Using Argumentation Schemes for a Persuasive Cognitive Assistant System

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Abstract. The iGenda framework is a cognitive assistant that helps care-receivers and caregivers in the management of their agendas. One of the problems detected in systems of this kind is the lack of user engagement. This engagement can be improved through the application of persuasion techniques in order to convince users to act in a specific way. According to this, this paper presents a new architecture that will allow the system to select and recommend activities that potentially best suits to the users' interests based on argumentation techniques.

1 Introduction

Ambient Assisted Living (AAL) is a subset area of Ambient Intelligence that is aimed to provide intelligent environments to elderly or disabled people. These people have certain needs (different from user to user) that have to be addressed distinctly from common people. Even though it is expected that intelligent environments conform to users, they are still constricted to the physical restrictions, sensors, and actuators that the environments possesses.

Due to medical and socio-economical advances, the life expectancy has been increasing over the last few years, i.e., in Portugal the life expectancy has increased 10% from 2004 to 2014, being in 2014 85 years old the mean age for both sexes [8]. In 1981 the ratio between the people between 15 and 64 years old was 5.5 and in 2011 is only 3.5, meaning that there has been a reduction of the people that are able to financially support elderly people [8]. Furthermore, the elderly population is left alone by their relatives during large periods of time,

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which gives rise to lack of socialisation and general help [3]. One solution may be the inclusion of technological devices that bring together the elderlies' relatives and other people, like friends.

The issue with the current applications directed to the elderly people is that they are not truly designed to the elderly, as most require intensive learning and more than advanced basic knowledge. Despite the shown interest, most abandon the application if they are not forced to use it, thus it is obvious that there is a need for appealing and understandable visual interfaces that engage the users. Also, people tend to trust the information that is presented by digital systems even if it is not true or incomplete, and when people realise that they were tricked they stop using the system [13]. Most recommender systems, for instance, tend to keep the information simple and hide the process behind the recommendation. However, several studies showed that when the control is given to the users (even if limited), and when the system can provide justifications, people tend to trust recommendations more [4,14]. Therefore, intelligent decision-support systems that can give understandable justifications for medical diagnosis and health-care recommendations have gained success in recent years. Recent work has investigated the role of argumentation theory in medical diagnosis and health care. In [2], authors present ongoing research on testing the effectiveness and usability of argumentation schemes, a well-known concept of argumentation theory, to improve the persuasion power of doctors and to enhance elderly diabetes patient's self-management abilities in chronic care. In [11], an argumentation-based approach to aggregate clinical evidence coming from multiple sources (randomised clinical trials, systematic reviews, meta-analyses, network analyses, etc.) and decide the best treatment is proposed. In [9], biomedical argumentation schemes are presented as logical programs to be able to automatically devise arguments from scientific texts. Also, the role of argumentation schemes to represent fallacious reasoning in public health has been analysed in [7].

In a previous work, we presented a persuasive module that has been integrated in a cognitive assistant framework, iGenda [5]. The proposed persuasive module improves user engagement generating arguments for the selection of activities that potentially best suits to the users' interests. These arguments where based on previous similar cases stored in a case-base database, which provided a justification only based on the information of the clinical guidelines used to recommend a specific activity. However, this was a basic argumentation feature that does not provide a way to generate more elaborated arguments and to determine the relation among arguments (e.g. specifying clearly how an argument can receive attacks). Furthermore, it is also important that users perceive the 'human-like' intelligence of the system, which is not only to be able to show experience-based arguments based on similar cases, but also arguments based on human common patterns of reasoning. Thus, in this work we investigate the role of argumentation schemes as knowledge resource to capture the way of reasoning that physicians and caregivers follow to recommend activities to patients.

