ABSTRACT

The Bounded Diameter Minimum Spanning Tree [BDMST] problem is known to be $NP$-hard for diameter bounds greater than 4. BDMST has been shown to be not only $NP$-hard but also approximate-hard. For such problems exact approaches do not scale well with instance size, therefore, a number of heuristic approaches exist in literature to solve small to moderate sized BDMST instances.

In this study, a number of approaches have been suggested to solve moderate to large sized BDMST instances. A fast construction heuristic the Discriminatory Randomized greedy Heuristic [DRGH], along with two neighborhood-based interpolation heuristics Arc Exchange Mutation [Arc_Ex_Mut] and Level Exchange Mutation [Level_Ex_Mut] have been suggested. Finally, these three heuristics have been embedded in a steady state Genetic Algoritm [GA] to develop a hybrid metaheuristic that can solve large sized problem instances having several hundreds of nodes obtaining high quality solutions, particularly for Euclidean instances. The construction heuristic has been incorporated in GA as initialization routine to built-in domain specific knowledge so as to reduce the effort of GA in terms of number of function evaluations, as well as the number of generations taken to find the solution. The interpolation heuristics have been casted in the role of mutation operators which would introduce the sufficient diversity while optimizing the solution locally. A new measure of evaluating the status of diversity has also been introduced in this work. It can be viewed as a general purpose switch which can act as a cutoff point for submitting the incumbent solutions to more expensive local search routines in memetic algorithms. A new multiparent recombination operator along with a novel chromosomal representation of trees has also been proposed that generates solutions only in the feasible region of the search space and exhibits a strong heritability.

The optimization ability of the proposed Guided Genetic Algorithm for Tree construction [G-GAT] and its constituent heuristics has been compared against the various popular heuristics and state-of-the-art metaheuristics like Ant Colony Optimization [ACO], Variable Neighborhood Search [VNS] and other good performing techniques from the literature, on a suite of standard Euclidean test instances from the OR-library.
Computational studies on benchmark problems suggest that the proposed algorithm is capable of achieving good solutions while avoiding premature convergence and is on par with some of the state-of-the-art algorithms in the literature. The study demonstrates a systematic method to explore hybridization of GA with heuristics to generate above average initial population, efficient local search yet maintain diversity, which could significantly influence the convergence of GA to best solutions.