptual integration effort provided by the IRIS Network of Excellence [3], the workshop was organized around three types of participants' contributions:

- Technology providers, with contributions developed by their research labs or companies available for sharing;
- Software integrators, with visions on how to technically organize the sharing of IDS-related components and with success and flop stories of community processes;
- Users, with needs and intention to use third-party IDS components and middleware within their own scientific, product, and/or artistic development.

The workshop was divided into three phases:

Phase 1: Selected technology providers presented their technologies and availability/integration status (with use cases illustrating their potential; related requirements; and available learning resources);
Phase 2: Selected software integrators presented their approaches in a similar way;
Phase 3: A working session aimed producing a first draft of a sharing policy for the IDS community.
Phase 4: A focused discussion on the next steps for the sharing effort.

Before and during the workshop, the contributions and findings were collected on a website [4] gathering existing technologies from participants and other actors in the IDS community. After the workshop, the website's content has been progressively extended and discussions have been encouraged/animated/moderated by the organizers.

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Rummaging in the Geek Culture Toolbox

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Keywords: Geek Culture, Pen & Paper RPG, Comic Books, Prototypes, Practical Tools.

1 Objectives

This workshop explored alternative approaches and tools for the creation of interactive digital stories. These tools were derived from elements of geek culture. Geek Culture [1] is an umbrella term for the subculture of fans of cultural artefacts and activities traditionally considered to be geeky such as role-playing games, science-fiction, computers and comic books. In this workshop, we were specifically examining pen & paper role-playing games and comic books. It included an introduction to those elements of geek culture we wished to examine, participatory exercises that employed those elements, and post-exercise discussion. The workshop was designed to make the participants aware of tools that may be borrowed from other similar media for use in interactive digital storytelling.

2 Description

Geek culture manifests itself in many forms: sci-fi and fantasy novels, role-playing games, comic books, board games, and animated films among others. Interactive Digital Storytelling has long been present in geek culture in the form of video games [2], starting from humble beginnings in text adventure games and spreading to nearly all genres. Besides being beloved by geeks, video games have much in common with other forms of geek culture. In this workshop, we explored these shared commonalities on a practical level, making use of specific forms of geek culture to assist in and enhance the creation of interactive stories. The workshop began with an introduction to geek culture and the specific forms that we were examining and making use of. Following were a series of exercises exploring aspects of those specific forms as they pertain to the creation of interactive digital stories. One example of this being the use of pen & paper Role-Playing Games [3] as brainstorming and narrative prototype tools [4]. Additionally, we explored the process of creating comics [5] and how writing for that medium can assist us in creation of IDS. One topic had been how working in a medium with limited space such as comics [6] can help with writing succinctly for games with limited screen space, such as those created for handheld platforms. Each exercise was followed by a discussion of the experience and results.

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