Practical Applications of Boolean-Based Optimization: A Bibliography

J. Marques-Silva

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Instituto de Engenharia de Sistemas e Computadores,
Investigação e Desenvolvimento, Lisboa
Abstract

This report provides an overview of existing applications of Boolean-based optimization, either in the form of Pseudo-Boolean Optimization (PBO), Minimum Cost Satisfiability (MinCostSAT), Maximum Satisfiability (MaxSAT), or Maximum Satisfiability Modulo Theories (MaxSMT).

1 Introduction

This report provides a preliminary overview of existing applications of Boolean-based optimization, either in the form of Pseudo-Boolean Optimization (PBO), Minimum Cost Satisfiability (MinCostSAT), Maximum Satisfiability (MaxSAT), or Maximum Satisfiability Modulo Theories (MaxSMT). The overview is not intended to be complete, but instead to provide a comprehensive view of the range of applications of Boolean-based optimization.

The applications listed below are organized by application area and not by the kind of algorithm used. The justification is that MinCostSAT is a restriction of PBO, and MaxSAT problems can be solved with PBO algorithms and vice-versa [62].

2 Practical Applications

2.1 Artificial Intelligence

Concrete examples in the area of Artificial Intelligence include computation of minimal models [15, 16, 18, 72, 17] and its uses (e.g. circumscription [25, 39]), computation of prime implicants [87, 79, 86] and its uses (e.g. knowledge compilation [43] and Boolean function minimization [88, 42]), computation of preferred models [26, 4], planning with preferences [52, 53, 54], probabilistic inference [92], winner determination in combinatorial auctions [91], decision tree minimization [20], inference for sentence compression [34, 35], among many others.

2.2 System Design

System design applications include two-level logic minimization [88, 89, 81, 51, 41, 40], minimization of finite state machines (FSMs) [58, 82, 67], digital filter design [1, 3, 2], instruction-set extensions [12], routing in flip-chip design [46], memory partitioning and data allocation in multiprocessors [85], design debugging [33, 90], estimation of circuit activity [27, 77], computation of minimum-size test patterns [49], test set compaction [48], test reordering for power minimization [47], design of test access architectures [30, 31], and energy optimization in wireless sensor networks [68].
2.3 Software Engineering

A well-known example in software engineering is package management [94, 19, 11]. Other applications include software configuration [66], component based system assembly [78], goal models in software requirements [93], test-case prioritization [64, 97], test suite minimization [21, 65], compilation under code size constraints [84], optimizing cache locality [69], selective revalidation [61], and lock allocation for global variables in multi-threaded programs [45].

2.4 Formal Methods

Boolean-based optimization finds applications in formal methods, namely in the minimization of counterexamples [60, 28, 59, 29].

2.5 Bioinformatics

There are many applications of Boolean-based optimization in Bioinformatics. A well-known example is haplotyping [74, 56, 80, 76, 75, 73, 55]. Other examples include maximum quartet consistency in phylogenetic analysis [83], and genomic analysis [8, 6, 9, 22, 7, 10, 44]. In addition, there are many other potential applications, including structural bioinformatics [13, 14] and protein threading [95, 96, 5].

2.6 General Applications

The uses of Boolean-based optimization in applications include enterprise network security management [63], availability of telecommunication equipment [70], telecommunication feature subscription [38, 71, 37, 36], grid coverage in sensor networks [32], radio frequency assignment [24], medical diagnosis [50], and error detection and correction in large data collection [23].

3 Conclusions

Boolean-based optimization algorithms have been applied in many other settings. The ones presented in this overview represent examples of successful applications, in the vast majority of cases validated in real test cases.

References


