Let's Get Personal

Assessing the Impact of Personal Information in Human-Agent Conversations

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Abstract. Agents that are able to build relationships with the people they are interacting with are envisioned to be more successful in long-term interactions. Small talk about impersonal topics has been found an adequate tool in human-agent interactions for manipulation of such relationships. We suspect that an agent and the interaction with it will be evaluated even more positively when the agent talks about personal information it remembers about its interlocutor from previous encounters. In this paper a model of person memory that provides virtual agents with information needed in social conversations is presented. An interaction study demonstrates the impact of personal information in human-agent conversations and validates the performance of our model.

Keywords: conversational agents, intelligent virtual agents, human-agent interaction, person memory, social conversations, interaction study

1 Introduction

In conversational and intelligent virtual agent research an important goal is to create agents that are able to build relationships with the people they are interacting with. This goal is motivated by the fact that virtual agents develop from tools to human-like partners [20].

Small talk has been found an adequate tool in human-agent interaction to, e.g., increase trust, which is an important prerequisite for close relationships. Considering theories on politeness strategies and *face work*, initial approaches focused on impersonal topics, like the weather, when engaging the agent in small talk with its interlocutor [3]. According to these theories, talk going beyond safe impersonal topics would seem inappropriate in initial encounters and therefore could threaten the development of a closer relationship.

For a relationship to develop from superficial acquaintance towards a level of closer friendship, personal matters are important. Bringing personal topics to the table is a sign of high involvement and signals willingness to deepen a relationship. One common approach to introduce more personal information in repeated human-agent conversations is to let the agent use a strategy of self-disclosure [12]. However, this information is centered around the agent.

To enable conversational agents to exhibit more appropriate behavior in social encounters, we [14] proposed to equip such agents with a person memory and demonstrated how this memory can be populated with personal information during initial encounters [16]. In more recent work we showed how the personal information can be exploited by our agent during conversation [17], [18].

Based on findings on *relational work* [21], we expect that an agent and the interaction with it will be evaluated more positively by human interlocutors, with regards to, e.g., likability and communication satisfaction, when the agent talks about personal information it remembers about its interlocutor from previous encounters.

In this paper we present our model of person memory and the results of a first interaction study we conducted to test our hypotheses. In Section 2, an overview of related work is given. We describe the key ingredients used in our model of person memory in Section 3. In Section 4, the interaction study and its results are presented.

2 Related Work

Various approaches have been proposed where different levels of behavior of virtual agents are adapted to achieve increased believability. It has been examined how to adapt the agent's display of emotions [2], and gesturing [10]. Also, influences of personality [13], and the interlocutors' cultures [7], on conversational behavior have been investigated. These approaches have in common that they focus on processes that affect the interpersonal relationship between the agent and a person the agent interacts with. As conversational agents start to appear in everyday interaction scenarios, the question arises how to provide agents with information fundamental for being able to handle repeated social encounters.

Most approaches dealing with virtual agents that are to operate in long-term scenarios rely on human-like memory systems, i.e. autobiographic and episodic memory [9], [6]: Autobiographic memories can be used to increase the performance of storytelling or narrative agents [9]. Episodic memories can be used in domains where learning and reasoning about actions is a crucial task [19], [6]. However, both these kinds of memories have in common that they are egocentric systems with the experiences of the agent in focus.

We question if an egocentric memory component is sufficient to handle the requirements that come up in social encounters. So, what would be the requirements of a person memory for a conversational agent?

3 Ingredients of a Person Memory for a Conversational Agent

We identified the following ingredients as crucial for a person memory for conversational agents (see. Fig. 1):

1. Representations of **persons** and **social categories**

2. A representation of the **interaction context** that integrates knowledge of the **social situation** and representations of the individuals
3. **Social memory tasks** and **social strategies** that function as operating rules and instructions on how to deal with the provided information
4. A **Person Memory Processing Unit** that provides an interface between the person memory and the agents cognitive architecture

