Towards Effective Evaluation of Serious Games in Relation to Educational Objectives

Afef Ghannem and Maha Khemaja

PRINCE Research Group, ISITC, Hammam Sousse, GP1 Hammam Sousse, Tunisia
{afefghannem,maha_khemaja}@yahoo.fr

Abstract. Serious games allow immersion and interaction with a virtual world that can be used to support training. To be engaging and encourage learning, games must include a clear educational gain and must be scripted by the objectives of the course designer. Games' evaluation is therefore essential. Finding the right game that best suits the needs of any Instructional Designer is often a laborious task. In this paper, we aim applying ontology matching algorithms to both games and IMS-LD compliant Learning processes to decide whether a game could be entirely integrated to the e-Learning process or should be adapted. For that aim, we have chosen ontologies as a relevant formalism for both IMS-LD and game theory.

Keywords: Serious game, Game Based Learning, evaluation, ontology, alignment, education.

1 Introduction

The use of serious games had increasing interest and has grown significantly to affect several areas such as simulation and training, scientific research, health, education, strategic communication, etc. According to [5], a serious game is a virtual environment and gaming experience in which the contents that we want to teach can be naturally embedded with some contextual relevance in terms of the game-playing. Therefore, the serious game can take an important place and establish itself as a complement to traditional training methods.

This article considers as in [7] that a digital learning game requires learning goals, learning content, and a structural framework that ties together all these components. Thus, we support that to be engaging and encourage learning; the game must include a clear educational gain and should be scripted as objectives of the course designer. Previous to its effective use within a learning experience the game should be assessed or evaluated against learning objectives.

The goal of this research which the first results are presented in the present paper is to find the adequate game that best suits the needs of any instructional designer. Indeed, a game is a sort of program or software which we can apply the method of reverse- engineering of studying a game to determine the inner workings or its method of development. In Fig. 1, we support the need to develop models of intelligent agents

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for serious games. The agent is expected to know the internal structure of a serious game to decide the different adaptation scenarios needed (context, metaphor of the game, the game graphics, etc).

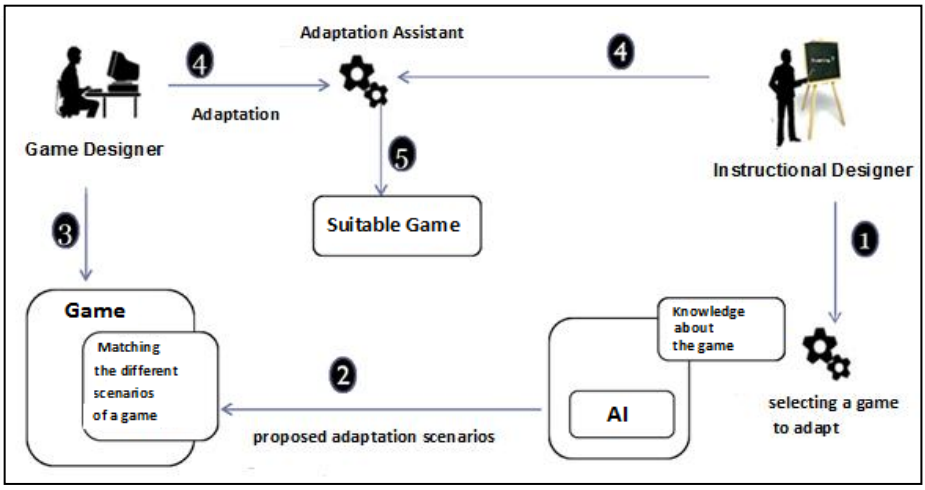

Fig. 1. Architecture of our future framework

We proceed in this paper as follows: we will first present in section 2 the related works and we will show that we have treated different aspects, in section 3 we will present a taxonomy of learning processes. We specifically present our course ontology designed accordingly to the Instructional Management System Learning Design (IMS-LD) specification. In section 4 we present a serious game taxonomy. In section 5, we propose an ontology alignment based approach to build the first phases of the evaluation framework of game based learning systems. In this approach we attempt to find the best method for aligning between the both ontologies (the course ontology and the game ontology). In section 6, we present a part of results of alignment process. Finally in section 7, we conclude and outline our future works.

