Strangers and Friends
Adapting the Conversational Style of an Artificial Agent

Nikita Mattar and Ipke Wachsmuth

Artificial Intelligence Group, Bielefeld University
Universitätsstr. 25, 33615 Bielefeld, Germany
[nmattar|ipke]@techfak.uni-bielefeld.de

Abstract. We demonstrate how an artificial agent's conversational style can be adapted to different interlocutors by using a model of Person Memory. While other approaches so far rely on adapting an agent's behavior according to one particular factor like personality or relationship, we show how to enable an agent to take diverse factors into account at once by exploiting social categories. This way, our agent is able to adapt its conversational style individually to reflect interpersonal relationships during conversation.

Keywords: embodied conversational agents, conversational style, social categories, personality, relationships, situational context

1 Motivation

More than two decades ago, Wahlster and Kobsa [19] argued that systems employing long-term models of users are not in the focus of interest, one reason being privacy concerns. That the systems did not need to account for recurring interactions since these did not happen that often, was considered another important reason.

With nowadays technology, these assumptions do not seem to hold anymore. Smartphones bring technology to our fingertips that is consulted on a daily basis and that is able to have access to voluntarily provided private data of their owners. The availability of such technologies fosters the need for more natural interaction metaphors. For instance, Apple's Siri allows users to use natural language to query information, delegate tasks, and to have minimal task-related conversations (e.g., adding a new appointment in the calendar). Embodied conversational agents (ECAs) go even further, exploiting factors like personality characteristics or interpersonal relationships of the interlocutors [1]. Still closer to human-like partners, in terms of length of interaction and closeness of relationship, are companion agents as envisioned by Yorick Wilks [20]. If his vision came true, encounters with more than one human are inevitable. Such agents would need facilities to keep track of their relationships with different individuals and to adapt accordingly.

However, most of the current approaches do not pay enough attention to the interaction between the factors that play a role in human-human interaction.

Research findings in psychology indicate that the factors are interwoven and cannot be considered in separate that easily. Therefore, we stress the importance of providing artificial agents, that are to engage in long-term interactions, with means to represent individual information about different persons and the conversational style that is appropriate for the agent to use when interacting with a certain interlocutor. Access to this kind of information should allow an agent to regard the interaction in its individual interpersonal context.

The paper is structured as follows. In Sect. 2, work on conversational systems taking personality factors and interpersonal relationships into account is reviewed. Section 3 is dedicated to the factors that influence conversational style. In Sect. 4, our approach of exploiting a Person Memory to control the conversational behavior of a virtual agent is presented. The paper concludes with a brief summary and hints about future work.

2 Related Work

The possibility of equipping a technical system with a human-like embodiment changed the intended use from mere tools to systems, in which the relationship to the user influences the success of the system. For example pedagogical agents have to interact over a longer period of time with an individual learner where embodiment fosters the development of a relationship. In turn, the relationship has important effects on the learner [7].

Even in single-encounter interactions, the relationship plays an important role. Bickmore and Cassell [1] demonstrated how small talk can be used to affect the (trust) relationship between an agent and its interlocutor in a task-oriented interaction. The authors found that their real estate agent REA when engaging in small talk was more preferred by extroverts than by introverts [1]. In more recent work, Bickmore and Schulman describe their approach on building and influencing a relationship [2]. Here, dialogue acts are grouped into four relationship categories (stranger/professional, more than professional relationship, casual friend, close friend). While their system is able to infer the current relationship, it is not able to change the relationship into a more intimate direction. As one reason why their system fails to do so, they regard individual differences in the behavior tolerated as appropriate for a given relationship.

While the former approaches are concerned with the effects of the type of relationship on the interaction, Mairesse and Walker [11] examined how the personality of a system and its interactants influence their conversation and demonstrate how utterances of a dialogue system can be adapted according to different personalities. They show that the utterances produced by their system can reliably be assigned different personalities.

The systems described above have in common that they attempt to improve human-computer interaction by adapting the system's conversational behavior in respect to relationship or personality factors. In social psychology, factors that affect the conversational behavior are referred to under the term **conversational style**, as discussed in the following.

