

Lydia Ould Ouali¹, Charles Rich² and Nicolas Sabouret¹

¹ LIMSI-CNRS, UPR 3251, Orsay, France
Université Paris-Sud, Orsay, France
{ouldouali, nicolas.sabouret}@limsi.fr

² Worcester Polytechnic Institute
Worcester, Massachusetts, USA
rich@wpi.edu

1 Interpersonal relationship

Social relationship and its effects on behavior lies at the heart of social science. It was proved that understanding interpersonal relationship is crucial for social cognition [3]. Most of the literature that get interested in the conceptual analysis of interpersonal relationship have agreed that the essence of relationship appears in the nature of interaction that occurs between relationship partners. Moreover, social relationship is a dynamic system that may develop and change continuously over interactions [3, 4]. Communication between relationship partner will grow in stages from the initial interaction where partners share superficial information to a more deeper relationship where partners can share more personal information. Therefore, the social relationship of partners affects their behavior and their strategy of dialogue.

2 Representation of interpersonal relationship

The aim of this section is to relate the work of N.HASLAM who get interested on the mental representation of social relationship. In summary, there are three different representation in the literature.

The first is the dimensional representation. It is the most common representation that consists on represent relationships in a dimensional circle (c.f wiggins model). Therefore, any relationship can be situated and valued in this *continuous* dimensional space.

The second representation is the lawful representation. Laws are defined in the same circle's dimension of affiliation and control. The main difference with the dimensional representation is that laws try to make discrete prediction about the other behavior. For each behavior, complementarity and symmetry make discontinuous prediction about the the other interact behavior.

Finally, categorical representation make a discrete prediction on which kind of social relationship are well performed. In addition the categorical representation focus only on local prediction (prediction in a small region within a dimensional scheme).

Dimensions	Laws	Categories
Continuous	discontinuous	discontinuous
Local	Global	Local

2.1 Dimensions of interpersonal relationship

The definition of dimensions was widely studied under different labels. However, we distinguish four dimensions that are always used for the representation of interpersonal relationship.

Dominance and power Scholars from different fields converge to define power as the ability to influence the other behavior [4]. Power may be latent (Komter, 1989), which is in contrast with the definition of dominance which is inevitably manifest (Dunbar, 2004). It is an asymmetric variable in which one interactant's assertion of control is met by acquiescence from another (Rogers-Millar & Millar, 1979).

Familiarity In Svennevig's relational model [4], the definition of familiarity is based on social penetration theory (Berscheid and Reis, 1998) which describe the grades of relationship evolution through mutual exchange of information both in depth (superficial information to personal and intimate information) and breadth (from narrow to a broad range of personal topic).

Affect This dimension represents the degree of liking that have one interact for the other. This dimension allows interactants to create personal attachment and improve the relationship of interactants [2]

Solidarity The solidarity dimension is in the opposite of power dimension. It is a symmetrical dimension where two individuals share equal obligations and rights [4]. It is identified as like-mindedness [1] where interactants have the same behaviors and share for example the same preferences.

2.2 Dialogue utterances

In this paper we are interested in modeling a collaborative negotiation of preferences in the context of social dialogue. The negotiation takes its values during the dialogue when messages are exchanged between interlocutors. A message $M = \langle i \rightarrow j, s(\text{cont}), F \rangle$ is defined as triple where $i, j \in \{\text{agent, user}\}$ are the agents participating in the dialogue, $s \in \emptyset$ is the utterance used to express a message and $\emptyset = \{\text{Ask, Propose, Reject, Accept, State}\}$ represents the set of utterances that agents can express to exchange messages. $F \in \mathcal{F}$ where $\mathcal{F} = \{\text{Strongly, weakly, yelling, withhesitation...}\}$ is a set of multimodal features that are applied to the utterance to express a personal linguistic style or social move.

The social relationship evolves during the interaction and influence this later. We focus on the relation of dominance in this paper. $\text{Dom} = \{+, -, =\}$. For example, when $\text{Dom} = +$ represents the fact that the agent is dominant and the user is submissive. We assume a social relationship: $2^{\mathcal{F}} \times \text{context} \rightarrow \text{Dom}$ that tells which feature says in term of social move. The context represents all the previous knowledge of the speaker.

