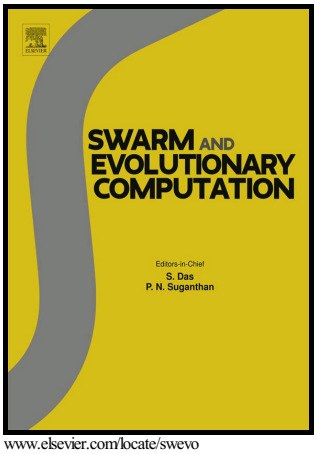
Success Rates Analysis of Three Hybrid Algorithms on SAT Instances

Xinsheng Lai, Yuren Zhou



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Success Rates Analysis of Three Hybrid Algorithms on SAT Instances

Xinsheng Lai[a], Yuren Zhou[b]

[a]*School of Mathematics and Computer Science, ShangRao Normal University, Shangrao,* 334001*, China*
[b]*School of Data and Computation Science, Sun Yat-sen University, Guangzhou* 510275*, China*

Abstract

In recent years, combining different individual heuristics to construct hybrid algorithms seems to be a promising way for designing more powerful algorithms. We are interested in when a certain termination criterion is met, whether the **success** (referring to finding a globally optimal solution) **rate** of a hybrid algorithm can be better than that of the individual algorithms on which the hybrid algorithm is based or not. In this paper, we concentrate on rigorously analyzing the success rate of hybrid algorithms. This makes a step into theoretical understanding of hybrid algorithms, which lags far behind empirical investigations. We derive the formulas for calculating the success rates of three hybrid algorithms by making use of a Markov chain. These three hybrid algorithms are based on different ways of combining two individual heuristics. As an application of these formulas, we then investigate the relationships between the success rate curves of RandomWalk, Local (1+1) EA (evolutionary algorithm) and that of three hybrid algorithms based on different ways of combining the two heuristics for solving two satisfiability (SAT) problem instances. The computational success rate curves are validated by experimental ones. Meanwhile, we discuss the relationship between success rate and time complexity.

Keywords:
success rate, Markov chain, heuristic algorithms, hybrid algorithm, time complexity, satisfiability

1. Introduction

Heuristic algorithms include such as the (1+1) EA (evolutionary algorithm), RandomWalk, Simulated Annealing and Tabu Search [1, 2]. In recent years, it seems to be an effective way to design more powerful heuristic algorithms by combining several individual heuristics, and a great deal of hybrid algorithms have been constructed and used to solve complex problems [3, 4]. Some of them are catching more and more attention of researchers. For example, memetic algorithm, a hybrid algorithm combining evolutionary algorithm with local search has become an emerging field [5, 6, 7].

However, heuristic algorithms sometimes cannot successfully find a globally optimal solution for a combinatorial optimization problem, although their time complexities are relatively low [2]. This means that there exists a success rate (referring to finding a global optimum) for a heuristic algorithm in one run.

As two important metrics for heuristics, convergence and time complexity have received considerable attention from researchers, and a lot of theoretical studies on them have been done, e.g., [8, 9, 10, 11, 12, 13]. Theoretical investigations on another metric for heuristics, i.e., success rate, often comes with the theoretical work on time complexity, e.g., [14, 15].

In fact, success rate is an important metric for the performance evaluation of heuristic algorithms [16]. Usually, the definition of success rate is dependent on the problem to be solved, and there are some subtle differences. For example, in order to evaluate the heuristic algorithm's effectiveness on path selection problem, Yang [17] used a success rate defined as the ratio of the number of feasible paths found by an optimization algorithm to the number of feasible paths found by a tabu-search based heuristic algorithm. Frikha and Lahoud [18] used a success rate to evaluate algorithms for inter-domain QoS routing problem, which is defined as the percentage of QoS requests for which a feasible path is found. The success rate defined as the ratio of the number of successful runs to that of total runs is most commonly used [19, 20].

A high success rate implies that an algorithm will find a global solution with a high probability, while a low time complexity indicates that an algorithm can converge within a short time. If we consider the time to find a globally optimal solution rather than a locally optimal