3 Influences on Conversational Style

According to Tannen [17], conversational style is not to be understood as something humans can choose to use during conversation or not. Stylistic strategies make up the conversational style of a person. Tannen states that the repertoire of strategies are determined by the individual's context (e.g., a narrow geographical region or a culture), and are habitual and rather learned automatically. This way conversational style of a person can serve as an indicator for a person's personality [17].

In social psychology, **personality traits** are an important tool to describe differences in human behavior. The Five Factor Model (FFM), one of the most prominent models to describe personality [15], comprises of the so called *Big Five* dimensions *Openness*, *Conscientiousness*, *Extraversion*, *Agreeableness*, and *Neuroticism*. It has been widely used in ECAs to model the personality of the agent, the interlocutor, or even both. Some of the traits are directly linked to conversational style. For instance, extroverted people tend to be more talkative and socially engaging, whereas introverts are more shy and reserved, especially during initial encounters. Conscientiousness, being an indicator of self-control, has effects on disclosure of personal information [15]. Mairesse [10] summarizes further effects of the Big Five personality traits on linguistic features. Furthermore, according to the similarity-attraction hypothesis, similarity in personality traits can serve as an indicator about how relationships develop. The more similar two persons are in a certain personality trait, the more likely they develop a closer relationship [16], [15].

Different models have been developed to describe **relationships**. In Bickmore and Picard's review of work on human-human relationships [4], the following five types of models are listed: *dyadic*, *provision*, *economic*, *dimensional*, and *stage models*. According to them, dyadic models are the most prominent in recent social psychology research. Here, a relationship is made up of the interpersonal interaction and the **situational context** of the interlocutors [21]. Since the behavior of one partner depends on the behavior of the other, a person with a certain personality does not necessarily behave in the same way in every interaction [16], [14], [21]. In dimensional models, which are frequently used in ECA design [8], diverse dimensions have been used to describe a relationship (see e.g., [16], [3]). Some of these dimensions, like dominance, friendliness, distance, or intimacy, are used to assess the level of emotional appraisal [8], use of certain topics, use of structural elements, irony, humor, and the tendency to be more agreeing or confronting during conversation [18], [6], [17].

In summary, several factors determine the conversational behavior of persons. Some of these factors depend on the individual relationship and the direct interaction of the partners. In human-human interaction, most of these factors are not under the direct control of the individuals. Nevertheless, personality traits, individual relationships and the situational context have influence on the conversational style. To enable an artificial agent to adapt its conversational style to different types of interlocutors (in particular, strangers or friends) our idea is to equip an agent with a Person Memory.

4 Exploiting an ECA's Person Memory to Adapt Conversational Style

Our model of Person Memory [13] enables the embodied conversational agent Max [9] to remember and retrieve information about the diverse interlocutors he interacts with. Furthermore, Max is able to exploit existing information to react to different kinds of persons. The model consists of two parts (see Fig. 1): The first part is used to represent information about groups of individuals in the form of *social categories*. The second part is used to represent information about individuals like *biographical facts, preferences,* and *events*.

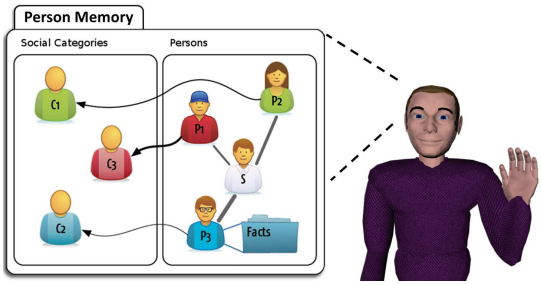

Fig. 1: Max and his model of Person Memory [13]. Social categories and individual information are associated to certain persons.

The Person Memory is embedded into the static knowledge layer of the agent's deliberative component that was introduced in [9] (cf. Fig. 2). In the deliberative component we differentiate dynamic knowledge, that is maintained during an ongoing conversation, and more static knowledge, that consists of long lasting information. In addition to the representation of the agent itself (denoted with S in Fig. 1), a representation of a person is *activated* in Person Memory when an interaction with a certain individual starts. The Person Memory transfers information relevant to the current interaction into the situation and discourse model as it has direct access to the dynamic knowledge layer (see Fig. 2). During conversation, different components use this information to influence the selection of appropriate dialogue plans.