Preferences Now, that the model of communication is defined, we introduce the notion of negotiation on preferences. First, let's define the domain of preferences. We assume that the agent expresses its preference on a defined object based on one or multiple criteria.

- Objects O : Set of all possible objects of negotiation. For example, negotiate to find at which restaurant have dinner.
- Criteria C : represents the criteria or features of preferences on a defined object. For example, we assume that we can choose a restaurant based on one or several of the following criteria = {cuisine, ambiance, quality of food, price, location}. Each criterion has its domain of values that we note: $\forall c \in C$, D_c is its domain. For example $\text{cuisine} = \{\text{chinese}, \text{italian}\}$.
- $\forall o \in O, \forall c \in C$, we define $v(c, o) \in D_c$ as the objective value of preference attributed for the object o in the context of the criteria c . For example, Ginza is an expensive Japanese restaurant. Thus $v(\text{prix}, \text{Ginza}) = \text{expensive}$ and $(\text{cuisine}, \text{Ginza}) = \text{japanese}$.
- Let's now define interlocutor's preferences. $\forall \text{agent}_i$ that has to define its preference for an object, for example a restaurant. First, the agent has to know his preferences on quality criteria of this object represented as follows: Pref_i^C is a total ordered set of criteria. $\text{cuisine} >_c \text{price}$ means that the criteria of cuisine is more important for the agent_i than the price. Second, when the criteria is defined, the agent_i defines his preferences on the domain of this criteria. Thus, $\forall v_1, v_2 \in D_C$, the agent has a partially ordered preference on these values noted $\text{Pref}_i^C(v_1, v_2)$ can be represented as $v_1 >_C v_2$. For example, the agent prefers the cuisine criteria, and for the cuisine the $\text{agent}_i : \text{Pref}_i^{\text{cuisine}}(\text{Japanese}, \text{Chinese})$, means that agent_i prefers the Japanese cuisine than the Chinese. Second, once the criteria were defined, agent_i can define its preferences on the object "restaurant". Based on what we defined above, we conclude that defining a preference on an object is a multi criteria decision. Assume a function of decision Dec such that $\forall o_1, o_2 \in O \times O, \text{Dec}$ define an order of preference on these objects where $\{o_1 < o_2, o_1 > o_2, o_1 \approx o_2\}$.

Belief base and intentions In this section we present the agent belief on his preferences. We situate our definition in the context of social conversation between two people. Suppose $i, j \in \{\text{Agents}\}$.

We define $B_i \varphi$ the fact that agent i believes that an entity φ is true. For example, Agent_i like Chinese cuisine is represented $B_i \text{Pref}_i^{\text{cuisine}}(\text{Chinese})$.

$I_i \varphi$ means that agent i has the intention to do or communicate φ . We define: $U_i \varphi = \neg B_i \varphi \wedge \neg B_i \neg \varphi$, means that the agent i has no belief on φ . For example What type of cuisine do you like? is represented $U_j \text{Pref}_j^{\text{cuisine}}(*)$. We define axioms of cooperation that allows an agent to respond to a communication. Thus, $B_i \varphi \wedge B_i U_j \varphi \wedge B_i I_j B_j \varphi \implies I_i B_j \varphi$.

Utterances semantic Agents communicates using utterances that encapsulate the message and at each communicated utterance agents will update their beliefs

about the preferences of the other agent. Therefore an utterance is communicated to a need to update a belief. In the following we suppose that agent_i is the speaker and agent_j is the hearer.

