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Test-cost-sensitive rough set based approach for minimum weight vertex cover problem

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Abstract

The minimum vertex cover problem (MVCP) and minimum weighted vertex cover problem (MWVCP) have been used in a variety of applications. This paper focuses on a view of test-cost-sensitive rough set for MWVCP. We first provide a method to convert a minimum weight vertex cover of a graph into a minimal test cost attribute reduct of a test-cost-sensitive decision table. Then, an induced test-cost-sensitive decision table from an undirected weighted graph is established. On the foundation of the induced decision table, an improved heuristic algorithm for finding minimum weight vertex covers is proposed, it can avoid a mass of redundant computation. Furthermore, to improve efficiency, a quantum-behaved particle swarm optimization with immune mechanism is presented, which can avoid the phenomenon of premature, improve the global searching ability, and enhance the convergence speed. The results of the experiment show the advantages and limitations of the proposed algorithms compared with state-of-the-art algorithms.

Keywords: Rough set, Attribute reduction, Minimum weight vertex cover, Graph theory

1. Introduction

The minimum vertex cover problem (MVCP) is a well-known optimization problem with a wide range of important applications such as network security, wireless communication, industrial machine assignments and data aggregation [1–5], the purpose of MVCP is to find a minimum subset of vertices that has at least one endpoint of each edge [6, 7]. The minimum weighted vertex cover problem (MWVCP) is an extension of the classical MVCP. Given an undirected graph where each vertex is weighted, the target of MWVCP is to find a subset of vertices with a minimum total weight that has all edges of the graph. Obviously, if all the vertices of a graph have the same weight that MWVCP reduces to MVCP. The MWVCP has also been applied to many real-world applications [8]. For example, urban traffic network leads in all directions and the passenger flow of transit is increasing day by day. More and more merchants choose urban traffic platforms to launch advertisements for attracting customers. Since the cost of launching advertisements in different platform is different, the merchants try to seek some traffic platforms which can connect every road while spending as little as possible. Urban traffic networks can be treated as an undirected graph, each traffic platform can be treated as a vertex, each road can be treated as an edge in this graph, and the cost of launching advertisements of a traffic platform can be treated as the weight of this vertex. Therefore, this real-world application can be translated as a MWVCP.

Rough set first proposed by Pawlak in 1982 [9–11], is a new mathematical soft computing method to deal with vague, uncertain and incomplete problems. The main advantage of rough set theory is that it is completely data-driven and requires no additional information. In recent years, many scholars have made a lot of researches and obtained some meaningful achievements in the field of machine learning, artificial intelligence, pattern recognition, data mining[11–14]. Attribute reduction is one of the research hotspot in rough set theory [15–20], the goal of

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