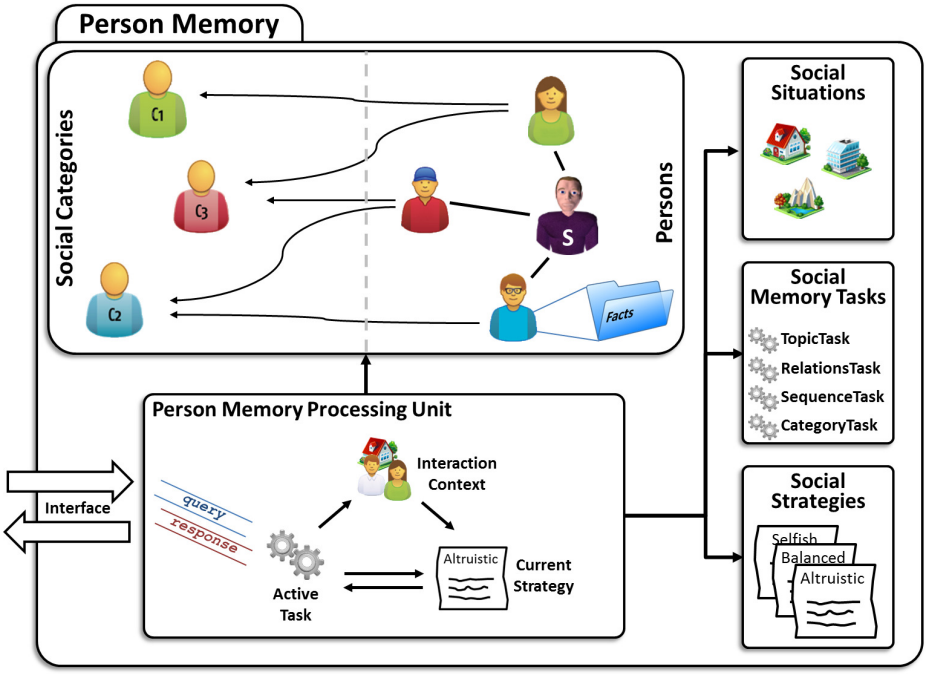

Fig. 1: Model of the person memory. Besides individual and generic representations (social categories) of persons, the model contains information of social situations, social memory tasks, and social strategies. The Person Memory Processing Unit delegates incoming queries to memory tasks appropriate in a given interaction context. The white S denotes the representation of the agent's self.

3.1 Persons and Social Categories

The heart of our model of person memory consists of representations of the persons the agent interacts with. We consider the following information as fundamental to be remembered about a person (cf. [16]): biographical facts, preferences and interests, personality traits, events, and relationship information.

The *individual* representation of a person consists of instances of such types of information. During encounters such information is stored directly in the individual representation. Figure 2 depicts example representations of the embodied conversational agent Max and a person known by the agent. In addition to the information stored in the individual representation, further generic representations may be linked which derive from *social categories*.

Key	Value
name	Max
age	14
hometown	Bielefeld
knows	[Person: Paula]
knows	[Person: Paul]
interest	[Interest: chess]
interest	[Interest: music]
memberOf	[Category: extrovert]
memberOf	[Category: artificialperson]

Key	Value
name	Paula
age	26
hometown	Bielefeld
knows	[Person: Max]
interest	[Interest: music]
interest	[Interest: cinema]
memberOf	[Category: introvert]
memberOf	[Category: sportsstudent]

Fig. 2: Two examples of individual representations in the person memory of the conversational agent Max: a representation of Max himself and a representation of a person Paula known by Max.

Within the person memory social categories are used to represent stereotypical information of groups of people, for instance shared interests and preferences. Furthermore some information, like personality traits and relationship, can be inferred from such generic representations (see [18]). During conversation with a person of a certain category, the agent can use the stereotypical information as hints of what the interlocutor might like to talk about.

3.2 The Interaction Context and Social Situations

Not only the personality of individuals, and the relationship between them, affect the interactant's behavior, but also the social situation the interaction takes place in [22]. So it is not sufficient to consider an interaction between two individuals without its context.

In our model, the interaction context consists of the social situation and the combined representations of the agent and the interlocutor (see Fig. 1). By joining the representation of the *I* (agent's self) and the representation of the *You* (interlocutor), a representation of the *We* is constructed, consisting of generic and individual information that is relevant to the current social situation.

