Rafael H. Bordini, Louise A. Dennis and Yves Lespérance (eds)
Pre-proceedings of the 7th International Workshop on Engineering Multi-Agent Systems (EMAS 2019)
13th-14th May 2019, Montreal, Canada
cgi.csc.liv.ac.uk/~lad/emas2019/accepted/EMAS2019_paper_31.pdf

What Does It Take to Create Social Awareness for Support Agents?*

Ilir Kola[1], Catholijn M. Jonker[1,2], and M. Birna van Riemsdijk[1,3]

[1] Interactive Intelligence group, Delft University of Technology, The Netherlands
[2] Leiden Institute of Advanced Computer Science, The Netherlands
[3] Human Media Interaction lab, University of Twente, The Netherlands
{i.kola, m.b.vanriemsdijk, c.m.jonker}@tudelft.nl

Abstract. Social awareness is a property that agents should have in order to support humans in their activities, especially if that advice might impact on the social relationships of their users. This paper describes the research method and the expected contributions of research that aims to answer the following question: *What knowledge structures and reasoning techniques can enable behaviour support agents to take into account the user's social situation when offering support?*. In particular we anticipate to produce a two-layer ontology of social situations, a mechanism to reason about the influence of the situation on the behaviour of the user, and a mechanism to reason about the social implications of possible behaviours and thus advice the user on the best course of action.

Keywords: Socially aware agents · Social situation modelling · Research methodologies

1 Introduction

Artificial agents that help people live healthier lifestyles or form certain habits are becoming a reality. These behaviour support agents mostly focus on modelling internal aspects of the users (e.g. their goals, values etc.), while neglecting the role of the context in which the users are in. For example, an online search performed in the autumn of 2018 showed that the most downloaded apps that help users quit smoking take into account the cigarette consumption, daily goals etc., but do not consider elements of the environment which lead to smoking.

In social psychology, the concept of *situations* is used when talking about elements of the environment, and research shows that the situation affects the behaviour of people. Situations have a physical and a social aspect. In computer science, while there is some work on modelling the physical aspect of situation (e.g. [20]), the social part is still missing. We define socially aware support agents as agents which are able to take into account the social situation the user is in. According to this definition, current support agents are not able to

* This work is part of the research programme *CoreSAEP* (project no. 639.022.416), supported by the Netherlands Organisation for Scientific Research (NWO)

provide socially aware support. In this project we do not focus on building a complete behaviour support agent, but rather on exploring reasoning techniques that would allow behaviour support agents to take the social situation into account when offering support. Based on this, the overarching research question of this project is the following:

> *What knowledge structures and reasoning techniques can enable behaviour support agents to take into account the user's social situation when offering support?*

In this article, we will explore the research steps needed to answer this question. The rest of the article is structured as follows: section 2 argues why social situations are important for behaviour support agents. In section 3 we review related work and position ourselves. Section 4 introduces our approach, as well as discusses the methodology and expected contributions. Section 5 concludes the article.

2 Motivation

In this section, we argue why the ability to model and reason about social situations is crucial for behaviour support agents. First we will argue about the importance of situations and their connection to human behaviour and social relations from the point of view of social psychology. Next, we discuss how these concepts have been reflected in artificial intelligence so far.

According to [10], the influence of situations on human behaviour traces back to the pioneering work of Kurt Lewin [13, 14], who posited that human behaviour is a function of personality and the surrounding environment, whereas the previous trends had only focused on behaviour being influenced by personality. This idea has been followed by sociologists when modelling social interactions. Kenny's Social Relations Model [11] proposes that social relations are a function of the actor effect, the partner effect, the relationship effect and the "occasion" effect. In a similar spirit, interdependence theory (e.g., [8]) argues that the Interaction (I) that occurs between two people (A and B) is a function of their respective tendencies in relation to each other in the particular situation of interdependence (S) in which the interaction occurs. This work suggests that an artificial agent that supports a human user needs to be able to model the social aspect of situations in order to be able to offer sensible support.

