Decision-Theoretic Planning for Intelligent User Interfaces

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The course of interaction between a system and a user cannot in general be predicted with certainty. An interface that is able to anticipate the user's actions several steps ahead can better adapt to the situation at hand, steer the interaction in a promising direction, and protect the user from possible pitfalls. Decision-theoretic planning (DTP) (see, e.g., Boutilier, Dean & Hanks, 1999) provides methods for considering the potential future consequences of available actions. The possible courses of interaction are modeled with a Markov decision process (MDP). Instead of a plan, DTP provides the interface with a policy, which specifies the optimal next step (maximizing the expected utility) for each possible state of the system's interaction with the user.

We have studied two problems in detail: (1) the presentation of location-aware navigation recommendations (Bohnenberger *et al.* 2002) and (2) the presentation of situation-dependent operating instructions for a technical device (Jameson *et al.* 2001). In both scenarios, the interaction between the user and the interface is modeled with a fully observable Markov decision process (FOMDP). Time is considered as a cost factor of the interaction. Important forms of adaptation include the selection of adequate output modalities and the degree of information detail.

Location-Aware Navigation Recommendations

A PDA-based airport guide presents to a user navigation information about how to get to their gate. If possible, the user wants to pass by some shops and buy, for example, a present for their child along the way. The guide obtains feedback about the user's current location and purchasing actions.

DTP enables the interface to adapt the navigation recommendations according to the relative importance of getting to the gate quickly vs. buying a present. The approach was evaluated in a user study with 20 subjects.

Situation-Dependent Operating Instructions

A PDA-based assistance system presents to a user operating instructions for a credit card phone. The instructions are designed to be concise (no annoying delays caused by foolproof dialog strategies) but also sufficiently comprehensive (to avoid mistakes by the user). The system makes use of inferences about the user's cognitive load and possible time pressure.

DTP enables the interface to adapt the operating instructions to the relative importance of getting the user through the dialog efficiently vs. minimizing the likelihood of the user making a mistake.

Focus of Future Work

The consideration of uncertain feedback about the current state of the interaction requires the use of partially observable Markov decision processes (POMDPs). The serious computational complexity problems associated with POMDPs are well known. A major focus of the rest of this PhD research will be on ways of dealing with this computational complexity (e.g., the approximative technique of Roy, Pineau & Thrun, 2000) that are suitable for typical scenarios faced by intelligent user interfaces.

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References

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