Approximation algorithm applied to some NP-class problems

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Abstract: This thesis investigates the design and analysis of approximation algorithms for a selection of NP-hard combinatorial optimization problems. Given the computational intractability of finding exact solutions for these problems in polynomial time, approximation algorithms offer a practical framework for obtaining near-optimal solutions with provable performance guarantees. The research focuses on developing novel algorithmic strategies, including greedy heuristics, linear programming rounding, and primal-dual methods, tailored to specific problem structures. Key problems addressed include variants of the set cover, vertex cover, and facility location problems. For each problem, we establish rigorous bounds on the approximation ratio, demonstrating the trade-off between solution quality and computational efficiency. The theoretical findings are complemented by experimental evaluations on benchmark instances, which validate the practical efficacy of the proposed algorithms. The results contribute to the broader understanding of approximability within the NP complexity class and provide efficient tools for solving large-scale instances encountered in real-world applications such as network design and resource allocation.

Keywords: Approximation algorithm, NP problem, complexity, optimization