2 The iGenda Framework

The iGenda is an AAL project, more precisely, a cognitive assistant platform [5]. Its aim is to provide assistance to the people in the elderly's sphere of people, e.g., family, relatives, health assistants, caregivers. This is achieved through its platform that manages daily activities that can be performed solo (like activities of daily living) or accompanied (like family visits or playing group games). The system provides automatic scheduling and conflicts management of events and user profiling and management [6]. Furthermore, it promotes active ageing by recommending activities (through direct scheduling) that impact physical or psychical aspects to keep the executers active and increase their happiness level.

Through its user mobile application, the iGenda is able to interact with their users and benefit from the sensors of the mobile device, like GPS or accelerometer, which may help iGenda by providing the platform with useful information about the current location and environment status. The iGenda visual interfaces divide into two strands: (i) the *care-receivers*, directed for the elderly, friends and relatives; and (ii) the *caregivers*, directed to health assistants, like registered nurses and physicians. The care-receivers will receive activities and perform them, creating a social network with other users, while the caregivers will attend to their assigned care-receiver's health status and assure that they are well and secure.

By using its recommendation module, the iGenda system periodically schedule activities that promote active living, selected from its *free time events* database. The events go through a filtering system that preselects activities that match the users medical condition (physical or psychological), the weather condition, and the available time. In its original version, iGenda gathers the events that outcome from the filter and uses a biased random function to suggest activities. However, the potential willingness of the user to accept a specific activity (based on his/her current social context - i.e. the specific user, the specific caregiver, their relation, etc. - and the knowledge of similar past experiences) was not taken into account. Then, the new persuasion module of iGenda enabled the provision of justification and argumentation about why each activity is recommended.

In this section, we provide an overview of the persuasive module of the iGenda tool, focusing on its knowledge resources (for a comprehensive explanation of the persuasive module see [5]) and on the operation of the module. This module allows the iGenda activities recommender system to collect the users' input and justify the recommendation provided in a way that emulates the humans way of reasoning. Therefore, when iGenda calls the recommendation module to recommend activities, the system tries to create one argument (or more) to support each activity and decide which one would be preferred by the user. Then, an internal argumentation process takes part to decide the activity that is better supported by its arguments.

2.1 Argumentation Framework

The persuasive module of iGenda implements the agent-based argumentation framework for agent societies presented in [10,12]. This framework takes into

account the values that arguments promote (the preferences of the users), the users' preference relations (preference orderings over values), and the dependency relations between agents (the relations that emerge from agent interactions or are predefined by the system) to evaluate arguments and to decide which ones defeat others. In our system, agents can play the role of *patients*, *caregivers* (e.g. relatives, personal health assistants, friends), and *doctors*. In addition, in our system we have established the following typology of values, which represent preferences for activities that: are performed still, sitting, standing up, etc. (*Motion* Values); are performed indoors with or without movement, outdoors with or without movement, etc. (*Location* Values); involve socialise with others, or not (*Social* Values); are weather-dependent, or not (*Environmental Conditions* Values); and have immediate or direct impact on health, or not (*Health Conditions* Values).

In this work, we have adapted the knowledge resources of this framework to cope with the requirements of the iGenda domain: a database of *argumentation-schemes* and a case-base with *domain-cases*.

Argumentation schemes represent stereotyped patterns of common reasoning whose instantiation provides an alleged justification for the conclusion drawn from the scheme. Many authors have proposed different sets of these argumentation schemes, but the work of Walton [15], who presented a set of 25 different argumentation schemes, has been the most widely used by the AI community. AI researchers have appreciated the simplicity of Walton's schemes and the fact that these argumentation schemes have associated a set of *critical questions (CQs)* that represent potential attacks to the conclusion supported by the scheme. Thus, the schemes can be used to generate arguments that support each activity, and to guide the argumentation process by determining potential attacks to these arguments.

The most obvious pattern of human reasoning to recommend an activity to take care of elderlies' health is because an expert (e.g. a physician or a caregiver) thinks that it could improve the health of the user (probably following a well-stablished clinical guideline). This pattern of reasoning is captured by the *Argument From Expert Opinion* scheme of Walton's set. For illustrative purposes, we provide next an adaptation of this argumentation scheme for the iGenda application domain (we refer the reader to [15, Chap. 9] for the original version of the scheme). Note that critical questions 3 and 6 cannot be instantiated as potential attacks by the same nature of this recommendation domain, since all activities recorded in the iGenda database have a proposer by default (the doctor, caregiver or at least the system that created the activity).