- State.Preference($\text{Pref}_i(P_1, P_2)$) : I prefer P_1 to P_2 .
 - (facultatif)Preconditions: $B_i \cup_j \text{Pref}_i(P_1, P_2)$
 - Effects: $B_j \text{Pref}_i(P_1, P_2)$
- We define two variant valuations on stating preferences as follows:
 - State.Preference($P_i, *$): I prefer the most P_i .
 - State.Preference($*, P_i$): I don't like /hate P_i .
- Ask.Preference($\text{Pref}_j(P_1, P_2)$) : Do you prefer P_1 to P_2 ?.
 - Preconditions: $\cup_i \text{Pref}_j(P_1, P_2)$, $I_i B_i \text{Pref}_j(P_1, P_2)$
 - Effects: $B_j \cup_i \text{Pref}_j(P_1, P_2)$, $B_j I_i B_i$
- We define two variant valuations as follows:
 - Ask.Preference($\text{Pref}_j(P_1, *)$): Do you like P_1 ?
 - Ask.Preference($*$): What do you like ?. This case appear when the speaker has no belief on the hear preferences.
- Propose.Preference($V(\text{criteria}, \text{value})$): I think that *value* would be great.
 - Preconditions: $I_i \text{Pref}_j(V(\text{criteria}, \text{value}))$
 - Effects: $B_j I_i \text{Pref}_j(V(\text{criteria}, \text{value}))$, $B_j \text{Pref}_i(V(\text{criteria}, \text{value}))$
- Accept.Preference($V(\text{criteria}, \text{value})$): Okay, let's choose *value*. After receiving a propose utterance from the agent_j , agent_i might accept the proposal.
 - Effects: $B_{i,j} \text{Pref}_{i,j}(V(\text{criteria}, \text{value}))$
- Reject.Preference($V(\text{criteria}, \text{value})$): Sorry, I would choice something else.
 - Effects: $B_i \neg \text{Pref}_j(V(\text{criteria}, \text{value}))$
- Propose.Object($V(\text{object}, \text{value})$): I think that *object value* would be great.
 - Preconditions: $I_i \text{Pref}_j(V(\text{object}, \text{value}))$
 - Effects: $B_j I_i \text{Pref}_j(V(\text{object}, \text{value}))$, $B_j \text{Pref}_i(V(\text{object}, \text{value}))$
- Accept.Object($V(\text{object}, \text{value})$): Okay, let's choose *value*.
 - Effects: $B_{i,j} \text{Pref}_{i,j}(V(\text{object}, \text{value}))$
- Reject.Object($V(\text{object}, \text{value})$): Sorry, I would choice something else.
 - Effects: $B_i \neg \text{Pref}_j(V(\text{object}, \text{value}))$

2.3 Find utterances in dialogs

In the following I represented the utterances in the hand made dialogues. When analyzing the recorded dialogues, the utterances appears in a more implicit manner. For example, when Lauriane says: " Sinon j'aime bien japonais". here its a State.preference(Lauriane, leonor,japonais).Loenor perceives it as a propose and make a reject by saying : "Je n'aime pas du tout le japonais." Dialogue Utterance

2.4 Synthetic dialogue with utterances

In this section, I present a synthetic dialogue to illustrate the language definition. The goal of the agent is to invite the user to a restaurant. The Agent

has a predefined list of preferences of types of food (AgentPreferences = { +Indian, +Italian, -Japanese}) and the agent has no information on user preferences (UserPreferences = {}). In this example the Agent is peer with the user.

- | | |
|--|--|
| 1. A: Would like to have dinner with me ? | 1. Propose.Preference(A,U,dinner). |
| 2. U: Yes, that would be great. | 2. Accept.Preference(U,A,dinner). |
| 3. A: What kind of food do you prefer ? | 3. Ask.Preferences(A,U,UserPreferences) |
| 4. U: I like Japanese food | 4. State.Preference(U,Japanese) |
| 5. A: Oh, I really don't like japanese food. | 5. RejectStrongly.Preference(A,U,Japanese) |
| 6. U: Ok. What do you prefer ? | 6. Ask.Preferences(U,A,AgentPreferences) |
| 7. A: I like italian food | 7. State.Preference(A,italian). |
| 8. U: Yeah, I like italian food too. | 8. State.Preference(U,italian). |
| 9. A: So let's have dinner at an italian restaurant. | 9. Propose.Preference(A,U,Italian). |
| 10. U: perfect for me! | 10. Accept.Preference(U,A,Italian). |

References

1. Timothy W Bickmore and Rosalind W Picard. Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 12(2):293–327, 2005.
2. Carolyn Y Nicholson, Larry D Compeau, and Rajesh Sethi. The role of interpersonal liking in building trust in long-term channel relationships. *Journal of the Academy of Marketing Science*, 29(1):3–15, 2001.
3. Harry T Reis, W Andrew Collins, and Ellen Berscheid. The relationship context of human behavior and development. *Psychological bulletin*, 126(6):844, 2000.
4. Jan Svennevig. *Getting acquainted in conversation: a study of initial interactions*, volume 64. John Benjamins Publishing, 2000.