**Analysis of 2opt Heuristic Solution Finding Methods to the Traveling Salesperson Problem**

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**Abstract**

The traveling salesman problem is a famous NP-Hard problem in the realm of computing. Due to its complex nature, heuristic solutions are often used to find useful solutions to the traveling salesman problem in reasonable time. Our team has created an adapted version of the greedy solution finding algorithm that incorporates 2 opt solution finding techniques in order to quickly arrive at a local solution.

**Introduction**

The traveling salesman problem is a well explored problem in the field of computing and computer science. The goal of this problem is to find the fastest route within network of nodes that passes each node only once. Additionally, this route through the network must begin and end at the same node. Though seemingly simple, when analyzed, the problem quickly reveals itself to be complex and tedious to solve completely.

Viewing the problem through a mathematical lens, we can begin to find the complexity of finding an exact solution to the traveling salesman problem. We begin by defining a set *V* which contains n number of nodes in a graph. Thereafter, we also introduce set *E*, which contains m weighted edges which connect the nodes of set *V* which define our graph. In a worst case scenario, we say that the edges of *E* are directional and that |*E|* is equal to |V|\* (|V| - 1), making each node connected to every other node. Finally we define our ideal solution as the subset of *E* that connects every vertex in *V* with the lowest total summation of edge weights.

Analyzing our worst case, we see that the number of possible solutions to this problem is n!. This is because after exploring a node from set *V*, we may explore |*V|* - b paths, where b is the number of nodes we have already visited. This classifies the Traveling Salesman problem as an NP-Complete problem, and thus shows the difficulty in computing the perfect solution with a brute force method.

Such difficulty as lead computer scientist to instead search for heuristic or imperfect solutions to the traveling salesman problem. Such solutions include greedy solutions, local optimums, and others. While not as ideal as the perfect solution, these heuristic approaches offer solutions that can be near optimal and extremely useful for practical computing, given their significantly better time complexities.

This report explores our team’s approach to finding a heuristic solution to the Traveling Salesman problem by adapting a greedy solving method to a 2opt solving method.

**The Greedy Algorithm**

A simple heuristic solution to the Traveling Salesman Problem is the greedy approach. Greedy algorithms are common in computing, they involve solving a problem by taking the more rewarding immediate path rather than planning far in advance. While the solutions that these algorithms output are often less than optimal, they have the advantage of reduced time complexity. In the case of the Traveling Salesman problem, a greedy algorithm would begin with a staring node in the set *V* previously mentioned. It would then find the shortest edge in set *E* that connects to *V* and add it to a solution set *S*. It would then repeat the process at the opposite vertex in the previously selected edge. Finally, this process is repeated until the edges in *S* completely cover the set *V.*

* Analyze the pseudocode and time complexity

**The 2opt Correction Approach**

* Explain how the 2 opt approach works
* Explain our approach
* Show pseudo code
* Explain time complexity

**Results**

**Analysis**