2 Related Works

In recent years, researchers have begun to address the use of serious games in education. Indeed, many research have emphasized the use of the games following the course objectives for improved profitability and usability of games. In [10], an ontology had been proposed to integrate and orchestrate the scenario of the game in a desirable educational world and architecture adaptability games that promotes the reuse of components has been implemented. In addition, the work of [8] had combined the use of educational elements and components of serious games for the proposal of a common modeling language between domain experts such as instructors and game developers. However, till now there is no work around the annotation and alignment of game content and a process of learning content through ontologies. Therefore, we

argue that the ontology alignment [1] (search mapping, matching or put into correspondence) is an important task in systems integration since it allows joint consideration of resources described by different ontologies and that the alignment is to connect two different areas to finally produce reusable templates for serious games Taxonomy of learning processes.

3 Taxonomy of Learning Processes

Based on the basic concepts of the IMS-LD specification [4], we have structured the domain knowledge to enhance the teacher's (course designer) research of a set of games that best matches his teaching system. IMS-LD [2] is an educational modeling language which uses pedagogical concepts for modeling learning units or Units of Learning (UoL). It aims to describe a wide variety of situations to share learning experience approaches and improve efficiency and accessibility of learning. The purpose of IMS-LD is to ensure reusability, interoperability and adaptability of training content.

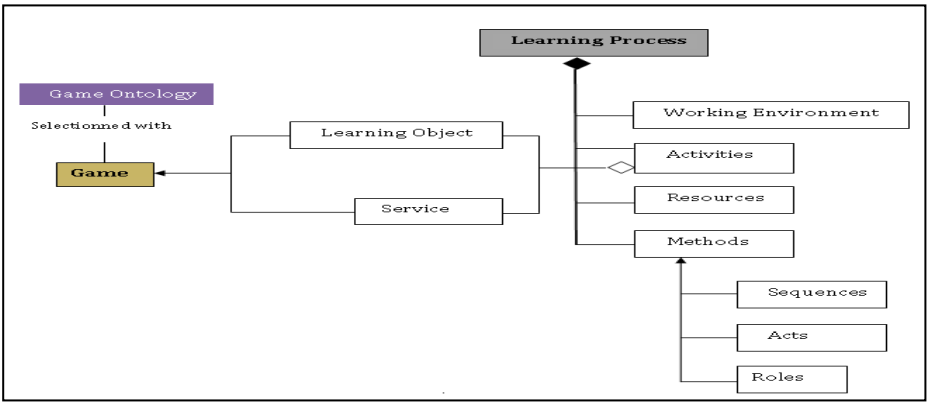

Fig. 2. Partial view of the ontology of learning process

Fig. 2 shows the different concepts that are related to a learning process. Indeed, a learning process is described and is scripted by IMS-LD for a set of physical and/or human resources, using a working environment and the activities that compose it. A learning process is made by methods which, in turn consist of sequences. Each sequence is composed of a set of actions that are associated with such roles as learners and/or teachers. A working environment is composed of learning objects such as web pages, pictures, tests, games and/or services such as chat, forum, search tools or also games. So we support a training set is both an object and an educational service that has just been added to a learning process in order to promote and maximize the latter.

The central question of our work is to know when and where to locate the game compared to a learning process and to identify the rules that were used to guide the choice of designers during game integration.

4 Serious Games Ontology

As stated previously, in order to foster and encourage the desire to learn, games are more and more used and integrated to learning processes. In [6], we have designed a game ontology that will be used as a reference for judging the adequacy of one's game accordingly to learning objectives within a learning process. When defining a game ontology [6], we used the game theory and the IMS-LD (IMS Learning Design) specification to highlight key concepts. According to IMS-LD [3], the training environment is composed of both learning objects and services that complement the learning process. Serious game ontology describes a number of concepts in the training game domain. Among the different types of games, games can be classified into many broad categories namely cooperative, competitive, static, dynamic games.

5 Our Proposal: An Ontology Alignment Based Approach

Ontologies provide the organization of information in the form of taxonomy of concepts and relations between them [1]. They formalize knowledge as they may be interpreted by machines and allow the reuse of a body of knowledge for different applications. However, heterogeneity and interoperability of ontologies require comparison between their provided concepts and semantics.

The ontology alignment [1] (search mapping, matching or put into correspondence) is an important task in systems integration since it allows joint consideration of resources described by different ontologies. The alignment of two ontologies helps to find a correspondence between their entities that are semantically similar.

