論 文 の 内 容 の 要 旨

論文題目　Widely Applicable Approaches to Adjust Intensity and Diversity for Constructing Efficient SAT Solvers
(集中性と多様性を調整しSATソルバー性能向上を目指す広く適用可能なアプローチ)

氏　　名　　文　性琇

The satisfiability (SAT) problem is a well-known NP-complete problem. Generally, there are no polynomial-time solutions for NP-complete problems. In the last two decades, substantial progress has been made on SAT algorithms; now, many application problem instances from domains such as puzzles, circuit verification, and planning can be encoded easily into SAT problems and solved using SAT solvers. Several elements, such as conflict driven clause learning (CDCL), restarts, propagation using a lazy data structure, and conflict-based branching heuristics, have played a significant role in the dramatic progress of SAT solvers. Furthermore, throughout the evolution of multicore hardware, many types of parallel SAT solvers have been proposed. Combinatorial search with a parallel SAT solver shares information among workers to diversify the search and avoid duplicate work. However, when the number of workers or the size of a problem increases, the amount of information increases exponentially. When the amount of information increases, the cost of maintaining and utilizing information also increases. This can cause a problem of search efficiency for massively parallel environments. In recent years, a portfolio-based approach has become mainstream for parallel SAT solvers. In portfolio approaches, maintaining the diversification and intensification tradeoff is very important. In this paper, we propose several methods for achieving efficient SAT solvers by adjusting search intensity and diversity. First, we propose breaking ties in branching heuristics. Branching heuristics decide which variable to branch on next during a tree search. Many of them have been proposed for search intensification of SAT solvers. We recognize the existence of ties inherent in branching heuristics and propose a method for breaking ties to enhance search intensification. Our approach is designed to intensify the interplay between branching heuristics and clause learning schemes. Second, we propose a hybrid model to secure search diversity and integrate different algorithms for building efficient SAT solvers. Our objective here is to provide an efficient single solver that can be reused for other research as a base solver. As a first step toward this, we applied a random forest model to integrate several branching heuristics. This model works as preprocessing to select an adequate branching heuristic for each SAT instance. All branching heuristics in our model use the same data structure. Hence, they can be implemented easily in a single solver. Finally, we propose an approximate history map (AHM) to share information among workers in a parallel SAT solver using only a small amount of memory. The AHM concept can be applied to a multitude of scenarios to manage search intensity and diversity. This map is applicable in massively parallel environments at low cost. To achieve an AHM in parallel SAT solvers, we propose a Polarity Search Space Index (PSSI). After the construction of an AHM with a PSSI, we propose a sparsely visited area walking on search space (SaSS) heuristic as an application of the AHM. All of our proposals are evaluated through the benchmarks from SAT Competitions.