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Cognitive Modeling of Human Planning and Human Interaction

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We aim at developing a computational model of human planning and interaction. A psychological experiment was conducted, during which subjects had to solve a problem related to a travel-agency application. Each solving produces three experimental protocols (actions recorded by the software interface, emails exchanged and verbalization noted by an experimenter). A set of protocols were analyzed to design the cognitive models and the remaining protocols were used for the validation of these models. The analysis was conducted from two points of view: human planning and human interaction.

The cognitive models

The planning model.

The protocols were analyzed individually to construct a planning model which uses the notions of *phase* (the different situations during the problem-solving), *state of mind* (the problem constraints taken into account), *strategies* (the way plans are built), *tactics* (the different choices of actions to be performed), *observations* (that subjects can make about the current situation) and *personality* (the individual differences between subjects).

The interaction model

Each three protocols were merged and analyzed considering both the utterance level and the discourse level.

Messages were matched with a *performative*, either *descriptives*, *directives* or *commissives*, referring to the speech act theory [Searle, 1969]. A performative is applied to a mental state (a belief or a desire), the scope of which is a predicate: a *descriptive* is applied to a *belief*, a *directive* is applied to a *desire of the sender* and a *commissive* is applied to a *desire of the receiver*.

At the discourse level, the analysis is based on Vanderveken's work [Vanderveken, 2001]. The experimental protocols were divided into *exchanges* (a set of bounded messages). Each of these exchanges is guided by the initiator's discourse goal, according to the first performative he sent. The way exchanges end defines their satisfaction. Nevertheless, an exchange can be considered as finished by the interlocutors even without explicit emission of an ending performative. Time is important regarding to re-queries and to terminate exchanges. Therefore, timed automata [Alur and Dill, 1994] are used to model these message exchanges and the temporality. To represent the observed exchanges, a pair of automata (an automaton for each interlocutor) is designed for each type of exchange.

A semantics of the performatives has been designed, in terms of beliefs and desires. Using beliefs and desires in both the syntax and the semantics of a performative, links the utterance and the discourse levels in our human interaction model.

Simulation and validation

The cognitive models are implemented into an agent architecture called BDIGGY. A BDIGGY instance is an agent which imitates a subject's behavior. To simulate the travel-agency problem, three BDIGGY agents have been running simultaneously, generating new artificial protocols through the interface.

The validation is based on a Turing-like test: experts were asked to hand analyze a random set of mixed protocols (human or artificial) and to classify them according to their type. The main result is that experts are not able to reliably separate the two classes of protocols.

Conclusion

This study deals with three main issues: cognitive modeling, human cooperative planning and human interaction. It proposes a complete study, from the collection of the experimental protocols to the implementation of the simulation system and its validation. The architecture of the cooperative planning model is generic, only the domain specialists have to be re-implemented to support another problem. The interaction model is exhaustive concerning the information-search dialogs. It has to be extended to other kind of dialogs. More details about this research can be found in [Pauchet, 2006].

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