Major Premise: Expert E (doctor, caregiver or expert system) is an expert on the area of expertise X where activity A belongs to
Minor Premise: Activity A is proposed by expert E
Conclusion: Activity A should be recommended in the current situation
CQ1: How credible is E as an expert source?
CQ2: Is E an expert on the area of expertise X where activity A belongs to?

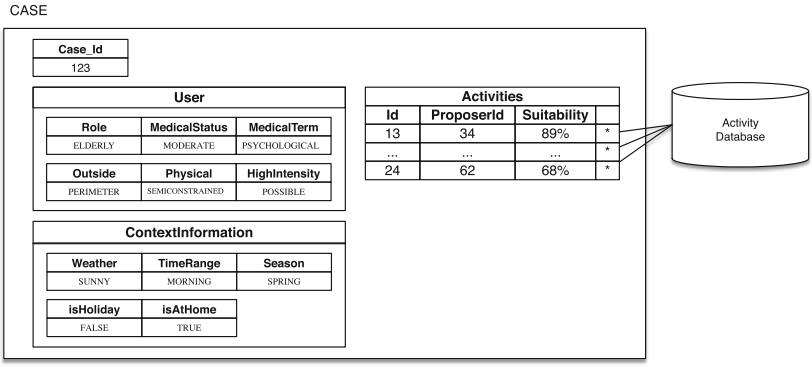

Fig. 1. Structure of a domain-case

CQ3: Did expert E recommend activity A?
CQ4: How personally trusted is E as an expert source?
CQ5: Is A consistent with what other experts have recommended?
CQ6: Is E's recommendation based on evidence?

Domain-cases represent previous problems and their solutions. The case-base of domain-cases stores previous experiences and their final outcome in the form of cases that can be retrieved and used later to select the best activity to recommend in view of past similar experiences. Domain-cases allow iGenda to generate basic experience-based arguments, and to store the new knowledge gained in each process, improving the system's recommendation skills. Figure 1 shows an example of the structure of a specific domain-case in our system. This domain-case is the representation of a set of previous activities that have been successfully recommended to the same kind of user. Each case has a set of attribute-value pairs (variables of any value type) that describe the characteristics of the user, the environmental context where the recommendation was provided, and the list of activities recommended. The characteristics of a user are a representation of users with the same attributes. These are their medical status (moderate, severe, mild, ...), their role (elderly, family, medical, ...), the medical term that defines them (psychological, physical, both, ...) and whether or not the user is allowed to go outside his/her house or just the perimeter. Besides the above, these characteristics also define if the user is physically constrained, semi-constrained or unconstrained and if the user is allowed to practice high intensity activities or not. The environmental context where the recommendation was provided is useful to be aware of the suitability of an activity regarding the environment. It's easy to conclude that an outdoor activity is directly dependent on the weather. The characteristics that are stored in the environmental context are: the weather, which is usually only important for outdoor activities, the time range when the activity was done, the season (there are activities that are more desirable than others regarding the season), whether the day was a holiday or not and, finally, if the user is at home or at other residence (hospital, holidays residence, ...).

Finally, the list of activities include the activity that was recommended (Id), the proposer of that activity (ProposerId) and a degree of suitability that represents if the activity was good or not for that case (Suitability).

Arguments that iGenda generates are tuples of the form $Arg = \{\phi, p, \langle SS \rangle\}$, where ϕ is the conclusion of the argument (e.g. the activity to recommend), p is the value that the argument promotes and $\langle SS \rangle$ is a set of elements that justify the argument (the support set). The support set $\langle SS \rangle$ is the set of features (*premises*) that represent the context of the domain where the argument has been put forward (those premises that match the problem to solve and other extra premises that do not appear in the description of this problem but that have been also considered to draw the conclusion of the argument) and any knowledge resource used by the proponent to generate the argument (domain-cases and argumentation schemes).