A representation of a social situation contains a description of the situation (e.g., name, type, location) and information that can have influence on the agent's behavior towards its interlocutor. The social categories described in Sect.

3.1 may contain triggers that are sensitive to certain situations. This allows to include information from specific categories when triggered by a social situation (cf. [18]).

To exploit the information provided by the interaction context, the agent is equipped with *Social Memory Tasks* and *Social Strategies*.

3.3 Social Memory Tasks and Social Strategies

As described in [17], three different kinds of tasks are associated with the information of a memory: storage, access, and manipulation. Two groups of social memory tasks (*core* and *extended* tasks) fulfill these actions in the person memory: Tasks of the first group handle basic actions, like storage of new information, or retrieval of existing information. Tasks of the second group carry out more context based information retrieval and manipulation on the data provided by, e.g., the interaction context. Examples for tasks of the second group are:

- Calculating probabilities for the use of
  - dialogue sequences (*"Question/Answer"* vs. more complex sequences like *"Question"*/ *"Counter"*/ *"Probe"*/ *"Reply"*, cf. [15])
  - topics from different topic categories (*"communication"*, *"immediate"*, *"external"*, cf. [5])
- Selecting a topic category according to the calculated probabilities
- Selecting a topic (from this category) for conversation

While core tasks are predefined operations, extended tasks can be exchanged dynamically at run time. This allows to define tasks that include different information when, for instance, selecting a topic the agent should bring up during conversation: While one task takes all available information into account that is located in the interaction context about the interlocutor and the agent, a second task may only consider the representation of the agent.

To activate appropriate tasks for a given situation the person memory contains a set of instructions in the form of *social strategies*. Each social strategy contains at least one *trigger* that is sensitive to certain social situations. Furthermore social strategies contain a mapping of social memory tasks to *keywords*. The keywords are predefined and used to identify tasks in the person memory.

3.4 Person Memory Processing Unit

The *Person Memory Processing Unit* (PMPU) provides an interface between the person memory and the cognitive architecture of an agent. In that, it handles the communication between different components, like a dialog manager, or further memory components.

This way, the proposed model of Person Memory enables an agent to cope with social encounters that may occur in different application scenarios. The information provided about the persons an agent interacts with, and the strategies that influence how the information is exploited, allow for an adaptation of the agent to different settings [18].

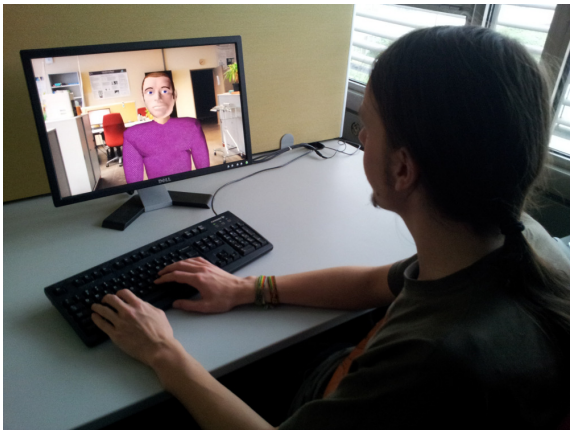

Fig. 3: Setup used for our interaction study: A human interlocutor and the virtual agent Max conducting a conversation.

4 Assessing the Impact of Personal Information in Human-Agent Conversations

One of the assumptions that motivated the development of the person memory presented in this paper, is that personal information can be exploited to enhance the interactions between a virtual agent and its human interlocutors. For instance, based on work by Deborah Tannen, Svennevig [21] states that in human-human conversations *"the preference for personal topics is a case of involvement in the interlocutor."* (p. 52). To assess the impact of personal information in human-agent conversations, and thereby evaluating the performance of our model of person memory, we conducted an interaction study with 22 particpants (see below).

4.1 Setup and Hypotheses

An embodied conversational agent, Max, is used in our work as research platform for human-computer interaction (see Fig. 3). Max's usefulness as a conversational partner is already demonstrated in a museum setting where he explains exhibits and engages visitors in small talk conversations since 10 years [11].

