Research Summary

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My interest in design stems from work on knowledge-representation and qualitative physics — particularly QPC. QPC is a qualitative-model builder that takes the general approach of Qualitative Process Theory, describing a scenario in terms of views, processes, and influences, and outputs a qualitative differential equation model.

Model building (for design, diagnosis, or other tasks) in non-trivial domains requires the utilization of a large body of complex knowledge from a variety of fields (*e.g.*, mathematics, physics, engineering, ...). Representing and reasoning with such knowledge is a non-trivial task. The representational and reasoning needs of QPC have been one of the primary driving forces in our knowledge-representation work on Access-Limited Logic (ALL) and its lisp implementation Algernon. ALL is a language for knowledge-representation that formalizes the access limitations inherent in a network-structured knowledge-base. Thus, where a deductive method such as resolution would retrieve all assertions that satisfy a given pattern, an access-limited logic retrieves all assertions reachable by following available access paths. The time complexity of inference is thus a polynomial function of the size of the accessible portion of the knowledge-base, rather than an exponential function in the size of the entire knowledge-base (as in much past work).

QPC embodies an approach to qualitative reasoning that states that one should reason by: selecting a set of approximations and abstractions that seem to be appropriate for a scenario, combining these views into a model of the scenario, calculating the consequences of this approximate model, and, finally, comparing these consequences with observations of the actual scenario (or with some collection of sanity checks if observations are not available). In our most recent work, we show how this paradigm can be extended to the general case of formalizing reasoning about change, thus providing the beginnings of a formal foundation for qualitative model building, and addressing some tricky problems in building non-monotonic formalisms for reasoning about time and action.

References:

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