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Introspective Reasoning in a Case-based Planner

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Many current AI systems assume that the reasoning mechanisms used to manipulate their knowledge may be fixed ahead of time by the designer. This assumption may break down in complex domains. The focus of this research is developing a model of *introspective reasoning and learning* to enable a system to improve its own reasoning as well as its domain knowledge. Our model is based on the proposal of (Birnbaum *et al.* 1991) to use a model of the ideal behavior of a case-based system to judge system performance and to refine its reasoning mechanisms; it also draws on the research of (Ram & Cox 1994) on introspective failure-driven learning.

This work examines introspection guided by expectation failures about reasoning performance. We are developing a vocabulary of failures for the case-based system, an introspective reasoner which uses a hierarchical model of system behavior, and a method of reusing CBR for parts of the case-based planner itself.

The system we are developing combines a model-based introspective reasoner with a case-based planning system. The planner generates high-level plans for navigating city streets, and is similar in structure to the planner CHEF (Hammond 1989). However, we implement components of the planner using the case-based reasoning mechanisms of the planner as a whole. Our primary interest in this approach is the advantage it offers for developing the model for introspective reasoning. We can reuse expectations that apply to the planner as a whole for its case-based parts.

During the planning process, the introspective reasoner compares the planner's reasoning to its assertions about ideal behavior. When a failure is detected, for instance if the system judges that the retrieved case is not the "best" case in memory, the introspective reasoner considers related assertions to pinpoint the source of the failure and to suggest a solution. In this case our system creates a new index to distinguish the true best case from the bad retrieved case.

Determining what information to include in the model and how to structure it are central issues. Birnbaum's model is a set of high-level assertions applicable to many case-based planners (Birnbaum *et al.* 1991). While such assertions cover a wide range of failures, they are too general to easily specify causes or repairs for failures. We propose as an alternative a hierarchical model including highly abstract assertions as well as assertions specific to this planner. Low-level assertions help to notice failures and pinpoint repairs, while high-level assertions provide connections between assertions for finding the root causes of failures. By using a hierarchy, the general structure of the model will apply to other systems while we retain the ability to detect and repair specific failures of our system.

We are developing a vocabulary of failure types to guide our choice of assertions to include in the model. For example, identifying the failure "failing to complete adaptation" leads to assertions about how to gauge the progress of adaptation in this planner. We also include higher level failure types as are described in (Ram & Cox 1994); some such failures recurred for different components of the planner, leading us to use CBR to implement components themselves.

We have constructed a skeletal hierarchical model and have begun testing the case-based planner with and without introspective corrections. Initial experimental results indicate that introspectively re-indexing memory alone improves the planner's efficiency in retrieval and allows it to succeed more often than without introspection. We are currently in the process of fleshing out the model and expanding the scope of possible repairs.

References

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