The study was split into two sessions: an initial interaction (*getting to know*) and a second encounter (*meeting again*). In both sessions, particpants were asked to get seated in front of a 24" computer monitor that was used to display the agent (Fig. 3). The particpants had to input their utterances using a keyboard, while Max's questions and answers were generated by a voice synthesizer.

During the first encounter participants were engaged in a short small talk with our agent. They were instructed that the first interaction is to get comfortable with the agent and the way of interacting with it, and that Max would end the conversation. Max used this first encounter to gather personal information, like interests and hobbies (e.g., *"Do you like to read?"*), about its interlocutor. The participants were asked to come back for a second conversation with Max.

In advance of their second encounter with Max, participants were randomly assigned to two groups (while maintaining gender balance between both groups), leading to a *between-subject* design of our study. In conversations with members of the first (control) group (**Group A**, $N = 11$), Max did not exploit the information stored in his person memory, by using customized tasks and strategies (see section 3.3). Instead he sticked to impersonal topics about the immediate and external situation, like the weather and recent events in the surrounding (e.g., *"A lot of construction going on here in the university building, right?"*).

During conversations with members of the second group (**Group B**, $N = 11$), Max recalled personal information it gathered in the first encounter and used this information as topics for the ongoing conversation (e.g., *"Are you reading something special right know?"*). Again participants were told to wait until Max ended the conversation.

Our hypotheses were as follows: If the agent Max exploits the personal information of his person memory during conversation, then

H1 the social presence of Max will be rated higher.
H2 Max's interlocutors will be more satisfied with the conversation.
H3 the impression that Max knows and remembers oneself is stronger.
H4 the participants' trust in the agent is stronger.
H5 the overall impression of Max will be more positive (in terms of sympathy, friendliness etc.).

4.2 Questionnaire

To assess how the agent is perceived in terms of social presence (*SP*), 3 items from a social presence questionnaire from [1] and 6 items of the *Networked Minds Social Presence Inventory* [4] were selected. Factor analysis with varimax rotation revealed two underlying factors that explain 58.09% of the variance. Cronbach's α was .82 for the first factor (5 items) and $\alpha = .8$ for the second factor (4 items).

In addition, 11 items from the *Interpersonal Communication Satisfaction Inventory* [8] were used to test how the interlocutors liked the overall conversation (*CS*). Again a factor analysis with varimax rotation resulted in two factors explaining 54.83% of the variance. Cronbach's α was .91 for the first factor (8 items) and $\alpha = .78$ for the second factor (3 items).

Three items (only included in Session 2) were used to test hypothesis **H3** (Cronbach's $\alpha = .81$). To test hypothesis **H4** an additional item (*"If nobody else was in the room, I would have no problem telling personal secrets to Max."*) from the questionnaire of [1] was used. As manipulation checks (*MC*), two items were added that focused on whether the topics of the conversation were considered personal or impersonal. All items were rated on a 7-point Likert-scale (with 1=*strongly disagree*, 7=*strongly agree*).

A semantic differential with 15 bi-polar adjective pairs (7-point scale) was used to assess the overall impression of Max (**H5**).

4.3 Participants

Participants were recruited within Bielefeld University through postings and a mailing list of people who previously attended interaction studies in the VR lab of our group. Initially a total of $N = 26$ people (7 females and 19 males) participated in our study.

However, two people had to be excluded from the final evaluation as they did not fully complete the questionnaires. Two further participants were excluded, since the conversational agent system got stuck during the interaction. Thus, in the final evaluation $N = 22$ particpants (11 particpants per group) were considered, with a mean age of 30.27 ($SD = 12.78$), ranging from 20 to 64. 17 of the participants were students.

The average time between first and second session was 6.23 ($SD = 1.82$) days, with an average duration of conversations of 6.17 ($SD = 1.58$) minutes in Session 1 and 4.2 ($SD = 0.80$) minutes in Session 2. No significant difference was found in terms of time between sessions and duration of conversations.

4.4 Results

The non-parametric *Mann-Whitney U* test was used to compare the results of the questionnaires of both groups.