In order to perform matching between the two ontologies, already presented respectively in the section 2 and 3 and more described in details in [6] and to identify the connections between them, we used an automatic alignment process.

The automatic alignment process was performed via OACAS (Ontologies Alignment using Composition and Aggregation of Similarities) method for determining a composition of linguistic measures of good quality [12]. OACAS is a method of ontology alignment that is based on the aggregation and composition similarities. It uses different similarity measures to determine the degree of similarity between ontological entities. The OACAS method gives better results for very complete ontologies.

Our choice of the OACAS method was not arbitrary, but it was after a research phase which used alignment of existing ontologies methods presented in the literature such as Neon toolkit [9] which is a plug-in for managing ontologies based on eclipse and is an extension of alignment products like KAON2. It provides a graphical editor for aligning ontologies interactively. We have also used the Prompt alignment method proposed by [11], which is implemented by a plug-in added to the ontology editor Protégé. Prompt requires human intervention in ontology alignment process. Or in our case, we propose a method that will works on a games repository to evaluate against educational objectives. Our method will run automatically. So, it shouldn't require any intervention from the designer and which would be applied at any stage of the

evaluation. We argue that the course instructor or teaching process receives automatic decision to integrate and adopt or not such a game to his system.

6 Experimentations and Results

Before starting the alignment process, the two ontologies are described in OWL-DL (Web Ontology Language-Description Logic) language through the Protégé editor. We tested first aligning our ontologies through the Prompt plug-in integrated into Protégé. We had a result that we consider less efficient since it requires guidance from the user. That is why we preferred the use of an automatic alignment method to facilitate the decision to adopt such a game in the learning process as it provides actual percentages of matches.

In OACAS method, the result of the alignment is produced in an RDF file types. The file contains the similarity measures between ontological entities, properties and instances. The alignment produced values between 0 and 1, and we found that more than the values are close to 1, more than the result of the alignment is consistent.

We have instantiated our ontologies by an object-oriented programming course and the concepts of the game COLOBOT for the game ontology. This alignment produced only 24 Similarities. Among the results, we observed 18 true matches and 06 false matches.

In addition, we observed that there are couples of many similarities that are not considered by the automatic alignment.

```
<?xml version='1.0' encoding='utf-8' standalone='no'?>
<rdf:RDF
xmlns='http://knowledgeweb.semanticweb.org/heterogeneity
/alignment'
xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
xmlns:xsd='http://www.w3.org/2001/XMLSchema#'>
<Alignment>
 <xml>yes</xml>
 <level>0</level>
 <type>11</type>
 <onto1>file://C:/ontocoursf.owl</onto1>
 <onto2>file://C:/ontojeux.owl</onto2>
<map>
 <Cell>
  <entity1
rdf:resource='file://C:/ontocoursf.owl#sequences'/>
  <entity2
rdf:resource='file://C:/ontojeux.owl#sequentiel'/>
  <measure
rdf:datatype='http://www.w3.org/2001/XMLSchema#float'>
0.6268888890743255
```

```
  </measure>
  <relation>=</relation>
 </Cell>
</map>
<map>
 <Cell>
  <entity1
rdf:resource='file://C:/ontocoursf.owl#competences'/>
  <entity2
rdf:resource='file://C:/ontojeux.owl#competences'/>
  <measure
rdf:datatype='http://www.w3.org/2001/XMLSchema#float'>
0.9181818157434463
  </measure>
</map>
</Alignment>
</rdf:RDF>
```

Fig. 3. Partial result of automatic alignment

After the automatic alignment, we have done a manual alignment by using a reference alignment to compare the efficiency of the results.

Therefore, we argue that the results are satisfactory in terms of the content of context ontologies. The following figure shows a screenshot of a part of the result of the automatic alignment obtained via OACAS method.

7 Conclusion

This paper presented the results of the alignment of the two ontologies: course ontology and game ontology. The alignment task has the goal of finding a match between ontologies to facilitate the integration and reuse of games within learning processes. This ontology alignment approach allowed as realizing first steps within an evaluation process.

In our future work, we will model and implement a benchmark system for assessing games content and game-play for educational requirements which in turn takes its inputs by exploiting the results of the alignment already presented in this paper.

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