Computer-driven Persuasive Dialogue: A Multi-Layer Reasoning Framework

Pierre Andrews and **Suresh Manandhar**
Departement of Computer Science
University of York
York YO10 5DD
UK
pandrews,suresh@cs.york.ac.uk

Marco De Boni
Unilever Corporate Research
Bedford MK44 1LQ
UK
Marco.De-Boni@unilever.com

Introduction

Human computer dialogue systems – despite being the subject of a long research – are limited to a few restricted domains and are still considered austere by their users. There is evidence that humans act differently when engaged in computer dialogue than during human to human dialogue (Shechtman & Horowitz 2003). This is because dialogue systems do not take into account aspects contributing to the natural effect of human to human conversation, such as *emotions* and *social cues*.

Our current research focuses on using human-computer dialogue for health-care counselling. In particular, we are developing a dialogue system that should be capable of changing the user health behaviour based on techniques of persuasion and argumentation.

In our opinion, natural argumentation – and especially persuasive argumentation – needs to *show empathy* and use *social cues* to be effective (Andrews, De Boni, & Manandhar 2006). We describe here the design of a multi layer framework to separate the persuasion planning and the management of surface-level dialogue cues.

Related Work

With the growing interest within computational linguistics in natural argumentation, there is an increased interest in using dialogue systems as an application (Norman & Reed 2003). However, most of the approaches only take the *logical aspect* of rhetoric into consideration. These approaches often forget the *emotional aspect*.

Cassell & Bickmore (2002) have taken this issue into consideration with a dialogue management system that integrates planning rules to generate small-talk to make the user comfortable during the dialogue. However, the management of this low-level phenomenon of the dialogue is embedded into the dialogue goal planning system, making it more difficult to manage (Lemon, Cavedon, & Kelly 2003).

Proposed System

It is important within the chosen framework and in applying the resulting planning strategies, that the system keeps the user comfortable, to ensure increased receptivity to its arguments. Hence, the choice of the argumentation strategy has to be directed by a user model. In addition, the persuasive dialogue moves need to be strongly bound to the user emotional state and should be interleaved with small-talk to manage this state.

In that perspective, we split the dialogue management to simplify the pursuit of the *persuasion goals* and the generation of the *small-talk* that will keep the user comfortable. Indeed, we want to preserve the reactivity of a chat-bot approach to keep the user comfortable and be able to adapt to its emotional cues but, in addition, we also want to keep control of the dialogue thread and lead the conversation to the persuasive goals which need some sort of planning. Our aim is then to develop a two level framework that will mix reactivity and continuity in the final dialogue.

This system is described in the next sections and illustrated in Figure 1. It is composed of four main components:

- **The two *data* components**: 1) *The belief model*, where the system knowledge is stored and matched with the user beliefs. 2) *The user model* that provides domain-dependent information on the user preferences, state of mind, etc.
- **The *reasoning* component** and its division in two independent layers is the novel approach to persuasion dialogue proposed in our research: 1) The *long term reasoning* layer is responsible of keeping the dialogue on track to achieve the persuasive goals. 2) The *reactive strategies* level performs short term reasoning and is directly responsible for the utterances presented to the user.

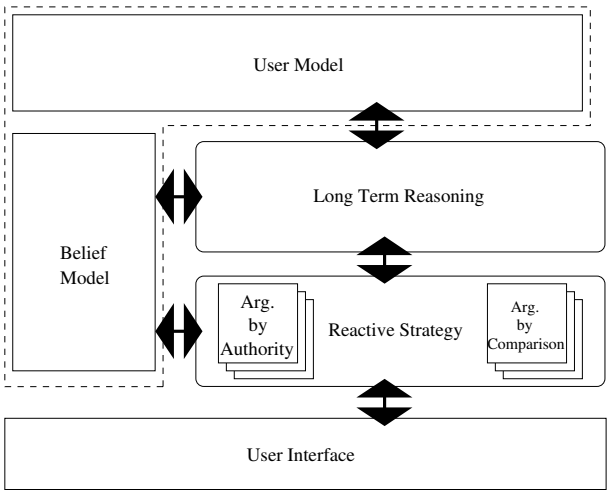

Figure 1: Mixed Planning/Reactive Framework

Belief and User Models

The belief model represents the arguments (conclusions and premises) that are proposed by the system or its interlocutor. Our model uses two basic relations between facts: a *support* relation improves the acceptance of a fact by the user, whereas an *attack* link diminishes the initial fact acceptance by the user. Furthermore, such relations are tagged with the argumentation strategy in which they are valid. In addition, we need to know which facts the system should try to enforce and which ones it should attack: in our application, the latter are tagged as "unhealthy" facts.

