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Preface

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In a problem-solving situation, the information and abilities needed for the task at hand are often distributed among the collaborators. As a result, direction and control of the interaction shifts among the participants. If future computational systems are to collaborate effectively with users to solve problems, they must have the ability to take and relinquish control of the problem-solving process and the communication about it. The theory and the mechanisms that underly these behaviors are the topics of this special issue of *User Modeling User Adapted Interaction* on computational models for mixed initiative interaction.

Systems capable of mixed initiative interaction must include mechanisms for recognizing when to lead or take control of an interaction and when to relinquish control to collaborators. They must be able to take the current locus of control into account when interpreting utterances and actions and formulating responses. From the perspective of user modeling, one way of tailoring an interaction to an individual is to vary the amount of initiative exhibited by the system for each user. Adapting initiative in response to individual user needs and preferences is yet another challenge to building mixed initiative systems.

The contributors to this two-part issue discuss theoretical models of mixed initiative as well as implementations that exhibit mixed initiative behavior. The focus of the first part is on specifying the nature of mixed initiative – defining initiative and control, recognizing who has initiative, and simulating mixed initiative. The focus of the second part is on illustrating the utility of mixed initiative by presenting an array of applications, including tutoring, scheduling of meetings, and information retrieval, in which mixed initiative plays an important role.

The first article provides an introduction to the issue of what mixed initiative is and why it is important. Cohen et al. present four theories of initiative that classify and sythensize early work on mixed initiative. They discuss the circumstances under which each theory is valuable – a discussion which naturally leads to whether it is necessary to model initiative at all and whether different models of initiative are needed for different types of problem-solving activities. The survey of early work in mixed initiative also provides useful background for the other work discussed in this issue.

The next two articles present computational models of mixed initiative. Chu-Carroll and Brown describe a predictive model for determining who will have the initiative during the course of a dialogue, where initiative with respect to solving the task is distinguished from initiative in the dialogue about it. The determination of who will have initiative is based on the current distribution of initiative across participants in the dialogue, in combination with a set of observed cues. Guinn provides a prescriptive model that explains how mixed initiative can be achieved by a system, including how agents should decide who should be in control of constructing a plan for the next subgoal in a planning problem. In this context, dialogue is a by-product of agent collaboration where no single agent has all the information necessary to solve the planning problem. In contrast to the theory of Chu-Carroll and Brown, dialogue initiative is the same as task initiative.

The last article in the first part discusses the development of a software agent that provides human-computer mixed initiative assistance. Rich and Sidner describe COLLAGEN, a program that manages a collaboration between an application and a user, mediating between a software interface agent and the user by tracking the attentional state and collaborative intentions of each participant. The COLLAGEN agent's mixed initiative capability results from the representation and use of the discourse state and the collaboration model.

The second part of this issue begins with a discussion of simulations of computer dialogues, by Ishizaki, Crocker and Mellish, in which initiative is mixed. Their results suggest that the utility of mixed initiative may be a function of the type task–in their experiments, mixed initiative dialogue proved to be in inefficient for solving hard problems. Previously, it has been shown that the utility of mixed initiative also depends on the abilities of the agent who is allowed to take control.*

The remaining articles of this issue discuss different applications of mixed initiative. Lester, Stone, and Stelling present their work on an interactive tutoring system. In such systems, efficiency of problem solving is not as important as engaging the learner's interest and enhancing learning. In the authors' system, initiative changes depending on the learner's state of knowledge. For example, at the beginning the agent takes control to introduce the problem. Once the learner begins to solve the problem, the system allows the learner some control. However, the system will retake control when the learner has difficulty or requests assistance and then release control when the learner is ready to continue with the learning exercise. Cesta and D'Aloisi present an application of mixed initiative to the design of a personal assistant. In such systems, usability and trust are important concerns. The

* Performance issues for mixed-initiative interaction have been studied previously in the context of expert-client dialogs (Whittaker and Stenton, 1988), in collaborative planning (Burstein and McDermott, 1986; Veloso, 1996; Ferguson et al., 1996) and in collaborative problem-solving (Walker and Whittaker, 1990; Smith and Hipp, 1994; Guinn, 1996; Rich and Sidner, 1996; Rich and Sidner, 1997). This work suggests that efficiency can be improved by allowing the initiative to shift to the agent with the best knowledge of a particular subproblem.

authors discuss the design of an interactive meeting agent that gradually increase its degree of initiative as the user develops trust in the agent's reliability.

Stein, Gulla and Thiel discuss the mixed initiative aspects of an information retrieval system. In such systems, there is often no well-defined model of the task that can be drawn upon to focus the interaction. Users may refine or change their goals during the problem solving process. They argue that a system can best support this exploratory style of problem-solving by explicitly managing a mixed initiative interaction. In contrast, Hagen describes an acoustic user interface to a database. She argues that initiative tracking and control is an emergent property of her approach. In the last article, Green and Carberry describe a computational mechanism for taking the initiative to include unsolicited information during response planning. In their approach, discourse plan operators are supplemented with stimulus conditions to motivate the inclusion of unsolicited information. Stimulus conditions are evaluated with respect to the user model, the discourse context, and anticipated effects of the planned response.

Examination of the different domains and genres of human-computer interaction exposes the need for new theories and mechanisms for controlling the progress of the interaction itself in a way that is efficient and productive. We trust that you will enjoy this special issue on computational models for mixed initiative interaction. As guest editors of the special issue, we welcome your feedback.

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