In earlier work [13], we used information from the Person Memory to determine suitable subjects for initial conversations with strangers (cf. Fig. 3). A further extension of the deliberative component [12] allows to control the types of **dialogue sequences** Max uses during conversation (e.g., "*Question/Answer*" vs. more complex sequences like "*Question/Counter/Probe/Reply*"). The process of social categorization can now be extended to hold information on how to influence the conversational style according to different personality traits, relationships and further factors, like social roles, for instance by influencing the agents choice of such *dialogue sequences*.

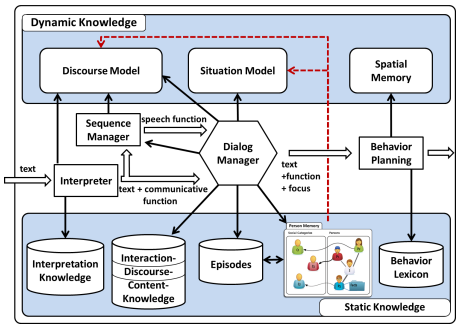

Fig. 2: Deliberative component of our ECA Max ([9], extended). The Person Memory has direct access to the dynamic knowledge layer.

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...
Agent: I have never met you here before, Paula.
       Are you waiting for someone?
Paula: Yeah, I am waiting for a friend of mine.
Agent: Do you study computer science? Most of
       the people I meet here do.
Paula: No. I am a student of sport sciences.
Agent: Oh, nice to finally meet someone from
       another discipline.
Agent: So do you live here in Bielefeld?
Paula: Yes, I moved here two years ago.
Agent: Oh, ok.
Agent: Did you see the last match of Bielefeld's
       soccer club?
Paula: Yes, that was a great game.
...
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Fig. 3: Excerpt of a conversation between our agent and a previously unknown person [13].

4.1 Representing Personality Traits, Relationships, and Social Roles in Person Memory

Building on our previous work, a certain type can be assigned to a category, to distinguish between them in the Person Memory. Three types – *Relational*, *Personality*, *Generic* – for representing categories that describe relationships, personality traits, and generic social categories, respectively, are used (see Fig. 4). Categories of the types *Relational* and the subtypes of *Personality* are considered mutually exclusive. That is, every person in the Person Memory can only be assigned one relational and one personality category for each personality dimension at a given time. However, the same person can belong to several generic categories at once. Note that categories like *boss*, *co-worker*, etc., that could also be considered relational categories, are treated as social roles and therefore belong to the generic categories.

In addition to the information we previously associated with social categories [13], information that has impact on the conversational style of the agent can now be provided. Table 1 depicts a sample category C. Slots with the name *sequence* are used to represent information about the **choice of dialogue sequences** [12]. In this case, the optional argument [*Arg*] is used to specify a probability $\in [0, 1]$ for the agent to choose a certain sequence when its interlocutor belongs to the category C. In this example three types of dialogue sequences can be used by the agent during conversation: *short, medium*, and *long*. The sum of the probabilities is normalized to 1. It is possible to only provide probabilities for some of the sequences. The difference between the sum of the probabilities provided and 1 is distributed equally among the remaining sequences.

The **use of topics** is implemented following Breuing and Wachsmuth's [5] approach. The *topic*-slots hold information about the probability for the agent to use topics from a certain topic category (immediate, external, communication).

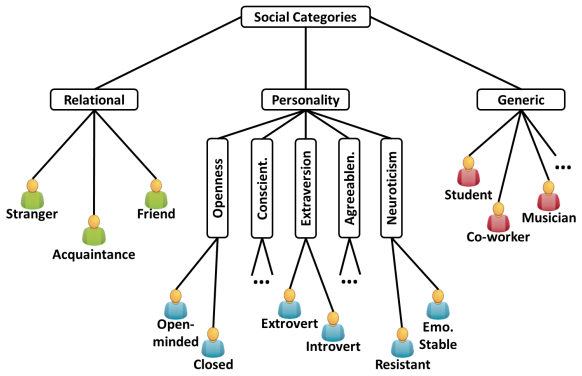

Fig. 4: Types of social categories in our Person Memory.