Carley and Newell [2], already in 1994, proposed the building blocks that are needed to build an artificial social agent. They argue that a social agent should have information-processing capabilities and knowledge. The former are goal oriented and depend on the agent's internal capabilities. Knowledge is dictated by the environment. The authors argue that agents exist in particular situations (both physical and social), but how much of this situation is encoded by the agent and how it is encoded, is an open issue. In the past years, most work has focused on the information-processing capabilities of the agents, and there has been considerable success in building cognitive agent architectures (e.g. [7],

[17]). On the other hand, approaches that model situations have mostly focused on the physical aspects of the environment. Most of these attempts are part of the work on situation awareness (e.g. [6]). This line of research focuses more on emergency situations and is task oriented. Therefore, it lacks the tools that would enable agents to model daily life situations, which often have a social nature. The importance of tackling this issue is accepted in the community. For example, Kaminka [9] argues that agent systems should incorporate general social intelligence building blocks, and Dignum et al. [5] suggest that the next step in artificial intelligence is the ability to show social intelligent behaviour. Our research aims at closing this gap. Other related work which attempts at doing this is discussed in the next section, where we position our work in relation to these approaches.

3 Related Work

We are not the first to research how to enable behaviour support agents to offer socially adaptive help. **Social Practices** are proposed by Dignum and colleagues [3, 4] as a way to reason about support in a social context. This approach is based on the sociological concept of social practices [19], which tries to establish a link between practice and their social context. In [4], Dignum et al. propose to represent social practices by using physical context (resources, places, actors), social context (social interpretation, roles, norms), activities, plan patterns, meaning and competences. In turn, these social practices can inform the agent about the expectations in a given setting. This approach is not very different from ours, since we are also reasoning about what is expected from an agent in a social situation. However, their main contribution is on "how the agent uses practices in its deliberation and planning" [3], while the set of social practices is considered to be a given one. In our approach we model the social relationships as well as the elements of the situation explicitly by using input from the user as well as sensory data, and use these models in order to reason about what is expected from the user in that situation.

Platys Social is an approach proposed by Murukannaiah et al. [15] to add social context in artificial agents. They link the concept of places with the amount of interaction that the user has with other people in order to identify social circles of the user. For example, individuals that are met at the user's home are most probably the family members. The interaction with other people is detected from Bluetooth data as well as amount of calls or messages, while in order to link geographical positions to conceptual places and activities that take place in those places, they use an ontology-based approach [20]. While the concept of *places* can play a role in determining part of the social environment, we think this is not enough to capture all aspects of a social relationships. For example, a person might be attending a work dinner in a restaurant, however, seen statistically, the restaurant as a conceptual place could be linked to a casual social setting. Moreover you might have had limited or no contact with the other attendees before the dinner, so the system would give a low priority to the connections,

which does not match with the fact that the meeting is actually very important. Furthermore, we believe that only relying on sensor data is not enough to fully capture the subjective point of view of the user, this is why in our approach relying on input from the user is one of the core concepts.

Ajmeri and colleagues [1] propose **Arnor**, a method that allows the implementation of privacy aware socially intelligent personal agents by using social constructs. Arnor's steps include modelling goals, the environmental context, the social expectations, and the social experience of the user. However, the way in which the environmental context is modelled seems to be implicit. The authors say "The social context could include the place where the interaction occur, attributes of the place, neighbors in the vicinity, the social relationship between primary and secondary stakeholders, the activities the stakeholders are involved in, and so on". All these are indeed potentially important elements of the social context, however at this point they seem to be selected ad-hoc for specific example scenarios.

We think our proposed framework is a middle ground of these approaches. On the one hand, we agree with the approach of Social Practices and Arnor that modelling the social environment requires representing many nuances (actors, roles, social interpretations etc.). However, we also think that considering these social elements as given is not enough if we consider real life applications, therefore it is important to have explicit knowledge structures which define the elements of the environment that have to be represented, like it is done in the Platys Social approach.

4 Proposed Approach

As aforementioned, situation awareness literature offers ways how to model the environment and reason about that knowledge. Although that work is not aimed at social situations, we can use their proposed concepts as an inspiration. One of the most accepted frameworks for situation awareness is the one proposed by Endsley [6]. This framework consists of three levels:

- **Level 1** is perception, and involves capturing the status, attributes, and dynamics of relevant elements in the environment;
- **Level 2** is comprehension, which deals with understanding the significance of elements in the environment, beyond just being aware of their existence;
- **Level 3** is projection, which is the ability to project the future status of the elements of the environment, based on levels 1 and 2.

