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Xue Li, ***Automating the Repair of Faulty Logical Theories***, Artificial Intelligence Applications Institute, School of Informatics, University of Edinburgh, UK, 2021. Supervised by Alan Bundy, with Alan Smaill, Eugene Philalithis, and Ewen Maclean as secondary supervisors. MSC: 68T05, 68T30 and 68T15. Keywords: automated reasoning, belief revision, abduction, conceptual change, reformation, theory repair.

Abstract

This thesis aims to develop a domain-independent system for repairing faulty Datalog-like theories by combining three existing techniques: abduction, belief revision, and conceptual change. Accordingly, the proposed system is named the ABC repair system (ABC). Given an observed assertion and a current theory, abduction adds axioms, which explain that observation by making the corresponding assertion derivable from the expanded theory. Belief revision incorporates a new piece of information which conflicts with the input theory by deleting old axioms. Conceptual change uses the reformation algorithm for blocking unwanted proofs or unblocking wanted proofs. The former two techniques change an axiom as a whole, while reformation changes the language in which the theory is written. These three techniques are complementary. But they have not previously been combined into one system. We are working on aligning these three techniques in ABC, which is capable of repairing logical theories with better result than each individual technique alone. In addition, ABC extends abduction and belief revision to operate on preconditions: the former deletes preconditions from rules, and the latter adds preconditions to rules. Datalog is used as the underlying logic of theories in this thesis, but the proposed system has the potential to be adapted to theories in other logics.

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Andrew Parisi, ***Second-Order Modal Logic***, University of Connecticut, USA, 2017. Supervised by Marcus Rossberg. MSC: 03B15, 03B45, 03F03, 03F05, 03B20, 03B60, 03A05. Keywords: modal logic, higher-order logic, free logic, sequent calculus, hyper-sequents, inferentialism, proof-theoretic semantics, philosophical logic, quantification, ontological commitment, necessitism, contingentism.

Abstract

The dissertation introduces new sequent-calculi for free first- and second-order logic, and a hyper-sequent calculus for modal logics K, D, T, B, S4, and S5; to attain the calculi for the stronger modal logics, only external structural rules need to be added to the calculus for K, while operational and internal structural rules remain the same. Completeness and cut-elimination are proved for all calculi presented.

Philosophically, the dissertation develops an inferentialist, or proof-theoretic, theory of meaning. It takes as a starting point that the sense of a sentence is determined by the rules governing its use. In particular, there are two features of the use of a sentence that jointly determine its sense, the conditions under which it is coherent to assert that sentence and the

conditions under which it is coherent to deny that sentence. The dissertation develops a theory of quantification as marking coherent ways a language can be expanded and modality as the means by which we can reflect on the norms governing the assertion and denial conditions of our language. If the view of quantification that is argued for is correct, then there is no tension between second-order quantification and nominalism. In particular, the ontological commitments one can incur through the use of a quantifier depend wholly on the ontological commitments one can incur through the use of atomic sentences. The dissertation concludes by applying the developed theory of meaning to the metaphysical issue of necessitism and contingentism. Two objections to a logic of contingentism are raised and addressed. The resulting logic is shown to meet all the requirement that the dissertation lays out for a theory of meaning for quantifiers and modal operators.

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Sewon Park, ***Continuous Abstract Data Types for Verified Computation***, KAIST, South Korea, 2021. Supervised by Martin Ziegler. MSC: 68N15, 03F60, 03B70. Keywords: real number computation, continuous abstract data type, computable analysis, imperative programming, formal verification.

Abstract

We devise imperative programming languages for verified real number computation where real numbers are provided as abstract data types such that the users of the languages can express real number computation by considering real numbers as abstract mathematical entities. Unlike other common approaches toward real number computation, based on an algebraic model that lacks implementability or transcendental computation, or finite-precision approximation such as using double precision computation that lacks a formal foundation, our languages are devised based on computable analysis, a foundation of rigorous computation over continuous data. Consequently, the users of the language can easily program real number computation and reason about the behaviours of their programs, relying on their mathematical knowledge of real numbers without worrying about artificial roundoff errors. As the languages are imperative, we adopt precondition–postcondition-style program specification and Hoare-style program verification methodologies. Consequently, the users of the language can easily program a computation over real numbers, specify the expected behaviour of the program, including termination, and prove the correctness of the specification. Furthermore, we suggest extending the languages with other interesting continuous data, such as matrices, continuous real functions, et cetera.

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