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Constant Factor Approximation Algorithm for TSP Satisfying a Biased Triangle Inequality

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Abstract

In this paper, we study the approximability of a variant of the Traveling Salesman Problem called the `Biased-TSP`. In the `Biased-TSP`, the edge cost function violates the triangle inequality in a "controlled" manner. We give a $\frac{7}{2}$-factor approximation algorithm for this problem by a suitable modification of the double-tree heuristic.

Keywords: TSP, relaxed triangle inequality, approximation algorithms

1. Introduction

The Traveling Salesman problem (TSP) is one of the central problems in the field of combinatorial optimization. In the TSP we are given a complete undirected graph $G = (V, E)$ on $V = \{v_1, v_2, \ldots, v_n\}$ vertices and an edge-cost function $c : E \mapsto \mathbb{R}^+$. The aim is to find a Hamiltonian tour $\sigma = \langle v_{\pi(1)}, v_{\pi(2)}, \ldots, v_{\pi(n)}, v_{\pi(1)} \rangle$ with minimum cost $c(\sigma) = \sum_{i=1}^{n-1} c(v_{\pi(i)}, v_{\pi(i+1)}) + c(v_{\pi(n)}, v_{\pi(1)})$, where π is a permutation of $\{1, \ldots, n\}$. TSP has many practical applications and a list of them can be obtained from [3, Chapter 2]. One of these applications is drilling of a printed circuit board. In this drilling problem, the vertices correspond to the locations where a hole is to be drilled and the cost function is the time required to move the robotic arm between the holes. The minimum cost Hamiltonian tour corresponds to the sequence in which the holes are to be traversed so that the total time to traverse the sequence is minimum among all sequences.

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