Simulated annealing algorithm with restart strategy for optimizing k-minimum spanning tree problems

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Abstract. In this paper we consider the k-minimum spanning tree problem that generalizes the famous minimum weight spanning tree problem which is one of the major classes of combinatorial optimization problems. We propose an approach for solving this problem based on the Simulated Annealing algorithm. The performance of the proposed method is compared with existing metaheuristics using the well-known benchmark instances KCTLIB.

1 Introduction

In this paper we are interested in solving one of the well known combinatorial optimization problems: The k-minimum spanning tree problem (k-MST). The objective is to find a subtree with exactly k edges in an edge-weighted graph $G = (V, E)$, such that the sum of the weights is minimal. The combinatorial optimization model was introduced at first by Hamacher et al. (1991) for the relinquishment of petroleum licenses. It was demonstrated that the k-MST problem is NP-hard and it is very difficult to solve problems that can be formulated as a k-MST within a reasonable time (Fischetti et al., 1994; Ravi et al., 1996). In the literature, there have been several local search methods based on metaheuristic algorithms proposed for solving the k-MST problem. In 2005 Blum and Blesa (2005) suggested three metaheuristics: evolutionary computation (EC), ant colony optimization (ACO) and tabu search (TS). They compared their performances through benchmark instances KCTLIB and showed that an ACO approach is the best for small cardinality, whereas TS is the best for large cardinality. In 2012, a new hybrid algorithm that combines TS and ACO is provided by Katagiri et al. (2012). The purpose of the present paper is to offer new method for solving the k-MST problem. We propose an approximate approach to solve the problem of k-MST based on the simulated annealing (SA) algorithm. We were motivated by the fact that the SA algorithm was proposed to solve the problem of the generalized minimum spanning tree problem (Pop et al., 2007).However, to our knoledge, there is no previous work using SA algorithm to tackle the k-MST. Our primary focus was on developing an algorithm capable of producing solutions of high quality. Results of