Inference In Logic Theories

Alexander Sakharov

Logic calculi are defined by axioms and inference rules that specify properties of logical connectives and quantifiers. Logic theories are extensions of logic calculi with nonlogical axioms. We consider logic theories of standard and nonstandard first-order logics whose nonlogical axioms do not contain metavariables, functions and predicates are concrete (interpreted) in their nonlogical axioms. Nonlogical axioms in these theories express domain knowledge. Such logic theories formalize AI systems.

There exist efficient inference methods for standard logics. They include the resolution method for classical logic and formulas in clausal form. Several efficient inference methods are designed for sequent calculi: the tableau, inverse, and focusing methods. Inference in nonstandard logics and logic theories is much less explored. Nonetheless, there are recent works on adaptation of focusing methods to logic theories. For instance, focusing is applicable to theories with axioms of the form:

$$P_1 \wedge ... \wedge P_k \supset Q_1 \vee ... \vee Q_m$$

where P_i, Q_j are atoms. It is also known how to limit inference to some normal form for a variety of sequent calculi. This normal form restricts choices for inference steps and thus makes inference more efficient.

Logic theories are a useful tool for making modern AI based on neural networks explainable. Computation in fuzzy knowledge systems can be implemented as inference in logic theories.

Alexander Sakharov
Synstretch
Framingham, Massachusetts, USA
e-mail: mail@sakharov.net