2.2 Recommendation Process

The recommendation process starts when iGenda has to schedule a new activity for the user. Then, the recommendation module is called to retrieve a list of candidate activities (those that match the requirements of the current situation) from the activities database. After that, the persuasion module executes the classical case-based reasoning cycle [1] (the Retrieve, Reuse, Revise, and Retain phases) to select from this list the best activities to recommend in view of past similar experiences. The design decisions adopted for each phase of this cycle were influenced by the proposed domain and the aim of providing flexibility.

The main goal of the *retrieval* phase is to obtain the set of stored domain-cases that are similar to the current situation. The module is able to work with heterogeneous activities with missing information and can also compute the similarity between them and the current context of the recommendation (user, schedule and environment). To implement the retrieval algorithm, we have adapted and tested several well-known distance measures (e.g. Normalised Euclidean, Tversky) in order to work with heterogeneous data. The most similar case or cases are selected by means of a k-nearest neighbour algorithm by using these distance measures.

In the *reuse* phase, for each activity selected by the recommendation module, the persuasion module looks at the set of retrieved cases if there are any whose activities list include the current activity under consideration. This would mean that the system has gained previous knowledge from a similar past recommendation experience and hence, the persuasion module can generate experience-based arguments that support the recommendation of a specific activity. In addition, a minimum *suitability threshold* is set to only take into account those previous cases that represent successful recommendation experiences (i.e. the activity recommended was enjoyable and useful for the user). If different cases can support the same activity or several different activities can be supported by the domain-cases retrieved, the experience-based arguments generated can be weighted by using the activities *suitability degree*.

Table 1. Argumentation scheme instantiation

Argument from expert opinion	
Elements of the scheme	Related data
Major premise	Proposer, area of expertise, activity proposed
Minor premise	Activity proposed
CQ1	Proposer reputation lower than a threshold or less preferably (computed from all recommendations provided by this proposer)
CQ2	Proposer area of expertise does not exactly match the required in this situation
CQ4	Trust degree between the user and the proposer lower than a threshold or less preferably (computed from previous interactions between them)
CQ5	Other different proposers that recommend different activities for this same situation (computed either from the iGenda database and/or from the retrieved domain-cases)

Regardless of whether the system has been able to generate experience-based arguments or not, the persuasion module tries to generate scheme-based arguments for each of the activities selected by the recommendation module. To do this, the module queries the iGenda database, which includes different tables to store information about patients, activities, doctors, caregivers, etc., and tries to retrieve the pieces of information that support the instantiation of the specific pattern of reasoning that each argumentation-scheme represents. Furthermore, any relevant data stored in the domain-cases retrieved can be also used to instantiate argumentation schemes. Table 1 shows these related data for the *Argument From Expert Opinion* example scheme. Thus, if any scheme can be instantiated, the module generates new scheme-based arguments to support the activity under consideration. Also, if a scheme is instantiated, the system also tries to retrieve data to instantiate their associated critical questions. In this way, attack arguments to the argument generated from the scheme can be also created.

Once all possible support and attack arguments have been generated to support each potential activity to recommend, an argument evaluation process is started to decide which of arguments hold or which are rebutted. The formal specification of this process is out of the scope of this paper and we refer the reader to [5,10] for details. Finally, the system recommends the activity that it is deemed to be more suitable and persuasive for the user, which is that activity supported by more arguments and/or with higher weights (in the case of experience-based arguments). At the end of the recommendation process, when an activity is scheduled, the user must indicate to the system whether the activity proposed was actually performed and his/her degree of satisfaction with it. Then, the *retention* phase is executed, and the system can learn from the recommendation experience and store the degree of suitability of its recommendations.

