論　文　の　要　旨

題　目　Studies on Bio-Inspired Hybrid Metaheuristics for k-Cardinality Tree Problems
（最小 k 部分木問題に対する生物規範型ハイブリッドメタ戦略に基づく近似解法の研究）

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The k-Cardinality Tree Problem (kCTP) is one of the famous combinatorial optimization problems, finding the best solution out of a very large, but finite, number of possible solutions. Accordingly, the goal of the kCTP is to find a subtree with exactly k edges in an undirected graph G, such that the sum of edges' weight is minimal. It is also a generalized version of the well known minimum spanning tree (MST) problem when k =|V|-1, where |V| is the number of vertices in the graph. kCTP is suggested to be NP-hard.

In this dissertation, new hybrid metaheuristics combining bio-inspired algorithms with Tabu Search and/or Dynamic Programming are proposed for the k-Cardinality Tree Problem (kCTP). Properties of metaheuristics and hybrid metaheuristics and the way to construct an efficient hybrid metaheuristic for kCTP are also discussed.

In Chapter 1, a brief introduction is provided. The previous studies on the subject of the dissertation are reviewed. In our study, new efficient hybrid metaheuristics combining bio-inspired algorithms (Ant Colony Optimization, Immune Algorithm, Memetic Algorithm) with Tabu Search and/or Dynamic Programming are proposed for kCTP.

In Chapter 2, the basic concepts and methods used in our study are introduced briefly. Firstly, combinatorial optimization concepts, such as NP-hard, benchmark problems, heuristic and metaheuristic, are outlined by introducing to metaheuristics and dynamic programming for solving kCTP. Secondly, we introduce the Biological Inspired Algorithms, which have attracted much attention in recent years. Finally, basic concepts of Hybrid Metaheuristics, promising methods to obtain high quality solutions to combinatorial optimization problems in a reasonable time, are provided.

In Chapter 3, a new hybrid metaheuristic based on Tabu Search and Ant Colony Optimization is presented. We propose a diversification algorithm based on Ant Colony Optimization by extending the Blum-Blesa's algorithm. In the proposed algorithm pheromone is depositted on the edges selected in the local optimal solutions which were obtained by the Tabu-Search-based local search algorithm. This procedure allows the proposed algorithm to explore a wide search space. The numerical experimental results show that the proposed method has improved some of the best known solutions and values with very short computational time, and provides a better performance with the solution accuracy over existing algorithms.

Chapter 4 focuses on a Hybrid Metaheuristic based on Tabu Search and Immune Algorithm. Since Tabu Search stops when the length of tabu list reaches its limitation, Immune Algorithm is applied to enlarge the search area by generating a new initial solution for tabu search. Experimental results show that Immune Algorithm improves the solution accuracy significantly. Some best known solutions are also updated by the proposed algorithm.

In Chapter 5, we develop two Hybrid Metaheuristics, both of which are based on Memeteic Algorithm and Tabu Search. In the first one, a Memetic Algorithm based on tabu search is proposed. It has both merits of Evolutionary Computation and Local Search. The second one is a Tabu Search with Memetic Algorithm, which acts as a powerful diversitification strategy. Experimental results show that the new hybrid metaheuristic is dramatically superior to exiting algorithms in precision.

Chapter 6 concludes the doctoral dissertation and briefly summarizes this research. The proposed algorithms reached or updates almost of all of the best known solutions in the literature (benchmark instances proposed by Blum et. al.). It also indicates that nothing else matches its balance of diversification strategy and centralization strategy in hybrid metaheuristics.