Session 1 Since the first session did not differ between groups, it was expected that there should be no statistical significant differences in the results. This held true for the *SP* and *CS* factors. However, a significant difference was found for one questionnaire item (*"The conversation flowed smoothely."*) in the first session ($Mdn_A = 5$, $Mdn_B = 6$, $U = 22.00$, $z = 2.61$, $p < 0.05$, $r = -0,56$), and for one dimension of the semantic differential (*superficial - profound*, $Mdn_A = 3$, $Mdn_B = 5$, $U = 28.50$, $z = 2.14$, $p < 0.05$, $r = -0.46$). These differences did not emerge in the results of the second session. For the remaining items no significant differences were found for the first session, as expected.

Session 2 Hypothesis **H1** predicted that Max's social presence will be rated higher when he uses more personal information during conversations. However, there were no significant differences in the factors that constitute the *SP* measure. Thus, hypothesis *H1* was not supported. Still, a significant difference was found in one item directly targeting the presence of Max (table 1, item 1).

Hypothesis **H2** predicted that the participants will be more satisfied with the conversation when Max uses personal topics. Both *CS* factors showed a significant difference (CS_{F1}: $Mdn_A = 38.00$, $Mdn_B = 44.00$, $U = 31.00$, $z = -1.94$, $p < 0.05$, $r = -0.41$; CS_{F2}: $Mdn_A = 13.00$, $Mdn_B = 17.00$, $U = 15.00$, $z = -3.01$, $p < 0.05$, $r = -0.64$). Thus, hypothesis *H2* was confirmed. Four out of 11 items were found to show a significant difference (see table 1, items $2 - 5$).

All items that were used to test hypothesis **H3** were found to show significant differences between both groups as depicted in table 1 (items $6 - 8$). Thus, hypothesis *H3* was confirmed. Furthermore, the results of items 9 and 10 show

Table 1: Results of the statistical analysis for selected items of the social presence (SP), communication satisfaction (CS), person memory performance (PM), and manipulation check (MC) parts of the questionnaire. Among the medians Mdn for both groups, the U value of the Mann-Whitney test, z-score, level of significance p ($* < 0.05$, $** < 0.001$), and effect size r are given.

		Item	Mdn_A	Mdn_B	**U**	**z**	**p**	**r**
SP	1.	I perceive that I am in the presence of another person in the room with me.	3	5	26.50	$-2,27$	$*$	$-0,48$
CS	2.	We talked about something I was not interested in.	3	2	27.00	-2.28	$*$	-0.49
	3.	I was very dissatisfied with the conversation.	3	1	33.00	-1.86	$*$	-0.40
	4.	Max genuinely wanted to get to know me.	3	5	10.00	-3.38	$**$	-0.72
	5.	I would like to have another conversation like this one with Max.	5	6	31.00	-1.99	$*$	-0.42
PM	6.	I had the feeling that Max knows me.	4	6	13.00	-3.18	$*$	-0.68
	7.	Max remembered me very well.	4	7	4.00	-3.81	$**$	-0.81
	8.	Max did not remember me at all.	1	1	33.00	-2.46	$*$	-0.52
MC	9.	The questions that Max posed were very personal.	2	5	23.00	-2.53	$*$	-0.54
	10.	The questions that Max posed were very impersonal.	5	3	24.00	-2.44	$*$	-0.52

that the topics addressed by Max were judged as more impersonal resp. personal in the corresponding conditions.

Considering the results of the item used to test hypothesis **H4**, the hypothesis was not confirmed: Participants of both groups rejected the idea of telling personal secrets to the agent ($Mdn_A = 2$, $Mdn_B = 3$), with no significant difference between groups.