The belief model also stores information about the user's beliefs and their history. A fact in the model is either shared with the user or only in the system knowledge. It is impossible to integrate all the possible beliefs hence it tries to cover the largest number of cases that appear in the application domain. The reactive dialogue component will then be responsible for dealing with unknown attacks.

Long Term Reasoning

The aim of the dialogue is defined by the application which, in our case, is to give constructive health advice and work on the user's barriers to change his behaviour. To guarantee continuity in the persuasive dialogue, the dialogue manager must not forget the goal of the conversation. The long term reasoning (LTR) component is responsible for this task. When the system is initiated, based on the information provided by the user and the belief models, the reasoning component decides on a first *main* goal to achieve in the dialogue. In our application, the reasoning uses heuristics that select a barrier to work on, or a new fact that should be enforced in the user's beliefs. In the future, this system could be extended with a real planning system.

Eventually, these selection heuristics lead the system to move healthy facts into the user's beliefs to hinder his unhealthy beliefs. Based on the selected goal, the reasoning component chooses the best persuasive strategy. This choice is constrained by the emotional impact the argument should have, and the user "personality" – i.e. his age, his preferences, etc. The *meta reasoning component* then passes the information to the lower level *reactive component* which initiates a dialogue with the user.

Reactive Dialogue Component

The reactive dialogue component (RDC) is responsible for the realisation of the dialogue goal decided by the LTR component. It decides on which facts – selected from the belief model – to present to the user to support the main goal.

The purpose of the RDC is to improve the user's level of agreement with the main argument selected by the LTR system. Therefore it tries to provide new supporting beliefs to the user and check if he agrees – i.e. if he believes in the fact proposed – or to present attacks to the user arguments to change his current "unhealthy" beliefs.

Depending on the strategy selected, the RDC chooses different *facts* to show to the user. Then, according to the user reaction and to the strategy, the system performs one of the following: 1) formulate an attack to the user argument, 2) add another support to the main goal, 3) add a support to its last argument.

This process takes place *repeatedly and independently* from the LTR until the RDC lacks dialogue moves for that strategy or it has realised the goal selected by the LTR. Then, the RDC notifies the LTR that either the main goal or the main strategy should be revised.

The reactive component can be compared to a constrained chat-bot system, where the next iteration is not decided by a plan, but by the direct observation of the last utterance, the user input and the conversational manners encoded in the persuasive strategy.

Conclusion

We propose a novel, mixed approach, to dialogue management. We claim that this method is more suited for tasks, like *persuasive communication* which need a less restricted dialogue than traditional task-oriented or planless systems.

Multiple planning level systems have already been proposed in the field of natural argumentation and persuasion (see Guerini, Stock, & Zancanaro (2004) for example), but the multiple levels were not used for adding reactivity and flexibility to the planning but mainly to resolve the problems of natural language generation.

The two layer framework proposed will enable more effective persuasion. Moreover, we assert that it helps the user to feel more comfortable in a conversation with the computer in comparison to both: 1) task oriented systems that are perceived as unfriendly and 2) chat-bot systems that cannot be easily programmed to achieve persuasive goals.

References

Andrews, P.; De Boni, M.; and Manandhar, S. 2006. Persuasive argumentation in human computer dialogue. In *Proceedings of ACH AAAI 2006 Spring Symposium*.

Bickmore, T., and Giorgino, T. 2004. Some novel aspects of health communication from a dialogue systems perspective. In *AAAI Fall Symposium on Dialogue Systems for Health Communication*.

Cassell, J., and Bickmore, T. 2002. Negotiated collusion: Modeling social language and its relationship effects in intelligent agents. *(in press) User Modeling and Adaptive Interfaces*.

Guerini, M.; Stock, O.; and Zancanaro, M. 2004. Persuasive strategies and rhetorical relation selection. In *Proceedings of CMNA-04*.

Lemon, O.; Cavedon, L.; and Kelly, B. 2003. Managing dialogue interaction: A multi-layered approach. In *Proceedings of the 4th SIGdial Workshop on Discourse and Dialogue*.

Norman, T. J., and Reed, C. 2003. *Argumentation Machines : New Frontiers in Argument and Computation*. Springer.

Shechtman, N., and Horowitz, L. M. 2003. Media inequality in conversation: how people behave differently when interacting with computers and people. In *Proceedings of the SIGCHI conference on Human factors in computing systems*.