

Propositional Reasoning

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Abstract. Propositional (Boolean) logic is conceptually simple. It provides a rich basis for the representation of finite structures, but is computationally complex. Many current verification techniques are based on propositional encodings.

Propositional representations lead to problems that are, in general, computationally intractable. Nevertheless, datastructures for representing propositional formulae, and algorithms for reasoning about them, provide generic tools that can be applied to a wide variety of computational problems. Natural problem instances are often effectively solved by these generic approaches.

There is a growing literature of algorithms for propositional reasoning, and of techniques for propositional representation of tasks in areas ranging from cryptography, constraint satisfaction and planning, to system design, validation and verification.

We present a model-theoretic account of propositional encodings for questions of logical validity. Validity is characterised model-theoretically. For restricted logics, checking validity in a restricted class of models may suffice. Classes of structures on a finite domain can be encoded as propositional theories, and validity in such a class is encoded propositionally, by means of a syntactic translation to a propositional formula.

This provides a unified setting for generating efficient propositional encodings suitable for analysis using BDD or SAT packages.