The Situational Context. Among the *active* representations of the agent and its interlocutor (see above), the situational context of the interaction is constituted by a set of "salient" social categories: a relational category, categories of the different personality dimensions, and further generic categories. Note that a person is always assigned to a relational category, whereas personality categories, and other generic categories are optional. Whenever an interaction starts, the Person Memory accesses the situational model of the dynamic knowledge layer (see Fig. 2). On the one hand, the situational model includes descriptions, like name, location, and type of the current situation (cf. Table 2) that can trigger certain categories (e.g., second and third slot in Table 1). On the other hand, weights $w_g, w_p, w_r \in [0, 1]$, with $w_g + w_p + w_r = 1$, for the three types of categories can be provided. Again, the difference of the sum of the probabilities of the provided categories and 1 is distributed equally among the remaining categories.

Combining Several Categories. Since several categories can contain information influencing the agent's conversational style, there needs to be a way of combining this information. To give an idea, the final probabilities for the *choice of dialogue sequences* are calculated as follows.

Let $S = \{short, medium, long\}$ be the set of available sequences, C_g, C_p, C_r three categories of the types *Generic*, *Personality*, *Relation*, respectively, and T the current situation with weights w_g, w_p, w_r. Since the sum of these weights is normalized to 1, they can be used to represent the prior probabilities $P(c_j) = w_j$, with $w_j \in \{w_g, w_p, w_r\}$, of a category $c_j \in \{C_g, C_p, C_r\}$. The law of total probabilities can be applied to determine $P(s_i)$:

$$P(s_i) = \sum_{j \in \{g,p,r\}} P(s_i|c_j)P(c_j) \ . \tag{1}$$

The final probability values $P(s_i)$ are transferred into the discourse model as described above. In this case, the sequence manager (see Fig. 2) uses these probabilities to determine which dialogue sequence the agent uses next.

Table 1: Excerpts of a social category representing information influencing the conversational style.

Slot	Value	[Arg]
cat_type	generic	
trigger	situation_type	casual
trigger	situation_location	work
sequence	short	0.75
sequence	medium	0.15
sequence	long	0.1
topic	immediate	0.6
topic	external	0.25
topic	communication	0.15
...	...	...

Table 2: Two different situations.

Slot	Value	[Arg]
situation_name	freetime	
situation_type	casual	
situation_location	home	
cat_weight	relational	0.7
cat_weight	personality	0.3

Slot	Value	[Arg]
situation_name	lunchbreak	
situation_type	casual	
situation_location	work	
cat_weight	generic	0.5

4.2 Encounters with Strangers and Friends

With the extensions of the Person Memory introduced above, our ECA Max is now able to adapt his conversational style taking several factors into account.

In Fig. 5, four encounters $E1_a$, $E1_b$, $E2_a$, $E2_b$, with two persons P_a, P_b, taking place in different situations $S1$, $S2$ are depicted. Situations $S1$ and $S2$ correspond to the situations depicted in Table 2. Person P_a is considered to belong to the category *stranger*, P_b to the category *friend*. In addition, both are assigned to the personality category *introvert* and a generic category *co-worker*. Next to the categories, the probability models for the *choice of dialogue sequences* $p_{C_j}(S)$ and for the *use of topics* $p_{C_j}(T)$ are given. The first, second, and third value denote the probabilities for *short*, *medium*, and *long* dialogue sequences, and *immediate*, *external*, and *communication* topic categories, respectively. The generic category only influences the *use of topics*, since no probabilities for the *choice of dialogue sequences* are given. The final probability models $p(S)$ and $p(T)$ for each encounter are calculated as described in Sect. 4.1.

