TRIPS: The Rochester Interactive Planning System

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Abstract

This demonstration showcases TRIPS, The Rochester Interactive Planning System, an intelligent, collaborative, conversational planning assistant. TRIPS collaborates with the user using both spoken dialogue and graphical displays to solve problems in a transportation logistics domain. In our demonstrations, users are encouraged to sit down and try the system, with only rudimentary guidance from us. For further information, including QuickTime movies of the system in action, please visit our website at the URL listed above.

Introduction

TRIPS, The Rochester Interactive Planning System (Ferguson & Allen 1998), is the latest in a series of prototype collaborative planning assistants developed at the University of Rochester's Department of Computer Science (Allen *et al.* 1995; Ferguson *et al.* 1996; Ferguson, Allen, & Miller 1996). The goal of the project is an intelligent planning assistant that interacts with its human manager using a combination of natural language and graphical displays. The two of them collaborate to construct plans in crisis situations. The system understands the interaction as a *dialogue* between it and the human. The dialogue provides the context for interpreting human utterances and actions, and provides the structure for deciding what to do in response. With the human in the loop, they and the system together can solve harder problems faster than either could solve alone.

TRIPS operates in a simplified logistics and transportation world, with cargos being delivered using a variety of vehicles. One example scenario involves evacuating the island of Pacifica ahead of an approaching hurricane. The manager's task is to plan the evacuation, using a variety of vehicles (with varying capabilities) at his or her disposal. There may be a variety of constraints placed on the final plans, such as time, cost, weather effects, and so on.

TRIPS Architecture

TRIPS is designed as a set of loosely-coupled modules that exchange information by passing KQML messages. A schematic description of the system is shown in Figure 1. At the top of the schematic are modality processing modules, such speech recognition and generation, keyboard input and output, and interactive graphical displays. Input from these modules is parsed into a uniform representation of the user's input as one or more communicative acts.

The middle layer in the TRIPS architecture contains the core modules of the system, responsible for mantaining the conversation with the user and helping them achieve their (and the system's) objectives. The Conversational Agent combines the interpreted communicative acts from the input with the discourse context in order to determine the intended speech acts, which might be either indirect ("Do you know the time?") or ambiguous ("Send the truck to Delta" when there are two trucks). The Problem-Solving Manager plays two roles in maintaining the dialogue. First, it helps resolve ambiguities by applying plan recognition techniques. In the previous example of an ambiguous reference to "the truck," for example, the PSM might infer that only one truck is not already at Delta, and so the user must be referring to it. Second, it coordinates the invocation of the specialized reasoners that provide solutions in service of user and system objectives.

These specialized reasoners form the bottom layer of the TRIPS architecture, and currently include a powerful but incomplete temporal logic-based planner, router, scheduler, temporal knowledge base, and a fast simulator with data mining capabilities for detecting (and hopefully correcting) problems with planned activities. The Problem-Solving Manager invokes these reasoners as appropriate, and integrates their responses into the problem-solving context.

Finally, the Conversational Agent uses the results of task-specific problem-solving (*e.g.*, a new part of a plan, or an answer to a query) together with general dialogue principles to determine appropriate responses. Both spoken language and graphical displays can be generated from the intended communicative acts specified by the Conversational Agent.

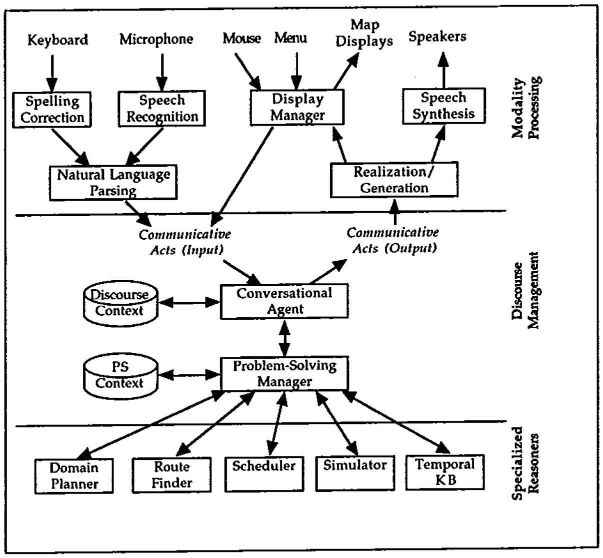

Figure 1: TRIPS System Architecture

Key Features

Space precludes a detailed discussion of TRIPS capabilities and shortcomings, so what follows is a just a quick summary of some of the main features.

- **Intuitive Interaction**: The goal of the project is to make interaction with intelligent systems like TRIPS as natural as human conversation. The representation based on communicative acts and the structuring of the interaction as a dialogue provide the structure for intelligent interaction.
- **Robust Understanding**: One of the main thrusts of our work on TRAINS and now on TRIPS has been making the system robust. This includes handling speech recognition errors, handling ungrammatical or partial utterances, dealing with the system's own shortcomings gracefully, and, hopefully, even handling system errors and continuing the conversation.
- **Recognition of User Intention**: TRIPS explicitly attempts to understand the intentions of the user in understanding their utterances. This is used both to resolve ambiguities and to provide useful or helpful responses. It can also drive the system into subdialogues to resolve problems.
- **Intelligent Plan Revision**: We have found that planning from scratch for goals is not the most important part of TRIPS. In the first place, it is impossible in practice for the user to fully specify their goals in any reasonably complex domain. Thus they will need to refine their plans as they discover new constraints, add new objectives, and so on. Even if the users knew exactly what they wanted, planning is so hard that it is unlikely that we will be able to do the planning in a reasonable amount time. The best we could hope for would be approximate solutions that the user and the system can collaboratively refine. Thus while we have developed some sophisticated planning techniques, they are incomplete compared to traditional planning algorithms but are also much more flexible, in order to accomodate human guidance and incremental refinement.
- **Simulation and Evaluation**: We are investigating the use of simulation to detect problems in plans, to repair problems, to help monitor plan execution, and to generate visualizations essential to human understanding and evaluation of plans.
- **Experimental Infrastructure**: TRIPS is designed to be an experimental testbed. To this end, we have built up a significant infrastructure to support repeated experimentation, evalution, and analysis. This includes, for example, the ability to replay sessions in real time, and to construct new, repeatable scenarios for use in controlled experiments.

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References

Allen, J. F.; Schubert, L. K.; Ferguson, G.; Heeman, P.; Hwang, C. H.; Kato, T.; Light, M.; Martin, N. G.; Miller, B. W.; Poesio, M.; and Traum, D. R. 1995. The TRAINS project: A case study in defining a conversational planning agent. *Journal of Experimental and Theoretical AI* 7:7–48.

Ferguson, G., and Allen, J. F. 1998. TRIPS: An integrated intelligent problem-solving assistant. In *Proceedings of the Fifteenth National Conference on AI (AAAI-98)*, 567–573.

Ferguson, G.; Allen, J.; and Miller, B. 1996. TRAINS-95: Towards a mixed-initiative planning assistant. In Drabble, B., ed., *Proceedings of the Third Conference on Artificial Intelligence Planning Systems (AIPS-96)*, 70–77.

Ferguson, G.; Allen, J. F.; Miller, B. W.; and Ringger, E. K. 1996. The design and implementation of the TRAINS-96 system: A prototype mixed-initiative planning assistant. TRAINS Technical Note 96-5, Department of Computer Science, University of Rochester, Rochester, NY.