Research Summary

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My general research interest is the development of systems and theories for reasoning about technical systems. The general emphasis of my research work is the question of how to design and control reasoning processes and strategies in order to cope with the inherent structural and behavioral complexity of technical systems. The main focus of this work is the investigation of non-monotonic reasoning and truth maintenance techniques (and to some extent also temporal reasoning) while selecting diagnosis as an application task.

More specifically I initially started off with some efforts to narrow the gap between formal theories of non-monotonic reasoning and practical NMR-systems by developing a non-monotonic deduction system which is based on a formal theory (non-monotonic formal systems [Reinfrank and Freitag, 1988]) and provides an efficient implementation based on a TMS/ATMS [Freitag and Reinfrank, 1988]).

Further work diverted into the application of dependency recording techniques to temporal reasoning and model-based diagnosis. The ability to predict the time-varying behavior of a device in multiple reasoning contexts is a major prerequisite for the application of dependency-based diagnosis (i.e. the GDE-paradigm) to this device. Combining temporal elaboration procedures like e.g. temporal constraint propagation (TCP) and assumption-based truth maintenance (ATMS) in a straightforward manner leads to tremendous complexity problems: the complexity of both procedures roughly multiplies. MCTCP (Multiple Context TCP) [Dressler and Freitag, 1989] therefore extends the basic ideas of dependency recording (caching of inferences and nogood detection) to both logical and temporal reasoning contexts and thus overcomes the limitations of the aforementioned combined systems.

Dependencies recorded during a problem solving process provide complete and detailed information about the state of the process and thus a basis for subsequent reasoning tasks. In particular, they may be exploited to perform a limited kind of look-ahead to decide whether additional information discriminates between competing plausible views currently held by the system, e.g. preferred diagnoses of a device. Additional information may take the form of additional observations and measurements. One effort of my work thus has been the development of a generic measurement proposer [Freitag, 1990] which allows the definition of different strategies for determining which kind of additional information to acquire by exploiting the cached dependencies. Existing strategies are covered by this system as instances of a general scheme.

Another possibility to exploit the idea of discrimination is the use for structural focusing in complex systems. Starting with a small initial focus which may be determined by exploiting symptom information the focusing strategy identifies diagnosis (sub)problems which are independent w.r.t. discrimination between preferred diagnoses and limits its efforts to these problems [Freitag and Friedrich, 1991; Freitag and Friedrich, 1992].

Even though developed in the context of diagnosis, these techniques are basically task-independent and I would be very much interested in applying them to other reasoning tasks, particularly design. On the other hand, design from physical principles strongly needs similar elaborate techniques to cope with the complexity of the design process.

References

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