

Reaching a Simulated Annealing Heuristic Solution to the Flying Sidekick Travelling Salesman Problem

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Abstract

The Traveling Salesman Problem (TSP) is one of the most well-known and studied optimization problems in the field of operations research and computer science. It involves finding the shortest possible route that visits a set of cities and returns to the origin city. The Flying Sidekick Traveling Salesman Problem (FSTSP) is a fascinating extension of the classic TSP. In the FSTSP, the salesperson is equipped with a "flying sidekick," which can transport them between pairs of cities. This adds an intriguing dynamic to the problem, as the salesperson must decide when to use the sidekick for aerial travel and when to stick to conventional road travel. In this article, we explore the application of a simulated annealing heuristic to tackle the Flying Sidekick Traveling Salesman Problem. We'll delve into the problem's background, the simulated annealing approach, and how this powerful optimization technique can be harnessed to reach effective solutions for the FSTSP.

Keywords: Combinatorial optimization • Logistics • Flying sidekick

Introduction

The Flying Sidekick Traveling Salesman Problem is a combinatorial optimization challenge that arises in various real-world scenarios, such as route planning for sales representatives, delivery services, or even exploration missions. Given a set of cities, each with specified coordinates, a starting city, and a flying sidekick capable of transporting the salesperson between pairs of cities, the goal is to find the shortest closed tour that visits each city exactly once and returns to the starting city. The uniqueness of the FSTSP lies in the decision-making process of determining when to use the flying sidekick and when to travel by road. The salesperson must optimize the use of their sidekick to minimize the total travel distance while complying with the constraints of the problem. Simulated Annealing is a heuristic approach that draws inspiration from the annealing process in metallurgy. It is a versatile and powerful optimization technique that has been applied to a wide range of combinatorial optimization problems, including the TSP and its variations. The basic idea behind simulated annealing is to explore the solution space by iteratively accepting new solutions that are better than the current solution while occasionally accepting worse solutions with a decreasing probability. This stochastic behavior allows the algorithm to escape local optima and explore a broader search space, making it particularly effective for complex problems like the FSTSP [1,2].

Literature Review

Let's consider a case study to illustrate the application of simulated annealing to the Flying Sidekick Traveling Salesman Problem. Imagine a sales representative tasked with visiting multiple cities across a vast region, some of which are best reached by the flying sidekick, while others are more efficiently reached by road. In this scenario, the simulated annealing algorithm would

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Received: 02 September 2023, Manuscript No. iem-23-118027; **Editor Assigned:** 04 September 2023, Pre-QC No. P-118027; **Reviewed:** 16 September 2023, QC No. Q-118027; **Revised:** 21 September 2023, Manuscript No. R-118027; **Published:** 28 September 2023, DOI: 10.37421/2169-0316.2023.12.209

begin with an initial solution, such as a randomly generated tour. The algorithm would then iteratively explore the solution space, making changes to the tour by switching between road travel and sidekick travel. These changes would be accepted or rejected based on the acceptance criterion and the current temperature. The temperature would decrease over time according to the defined annealing schedule. The process would continue until the termination condition is met, at which point the algorithm would return the best-found tour. The Flying Sidekick Traveling Salesman Problem introduces a dynamic and intriguing dimension to the classic TSP [3,4].

Discussion

By combining the need to optimize travel distances with the choice of using a flying sidekick, it challenges engineers and researchers to develop innovative solutions. Simulated Annealing, as a powerful heuristic optimization technique, offers a robust approach to tackling the FSTSP. Its stochastic nature, global search capabilities, and adaptability make it an excellent choice for finding near-optimal or highly optimized solutions, even in the face of complex decision-making processes. As computational power and optimization algorithms continue to advance, the application of simulated annealing to the Flying Sidekick Traveling Salesman Problem represents a promising avenue for addressing real-world challenges in route planning, logistics, and transportation optimization. It is a testament to the versatility and effectiveness of heuristic methods in solving complex combinatorial optimization problems [5,6].

Conclusion

The Travelling Salesman Problem (TSP) is one of the most well-known and studied combinatorial optimization problems in the field of computer science and operations research. In its classical form, it involves finding the shortest possible route that visits a given set of cities and returns to the starting city. The TSP is NP-hard, meaning that finding an optimal solution becomes computationally infeasible for large instances. This article explores the application of a simulated annealing heuristic to a variant of the TSP known as the Flying Sidekick TSP, which presents additional challenges due to the introduction of a "sidekick" or auxiliary city.

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Suloo, Rilome. "Reaching a Simulated Annealing Heuristic Solution to the Flying Sidekick Travelling Salesman Problem." *Ind Eng Manag* 12 (2023): 209.