Efficient Reasoning about Time in a Domain-General Automatic Inference System: Insights from Cognitive Science Can Illuminate the Path to Human-Level Artificial Intelligence

By

Perrin Gregory Bignoli

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Professor Nicholas L. Cassimatis, Thesis Adviser

Rensselaer Polytechnic Institute
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ABSTRACT

The fields of Cognitive Science and Artificial Intelligence can gain much from incorporating the results of each field into the other. Although many researchers are aware of the close link between the two disciplines, fewer are aware of how tightly integrated the work in them is possible to be. A dedicated research program of uncovering the underlying substrate of the human cognitive system in tandem with implementing functional equivalents them in conjunction with powerful computational algorithms has been shown to be highly successful in making progress towards synthetic general human-level intelligence.

This work focuses on extending an efficient, domain-general approach, satisfiability solving, which has long been used in artificial reasoning systems, with specialized mechanisms for representing and conducting inference about time and change. Despite being suited for a number of inference, planning, and constraint-satisfaction tasks, previous methods for satisfiability solving are unable to gracefully scale up to real-world size instances of those types of problems. To address this issue, it is necessary to introduce a formal system for representing a logic of temporal interval objects in a way that enables tractable problem instances to be described. Through the identification of algorithms for efficient temporal inference via constraint graphs, rule matching, and content-addressable memory, it can be shown that this formulation allows a significant extension to the domains in which satisfiability solvers are effective.

Using a formulation of the Polyscheme Cognitive Architecture that is capable of utilizing a DPLL-like satisfiability solving algorithm to perform this integration has enabled the creation of a new system that outperforms state-of-the-art Satisfiability solvers, namely LazySAT and MiniMaxSAT. Moreover, this novel approach is demonstrated to facilitate reasoning about the common sense change minimization problem, a sub-problem of the frame problem, which has long been known to be a barrier to the engineering of intelligent agents that must interact with a dynamic environment.