Inspired by these levels, we believe that a behaviour support agent should also be able to *represent relevant aspects of social situations*, be able to *reason about their meaning*, and lastly project how these situations will *affect the behaviour* of the user. Once this process is completed, we call the agent socially aware, and the agent can support the user while taking this information into account.

In the following subsections we will introduce the methodology that we plan to apply throughout our research in order to achieve this vision, and the contributions we expect to make.

4.1 Methodology

To tackle our research question, within this project, we will follow these steps:

1. Explore relevant literature from social science in order to base our approach on grounded theoretical models;
2. Organise these concepts in formal knowledge structures;
3. Propose reasoning techniques that can be used to infer new information from the elements of the knowledge structure;
4. Conduct user studies to evaluate whether the knowledge structure and reasoning techniques can be used in real scenarios.

We believe that basing our approach on formalizing concepts from social sciences should make it more useful in practice. This methodology is often used in the agents community (e.g. [3]). However, we are aware that concepts from social sciences are debated in the social sciences, much in the same way as artificial intelligence is debated by artificial intelligence researchers. As we cannot be sure to have selected an accurate model for our application domain, step four tests the practical validity of our proposed methods.

Our approach is user-centered rather than data-driven. As a result, instead of having a large amount of data, an approach which can raise ethical concerns regarding privacy, we will follow the *less is more* paradigm: only capture the information that together with the user the agent determines to be useful to help the user in the way they wish to be helped.

4.2 Contributions

As aforementioned, the main contribution of this project will be to provide knowledge structures and reasoning techniques that allow behaviour support agents to take into account the user's social situation before offering support. To illustrate our points, we will use the following scenario: Bob has a support agent which helps him be more punctual, and he has a meeting with his boss, Alice. Our contribution will consist in answering the following questions:

(1) What knowledge structures can represent the user's social situation?

The first step towards enabling behaviour support agents to reason about social situations is to decide which elements of the environment have to be represented. To tackle this issue we explore literature on social relationships and situation cues. Based on that, we propose a two-level ontology that can be used to model social situations. The upper level represents general concepts which apply to all social situations, and the lower one contains more specific domain-dependent features. In [12], we propose a set of features that can be used to model everyday social situations involving two people, and we evaluate our approach via a pilot study. In our scenario, we would model the role of Alice towards Bob, the level of formality in the relationship, the quality of the relationship, the type of meeting that they have etc.

(2) How can support agents reason about the characteristics of a situation?

Having elements of a situation is useful, however at this stage they are just abstract concepts which do not have any meaning. Behaviour support agents should be able to identify how these elements relate to each other and what do these interactions mean for the user. Social psychology literature refers to this as defining the *psychological characteristics* of the situation, and they are seen as different dimensions of a situation. In our scenario, we would infer that the meeting has a high level of duty and intellect, a low level of humor etc. There are different taxonomies of situations (e.g. [16], [18]), so our first step will be to identify which dimensions to use and how to structure that knowledge. Then we will propose reasoning techniques which can help us assess these dimensions of the situation, and in turn build the situation profile.

(3) How can support agents reason about what behaviour is expected from the user and what values are promoted in a certain situation?

Once we have a situation profile consisting of different dimensions relevant to the situation, in order to be able to provide support, we need to know how does the situation profile translate into what is expected in that type of situation. Social psychology research (e.g. the work of [18]) explores the correlation of situation dimensions with different behaviours and values that are promoted. This will serve as our theoretical background, and we will provide appropriate reasoning techniques which can deal with that information. In our scenario, the situation suggests that Bob is expected to be on time and prepared for the meeting, and that this meeting would promote his career development.

(4) How can an agent that is aware of the social situation best advice its user?

Until now we talked about how can we enable a behaviour support agent to assess a situation and reason about its characteristics. In order for the agent to actually provide support, there are two steps that need to be taken. The first step consists of detecting cases where support is actually needed. To achieve that, we can use as input the expected behaviour and values on one hand (from research question 3), and the user's personal values and commitments on the other. Then, the agent can reason about how to support the user. Going back to our example, the agent notices that Bob is expected to be on time for the meeting, and on the other hand it knows Bob has problems with being punctual. Since this meeting promotes Bob's values, it sends him an early reminder.

