The Weighted Vertex Cover Problem

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Finding the minimum weight vertex cover for a graph is a classic problem in graph theory. The optimization version of this problem is NP-Hard, but occurs regularly across many domains; solutions have applications in wireless sensor placement, software-defined network latency management, protein structure prediction, and image segmentation. Despite the frequency with which the problem occurs, most algorithms use approximation methods due to the exponentially-sized search space. While these algorithms can produce approximate results in subexponential time, the quality of the approximation varies depending on the nature of the graph. Conversely, exact algorithms typically operate through reduction, for example to 3SAT or integer programming. These algorithms produce exact solutions, but the reduction prevents optimization for the underlying structure of the graph.

We present a new algorithm that produces exact results for the minimum weight vertex cover without reduction to another problem. The algorithm simplifies the graph before conducting a branch-and-bound search. This approach is designed primarily for sparse graphs, which frequently occur in real-world data sets. Experimental results show that the algorithm is practical for use in graphs with millions of vertices provided the average degree of each vertex is reasonably small. Results compare favourably against current reduction and approximation algorithms, demonstrating the promise of this approach for the sparse graphs that often occur in practical applications of MWVC.