# Preface

Studies of human tutoring have argued the importance of conversation between the student and the tutor in making tutoring interactions successful, suggesting that intelligent tutoring systems will be more effective if they can engage in dialogues with students. Although building highly interactive dialogue-based systems presents a wide range of new computational challenges, recent advances in computational linguistics have made it possible to make significant strides towards the development of dialogue-based tutors in both educational and industrial settings. The goal of this symposium is to discuss the design, implementation and evaluation of dialogue-based intelligent tutoring systems (ITSs), their components, and related studies involving human tutors. This symposium is the first of its kind, bringing together researchers from the wide range of academic backgrounds that contribute to this rich interdisciplinary pursuit.

Organizing a successful symposium on such an interdisciplinary topic would not have been possible without the participation of our organizing committee members, each representing a unique piece of the puzzle. We'd like to thank Vincent Aleven from Carnegie Mellon University, Sandra Carberry from the University of Delaware, Michael Glass from Illinois Institute of Technology, Art Graesser from the University of Memphis, Nancy Green from the University of North Carolina in Greensboro, Pamela Jordan from the University of Pittsburgh, James Lester from North Carolina State University, Susan McRoy from the University of Wisconsin in Milwaukee, Ronnie Smith from East Carolina University, and Ingrid Zukerman from Monash University. In particular, Pamela Jordan and Vincent Aleven came through over and above the call of duty, being intimately involved in the organization of the reviewing and assembling of the working notes. We couldn't have done it without them!

We are pleased to present you with these working notes covering some of the most exciting work being developed today in the area of dialogue based tutoring systems. No one-dimensional classification scheme can do justice to the multi-dimensional research and overlapping topics covered in these papers. In addition to the major classifications, several themes reoccur. User modeling is important both in system design and in dialogue analysis. Several researchers are using spoken dialogue interfaces, and virtual reality, simulation and embedding tutoring systems in an application are becoming common modes of deploying an ITS. Empirical data, evaluation, and field reports are provided by many authors. Finally, the complexity of today's tutoring systems is shown by the number of systems using other research products as building blocks.

### Architecture

Architecture constitutes the most popular topic in the symposium. Many of the architecture papers focus on appropriate ways to implement dialogue strategies in an application, while McRoy and Ali illustrate the use of reasoning as an alternative to explicit coding of dialogue strategies. Several authors describe interfaces between ITSs and other components, including spoken-language interfaces, an expert problem solver, virtual reality and simulation, and the COLLAGEN collaboration manager.

Core, Moore and Zinn describe their plan for a two-level ITS architecture. The top level uses a feedback planner to handle content planning, while the lower level uses a recursive transition network to handle the details of communication management.

Heffernan and Koedinger describe Miss Lindquist, a tutor for algebra symbolization—learning to write algebraic expressions for real world quantities. Miss Lindquist adds an explicit representation of tutorial strategies to the model-tracing approach used in previous tutors.

Lehuen proposes a dialogue-based architecture for computer assisted language learning (CALL).

Person et al. discuss the transition network used by AutoTutor to generate conversationally appropriate dialogue moves.

It is interesting to note that each of these systems, along with Freedman's APE planner, all take roughly compatible approaches to the same problem: how to represent and handle the spectrum of tutor replies required by the fact that students don't always give the correct answer.

McRoy and Ali take a different approach, preferring to reason about interpretation and execution of communicative acts at each turn. The foundation of their system is a uniform mixed-depth declarative representation for all categories of knowledge.

Melis and Horacek discuss dialogue strategies for the proof assistant component of their interactive mathematics textbook.

Two research groups are using the domain-independent collaboration manager COLLAGEN to implement dialogue-based tutors. Gertner, Cheikes and Haverty are developing embedded training systems-instructional tools embedded

in the computing environment of an application- focusing on the development of instructional strategies and adapting them to the needs of the student. Rickel et al. have developed a series of systems that teach complex procedural tasks via simulation.

Finally, two groups are developing systems with spoken- language interfaces. Roberts describes a speech-based system embedded in a virtual reality environment used for training naval officers. Woolf plans to integrate several existing ITSs with TRAINS-96, a dialogue system that supports speech and graphics.

### Natural language understanding

In the natural language understanding section, one person describes a tool set for rapid implementation of NLU systems, one person describes semantic issues in an NLU component, and two researchers analyze students' input to ITSs.

Rosé describes her progress in building a tool set to facilitate the development of domain-specific sentence-level NLU for ITSs.

Aleven and Koedinger classify students' input to a geometry tutor, including explanations, reference to a domain rule, procedural replay, and off-task comments. We are reminded of the importance of the human side of ITS research upon noting that, in an experiment where responses were not validated, 50% of the students provided blank or off-task comments.

Popescu and Koedinger are working toward implementing an NLU component for this system using Rosé's parser and the LOOM knowledge representation system. Problems identified include distributive vs. collective readings, metonymy and anaphora resolution.

Glass provides a report of his experiences with an information- extraction style approach in CIRCSIM-Tutor.

### Natural language generation

Although most dialogue systems produce text, two papers in the symposium focus explicitly on text generation algorithms.

Di Eugenio and Trolio study the use of sentence aggregation rules in improving comprehension of ITS output.

McRoy, Channarukul and Ali describe YAG, a new text realization system based on a recursive template-based approach. YAG is designed with the needs of dialogue system authors in mind, especially speed, flexibility and robustness.

### Tutorial dialogue analysis

The symposium contains three papers from Helen Pain's laboratory, as well as two other papers on dialogue analysis.

De Vicente and Pain describe their progress toward including affect in a computational model for educational dialogues. Iacucci and Pain attempt to characterize overhearers' reactions to turns in a dialogue with respect to the topics under discussion. Porayska- Pomsta, Mellish and Pain are working on correlating teachers' speech acts with the conditions that gave rise to them.

Kayashima describes a model for dialogue that helps students develop the cognitive skill of self-regulation. The model is based on an analysis of the student's dialogue acts.

Reeder analyzes the categorization of errors and error repair in dialogue-based CALL systems.

We look forward to a great symposium, filled with stimulating conversation and sharing of ideas and background knowledge between communities. Perhaps we will even come to some consensus on the age old controversy over the spelling of *dialog* vs. *dialogue*.

See you in Cape Cod!

Reva Freedman, Department of Computer Science, Northern Illinois University and Carolyn Penstein Rosé, LRDC, University of Pittsburgh