The results of the semantic differential are given in fig. 4. Compared to the results of all participants of the first session, four dimensions (*superficial–profound*, *silly–serious*, *reliable–unreliable*, *offhanded–chatty*) were rated in a more positive direction and only two more negatively (*impolite–polite*, *introverted–extroverted*) by participants of *Group B*. Whereas none of the dimensions were rated better and 12 more negatively by participants of *Group A*. Between groups, five dimensions (*unsocial–social*, *reliable–unreliable*, *personal–impersonal*, *likeable–*

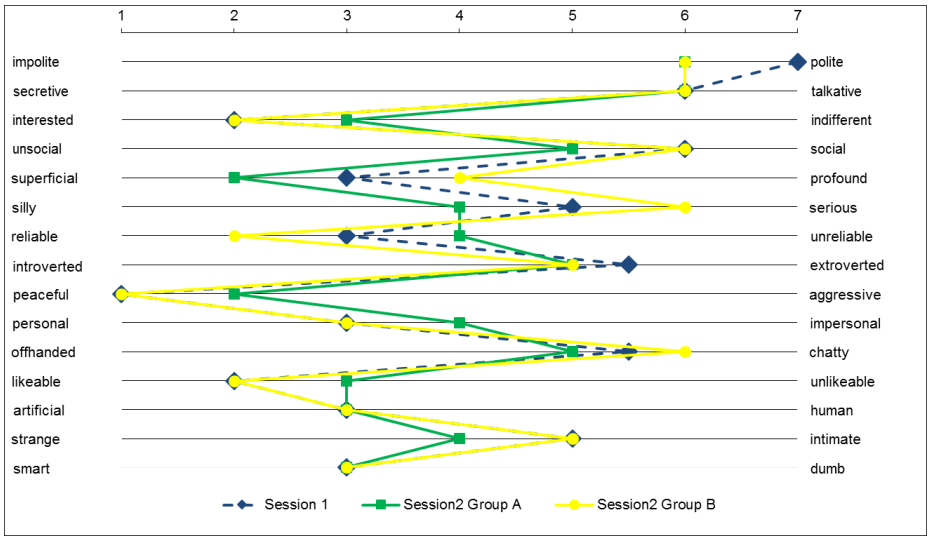

Fig. 4: Results of the semantic differentials used to assess particpants' attitudes towards the agent.

unlikeable, *strange–intimate*) showed a significant difference ($p < 0.05$) in Session 2.

4.5 Discussion

Given the overall results, we conclude that the use of personal topics indeed has quite a *positive impact* on human-agent conversations. Participants were *more satisfied* with the conversation and had a *more positive attitude* towards our agent after the second conversation.

The social presence of Max was not found to be affected by the use of more personal topics in conversation. Furthermore, both groups scored rather low on the two factors of social presence (normalized median factor scores for *Group A* are $SP_{F1} = 4.4$, $SP_{F2} = 3$, and $SP_{F1} = 4.8$, $SP_{F2} = 4$ for *Group B*). An explanation could be the setup of our study: Reactions of our agent were generated based on keyboard input only, no camera or microphone were attached to provide further input to the agent. While this was necessary to prevent uncontrollable behavior of the agent, the agent did not appear to genuinely take notice of the participants.

Regarding our model of person memory, the interaction study demonstrated that it enabled the agent to *successfully remember* useful information as hypothesis *H3* was confirmed. Remarkably, most participants of the control group felt that Max somehow remembered them as well (see table 1, item 8, $Max_A = 4$), although he did not explicitly talk about their first conversation or information stored in his person memory. This could be due to the fact that Max talked about things going on in the university and most of the participants were students.

5 Conclusion

In this paper, a model of person memory for artificial agents was presented. The main ingredients we identified – representations of persons and social categories, knowledge about social situations, social memory tasks, social strategies, and a central processing unit – build a foundation for a *social memory component* in the architecture of a conversational agent.

Our initial interaction study demonstrates that our model can be successfully exploited by our agent to *obtain, store*, and *recall* information about his interaction partners. Furthermore, the mechanisms to guide the agent's conversational behavior were successfully used to *adapt* the agent according to the two conditions (i.e., use of impersonal resp. personal topics) of our study.

The results of our initial interaction study show that social conversations between an agent and its human interlocutors *benefit* from the use of personal information in subsequent encounters. This we regard as evidence that we are on the right track by stressing the importance of a specialized memory component to represent the people an agent interacts with, as done within our person memory.

We expect a more thorough interaction study, where additional aspects of an agent's behavior are adapted according to the individual representations of the agent's interaction partners (see [16]), could further underpin these findings.

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