The weights of situation $S1$ let the relational category of the interlocutor dominate the conversational style in encounters $\boldsymbol{E1}$. Whereas in encounters $\boldsymbol{E2}$, the generic category *co-worker* has the strongest influence on the conversational style of the agent. In both encounters $E1_a$ and $E2_a$ with person P_a, the dialogue engine of the agent mainly produces dialogue sequences of the types *short* (e.g., *Question/Answer*). However, the agent is more likely to select topics from the communication topic category in encounter $E1_a$ than in $E2_a$. In the latter, the agent focuses on topics dealing with the immediate situation. In encounters $E1_b$ and $E2_b$ with person P_b, the difference in the conversational style of the agent becomes more evident. In encounter $E1_b$, the likelihood for the dialogue engine to select dialogue sequences of type *long* is much higher than in the more formal

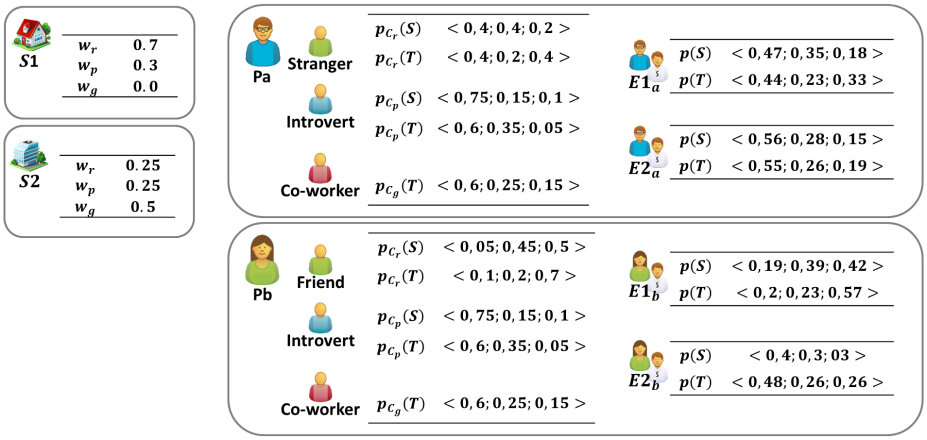

Fig. 5: Four encounters $E1_a$, $E1_b$, $E2_a$, $E2_b$, with two different persons P_a, P_b, taking place in different situations $S1$, $S2$.

encounter $E2_b$. Here the dialogue engine mainly uses *short* dialogue sequences, again. Furthermore, the agent focuses on private topics from the communication topic category in encounter $E1_b$, whereas he predominantly uses topics of the immediate situation in $E2_b$.

4.3 Discussion

As demonstrated in Sect. 4.2, the further exploitation of social categories enables the agent Max to integrate information like personality, relationship, and social roles with the ongoing situation. Therefore, Max is able to consider the individual interpersonal context the interaction takes place in. In encounters $E1$ in Sect. 4.2, the dialogue engine is able to take the private situation $S1$ into account. The agent focuses on the relationship and uses more private topics. Whereas, in encounters $E2$ the more formal situation is reflected. Whatever the relationship status between the interlocutors might be, discussing topics concerning the immediate situation is more appropriate than talking about private matters in a work context.

5 Conclusion and Future Work

In this paper, we demonstrated how information of a Person Memory can be used to adapt the conversational style of the agent Max towards different persons. While we showed how to manipulate two particular features, review of related work in Sect. 2, and the discussion of conversational style in Sect. 3, revealed more ways how conversational style can be influenced.

Currently, the dialogue engine of Max is able to differentiate between three relational categories (stranger, acquaintance, friend), two categories along the extraversion personality dimension (extrovert, introvert), and several generic social categories. However, while the dialogue engine is able to assign generic categories automatically during conversation (cf. [13]), right now mechanisms to assign the relational categories and to assess the interlocutors personality are in work to come.

The dialogues produced by our agent differ in the topics being talked about, and total length due to the selected types of dialogue sequences. A formal evaluation of these varying dialogues is planned as future work. In that, it will be examined if differences in the conversational style of Max can be correctly assigned to different person/situation constellations.

Besides an evaluation of the dialogues produced by Max, as a next step, we will focus on how to integrate and exploit strategies to change the relationship between an agent and its interlocutors into a certain direction (e.g., from stranger to friend). Building on the work presented, our agent will be enabled to choose among strategies appropriate for different individuals in different situations. To be noted, finally, the approach is not restricted to influencing conversational style and could be extended to trigger non-verbal behaviors like gesturing, use of eye contact, or proxemics and can therefore be exploited in diverse human-agent interaction scenarios.

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