5 Concluding

In this article, we discuss steps that are needed in order to enable support agents to take into account the user's social situation. However, this is just a starting point. Hopefully, you will read this article while we are still working on these steps, to stay updated visit our website[1]. If so, please feel free to join us, or reach out to us if you have comments, ideas or similar research interests.

[1] http://ii.tudelft.nl/coresaep/

References

1. Ajmeri, N., Murukannaiah, P.K., Guo, H., Singh, M.P.: Arnor: Modeling social intelligence via norms to engineer privacy-aware personal agents. In: Proceedings of the 16th Conference on Autonomous Agents and MultiAgent Systems. pp. 230–238 (2017)
2. Carley, K., Newell, A.: The nature of the social agent. Journal of mathematical sociology **19**(4), 221–262 (1994)
3. Dignum, F.: Interactions as social practices: towards a formalization. arXiv preprint arXiv:1809.08751 (2018)
4. Dignum, V., Dignum, F.: Contextualized planning using social practices. In: International Workshop on Coordination, Organizations, Institutions, and Norms in Agent Systems. pp. 36–52. Springer (2014)
5. Dignum, V., Jonker, C.M., Prada, R., Dignum, F.: Situational Deliberation; Getting to Social Intelligence. Computational Social Science and Social Computer Science: Two Sides of the Same Coin (2014)
6. Endsley, M.R.: Toward a theory of situation awareness in dynamic systems. Human Factors **37**(1), 32–64 (1995)
7. Franklin, S., Kelemen, A., McCauley, L.: Ida: A cognitive agent architecture. In: SMC'98 Conference Proceedings. 1998 IEEE International Conference on Systems, Man, and Cybernetics (Cat. No. 98CH36218). vol. 3, pp. 2646–2651. IEEE (1998)
8. Holmes, J.G.: Social relationships: The nature and function of relational schemas. European Journal of Social Psychology **30**(4), 447–495 (2000)
9. Kaminka, G.A.: Curing robot autism: A challenge. In: Proceedings of the 2013 international conference on Autonomous agents and multi-agent systems. pp. 801–804 (2013)
10. Kelley, H.H., Holmes, J.G., Kerr, N.L., Reis, H.T., Rusbult, C.E., Van Lange, P.A.: An atlas of interpersonal situations. Cambridge University Press (2003)
11. Kenny, D.A., La Voie, L.: The social relations model. Advances in experimental social psychology **18**, 142–182 (1984)
12. Kola, I., Jonker, C.M., Van Riemsdijk, M.B.: Who's that? - Modelling Social Situations for Behaviour Support Agents. Manuscript submitted for publication. (2019)
13. Lewin, K.: Principles of topological psychology. New York, NY: McGraw Hill (1936)
14. Lewin, K.: Field theory and experiment in social psychology: Concepts and methods. American journal of sociology **44**(6), 868–896 (1939)
15. Murukannaiah, P.K., Singh, M.P.: Platys social: Relating shared places and private social circles. IEEE Internet Computing **16**(3), 53–59 (2012)
16. Parrigon, S., Woo, S.E., Tay, L., Wang, T.: Caption-ing the situation: A lexically-derived taxonomy of psychological situation characteristics. Journal of personality and social psychology **112**(4), 642 (2017)
17. Rao, A.S., Georgeff, M.P.: Modeling rational agents within a bdi-architecture. KR **91**, 473–484 (1991)
18. Rauthmann, J.F., Gallardo-Pujol, D., Guillaume, E.M., Todd, E., Nave, C.S., Sherman, R.A., Ziegler, M., Jones, A.B., Funder, D.C.: The situational eight diamonds: A taxonomy of major dimensions of situation characteristics. Journal of Personality and Social Psychology **107**(4), 677 (2014)
19. Reckwitz, A.: Toward a theory of social practices: A development in culturalist theorizing. European journal of social theory **5**(2), 243–263 (2002)
20. Zavala, L., Murukannaiah, P.K., Poosamani, N., Finin, T., Joshi, A., Rhee, I., Singh, M.P.: Platys: From position to place-oriented mobile computing. AI Magazine **36**(2), 50–62 (2015)