uOEC Programming Competition

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Problem

- Real-time route optimization
- Time-efficient delivery sequence
- Produce accurate expected arrival times
- Handle up to 100 nodes
- Run under five seconds
- No third-party routing APIs

Algorithm used in Solution

K - Nearest Neighbour (KNN) and Clarke Wright Savings Algorithm used in solution. Both heuristic algorithms.

Dijkstra's and A* Algorithm were considered but not used in solution

When the number of nodes <= 30 then we try both KNN and Clarke Wright algorithm and give the output of the fastest algorithm.

When the number of nodes <= 60 then we just use savings algorithm.

For anything above 60 nodes then we just use KNN algorithm.

Assumptions

- Predetermined dynamic traffic (delays & speed factors)
- Json file is the order we made it. (created our own test bench)
- Time spent at node = 0 (can be set to a value)
- Assuming (nodes ≤ 0) isn't a viable option

How the Nearest Neighbour and Clarke Wright algorithm works

KNN:

K represents the number of nearby neighbours for the algorithm to check

The closest neighbour is chosen based on Euclidean distance. (Straight line between the deliverer and neighbour) (Kartik, 2025)

Clarke Wright:

The algorithm identifies pairs of delivery points that can be efficiently served together on the same route.

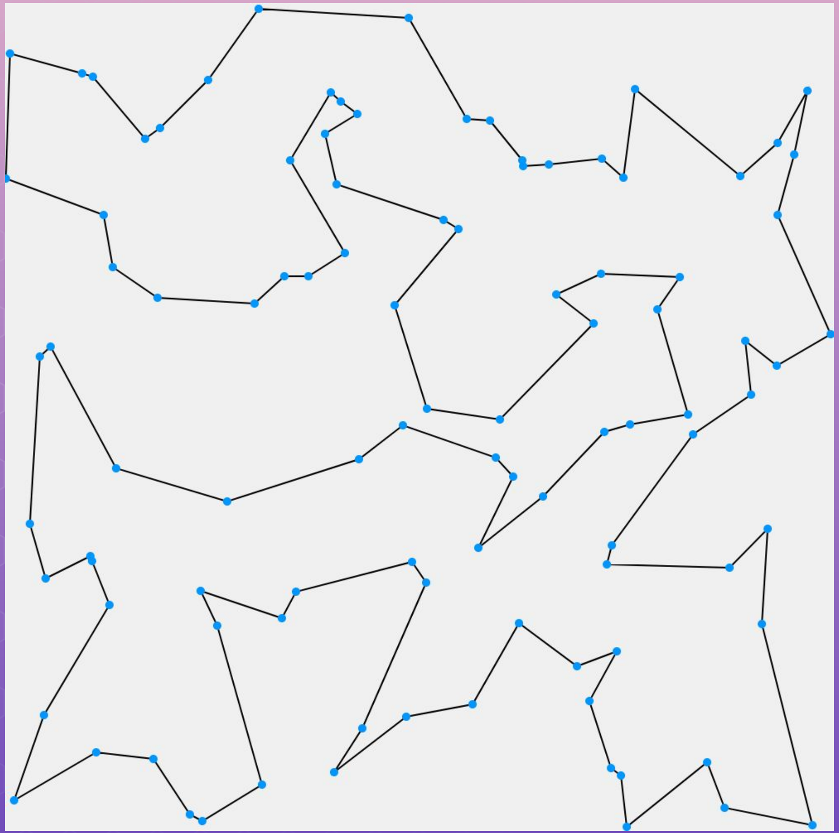
For every pair of deliveries (i, j), calculate the "savings" from combining them into one route.

These “savings” are stored in an array in descending order to get the largest savings first. (Kartik, 2025)

2-opt Algorithm

The main idea behind is to take a route that crosses over itself and reorder it so that it does not.

We run this after using KNN or Clarke Wright algorithms, making the routes cleaner.



Source: https://en.wikipedia.org/wiki/2-opt

Design Critique

The algorithms used are heuristic algorithms meaning that solutions may not be globally optimal.

Before any of the algorithms are used we precompute the distances between the nodes depending on the traffic conditions for each node. Then the algorithms use this precomputed data.

The precomputed data is cached into memory which decreases CPU usage but increases memory usage.

Python is used over C++ despite C++ yielding potentially more efficient performance

Resources Used

Most efficient implementation to get the closest k items - Stack Overflow

A Heuristic Approach Based on Clarke-Wright Algorithm for Open Vehicle Routing Problem - PMC

Kartik. (2025, July 23). *A* Search Algorithm.* GeeksforGeeks. https://www.geeksforgeeks.org/dsa/a-search-algorithm/

Kartik. (2025, August 23). *K-Nearest Neighbor(KNN) algorithm*. GeeksforGeeks. https://www.geeksforgeeks.org/machine-learning/k-nearest-neighbours/

https://en.wikipedia.org/wiki/2-opt

THANK YOU