To do this: (i) the system receives an input about the activity recommended; (ii) if the system was able to retrieve a domain-case that matches the current situation and the activity was in the list of activities associated with this case, the suitability degree of this activity is increased; (iii) otherwise, the activity is added to the list or, if no matching cases were found, a new domain-case is created to store the new knowledge acquired by iGenda.

3 Conclusions

Cognitive assistants try to enhance the user's well-being and quality of life managing his/her agenda, reminding appointments and events and becoming a constant helper. One of the main problems with applications of this kind is that users typically abandon the application if they are not engaged in some way to use it. This paper has presented an extension of the persuasive module included into the iGenda framework to improve user engagement through the generation of arguments for the selection of activities. As a future work, we want to test the complete iGenda framework in a real world scenario, with the new introduced features to support the activities recommendation. Moreover, the collected data about the users' experience would be useful to improve the iGenda framework and include new argumentation schemes to have a more powerful justification to the activities recommendations.

References

1. Aamodt, A., Plaza, E.: Case-based reasoning: foundational issues, methodological variations, and system approaches. AI Commun. **7**(1), 39–59 (1994)
2. Bigi, S.: Healthy reasoning: the role of effective argumentation for enhancing elderly patients' self-management abilities in chronic care. Active Ageing Healthy Living: Hum. Cent. Approach Res. Innov. Source Qual. Life **203**, 193 (2014)
3. Chao, S.F.: Changes in leisure activities and dimensions of depressive symptoms in later life: a 12-year follow-up. Gerontol. **56**(3), 397–407 (2014)
4. Chesñevar, C., Maguitman, A.G., González, M.P.: Empowering recommendation technologies through argumentation. In: Simari, G., Rahwan, I. (eds.) Argumentation in Artificial Intelligence, pp. 403–422. Springer Science + Business Media, New York (2009)
5. Costa, A., Heras, S., Palanca, J., Novais, P., Julián, V.: A persuasive cognitive assistant system. In: Lindgren, H., et al. (eds.) Ambient Intelligence- Software and Applications- 7th International Symposium on Ambient Intelligence (ISAmI 2016). Advances in Intelligent Systems and Computing, vol. 476. Springer, Cham (2016)
6. Costa, A., Novais, P., Simoes, R.: A caregiver support platform within the scope of an ambient assisted living ecosystem. Sensors (Basel, Switzerland) **14**(3), 5654–5676 (2014)
7. Cummings, L.: Reasoning and Public Health: New Ways of Coping with Uncertainty. Springer, Cham (2015)
8. Fundação Francisco Manuel dos Santos: http://www.pordata.pt/

9. Green, N.: Implementing argumentation schemes as logic programs. In: The 16th Workshop on Computational Models of Natural Argument. CEUR Workshop Proceedings (2016)
10. Heras, S., Botti, V., Julián, V.: Argument-based agreements in agent societies. Neurocomputing **75**(1), 156–162 (2012)
11. Hunter, A., Williams, M.: Aggregation of clinical evidence using argumentation: a tutorial introduction. In: Hommersom, A., Lucas, P.J.F. (eds.) Foundations of Biomedical Knowledge Representation. LNCS, vol. 9521, pp. 317–337. Springer, Cham (2015). doi:10.1007/978-3-319-28007-3_20
12. Jordán, J., Heras, S., Valero, S., Julian, V.: An infrastructure for argumentative agents. Comput. Intell. **31**(3), 418–441 (2015)
13. Marsh, S., Dibben, M.R.: Trust, untrust, distrust and mistrust - an exploration of the dark(er) side. In: Herrmann, P., Issarny, V., Shiu, S. (eds.) iTrust 2005. LNCS, vol. 3477, pp. 17–33. Springer, Heidelberg (2005). doi:10.1007/11429760_2
14. Staff, C.: Recommendation algorithms, online privacy, and more. Commun. ACM **52**(5), 10 (2009)
15. Walton, D., Reed, C., Macagno, F.: Argumentation Schemes. Cambridge University Press, Cambridge (2008)