Enhancing Efficiency in Microchip Distribution: Strategic Supply Chain Route Optimization

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Problem Description

A global microchip producer supplied a dataset from their outbound logistics network. This dataset includes demand information for 9216 orders which must be directed through their distribution system, consisting of 15 warehouses, 11 ports of departure, and a single port of arrival.

The project is to design an optimal distribution network that incorporates warehouses, shipping routes, and courier services to create the most economical supply chain possible. The goal is to minimize the total costs, comprising warehouse operations and transportation expenses while adhering to the constraints of demand, supply, and shipping logistics.

Data Source

The data for this project is from Brunel University London's public supply chain datasets.

- https://brunel.figshare.com/articles/dataset/Supply_Chain_Logistics_Problem_Dataset/7558679
- Detailed descriptions of this dataset can be found in the paper: Accelerating supply chains with Ant Colony Optimization across a range of hardware solutions

Challenges and ideas to overcome

- **Infeasible solution based on the current data**: total supply (manufacturing capacity) is higher than total demand, which requires creating synthetic data, allowing cross-day route assignment, or introducing soft constraints.
- **Unclear definition in data**: the dataset contains columns related to shipping time that lack clear definitions. To effectively consider shipping time constraints, it is necessary to generate synthetic data that provides meaningful and coherent shipping time information.

Methods

We will develop two linear programming optimization models:

1) **Basic Optimization Model**: this will assume that each warehouse has the capacity to take as many orders per day (uses a synthetic capacity table).
2) **Capacity-Constrained Model**: an improvement upon the basic model which accounts for warehouses not having sufficient daily capacity to take unlimited orders per day.

Expected Results

The model's expected deliverable is a tailored assignment of a warehouse, origin port, and carrier for each order in the dataset, ready for integration into the microchip producer's supply chain. The aim is for the model's cost calculations to surpass the efficiency of the existing allocation method. Future enhancements to the model include the ability to split orders into smaller segments, potentially leading to even greater cost savings.