Improving SAT Algorithms by Using Search Pruning Techniques

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Propositional Satisfiability (SAT) is fundamental in solving many application problems in Artificial Intelligence and in other fields of Computer Science and Engineering. In the recent past, intelligent backtrack search algorithms for SAT have empirically been shown to be highly effective in pruning the amount of search, by applying strategies for non-chronological backtracking and procedures for clause recording. Apart from the commonly used pruning techniques, these algorithms can be augmented with other different techniques, namely identification of necessary assignments, randomized strategies and simplification techniques.

Necessary assignments can be obtained by using different forms of *value probing*. The idea of probing consists in identifying assignments that are deemed necessary, usually called *implied necessary assignments*. In SAT algorithms, the most used procedure for identifying necessary assignments consists in the iterated application of the unit clause rule. Moreover, the identification of necessary assignments can be augmented with value probing techniques. For example, *Recursive Learning* recursively evaluates clause satisfiability requirements for identifying common assignments to variables, whereas *Stålmark's Method* also identifies common assignments to variables, despite being based on variables.

The utilization of different forms of randomization in SAT algorithms has seen increasing acceptance in recent years. Randomization is also a key aspect of restart strategies, ensuring that different sub-trees are searched each time the search algorithm is restarted. More recently, the utilization of randomization has been used in the backtrack step of a complete backtrack search algorithm, where we randomly pick the backtracking point from the set of literals in the recorded conflict clause.

Resolution is probably the most well-known from the existing simplification techniques. Two-variable equivalence is another well-known formula simplification procedure. Whenever a two-variable equivalence is detected, the number of variables in the formula decreases by 1. In addition, the inference of binary clauses using selective resolution, i.e. based on specific clause patterns, can contribute to finding more equivalent variables. We should note that the inference of clauses always contributes to adding more information to the problem specification, and therefore can potentially simplify the search.

With this work we propose improving backtrack search algorithms by integrating new and more effective search pruning techniques. Some interesting results have already been obtained. In the future, we expect to further pursue this work and conduct a more comprehensive experimental evaluation and categorization of the proposed techniques.