TECHINCAL REPORT

SOICT-2024-TIKI-Track Competition

1. Team Information

Team name: OptIT

Members:

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- Trần Quang Minh Toàn (Lead)

2. Introduction

This report details the approach and solution implemented for the SOICT-2024-TIKI-Track competition. The problem involves optimizing the routes for trucks to transport containers between various points, minimizing the overall completion time and travel distance. The solution aims to efficiently manage the pickup and delivery of containers using a fleet of trucks, ensuring that all requests are fulfilled in the shortest possible time.

3. Problem description

The problem involves a set of trucks, trailers, and containers located at different depots. The trucks need to pick up trailers and transport containers according to given requests. Each truck can carry up to two 20ft containers or one 40ft container. The objective is to minimize the maximum completion time of any truck (F1) and the total travel time of all trucks (F2). The combined objective function is F = $\boldsymbol{\alpha}$ * F1 + F2, where $\boldsymbol{\alpha}$ is a large constant.

Input

1. **Points (N)**: Number of locations.
2. **Distances (N^2)**: Travel times between locations.
3. **Trailer**: Location and time required to attach a trailer.
4. **Trucks (m)**: Number of trucks and their initial locations.
5. **Requests**: Pickup and delivery requests for containers.

Output

- **Routes (m)**: Number of trucks assigned routes.
- **Route Details**: Sequence of actions for each truck, including point IDs, actions, and request IDs

4. Methodology

4.1. Approach idea

We had devided the problems into 2 main parts, Truck assignments and Route building.

The truck assignments processs focus on how we partition the constructed path to K trucks so that the total complete time is smallest. Noticed that we can represent this problem by using a bipartie graph since each truck can be assigned to any route and vice versa. Therefore, we use the General Matching Algorithm and Bipartite Matching Algorithm to address this problem.

In order to build the route that best fit to K route, we first build atomic path that the smallest route which is the smallest valid route. Next, we merge these route together using backtracking. Down to the rabbit hole, we merge the route together base on some assumption made by exploring the atomic problem such as chainning the routing together base on the cost, channign the route if the truck in only a 20ft container and it could pickup another 20ft container,... After the route had been generated, we continue to try to make them as equal as possible. Finally, we decided to use stimulate annealing to further try to find a more optimal route.

4.2. Data model

DataModel: Stores all input data, inJcluding the number of vehicles, points, distance matrix, warehouse details, truck initial points, and requests.

Path: Represents a sequence of commands (actions) for a truck, including methods to calculate the cost of the path and print the commands.

4.3. Algorithms

Matching Algorithms: Used to find optimal matches between trucks and paths.

- Bipartite Matching: Finds the minimum max-weighted matching in a bipartite graph.
- General Matching: Handles more complex matching scenarios.

Path Construction and Optimization:

- Backtracking: Generates all possible paths for a given set of commands and selects the optimal one.
- Stress Path: Optimizes a given path by exploring different command sequences.
- Combine Paths: Merges two paths to create a more efficient route.
- Quantum Annealing: A metaheuristic optimization technique to find near-optimal solutions by exploring the solution space.

Truck Assignment: Assigns trucks to paths using a min-max matching algorithm to minimize the overall cost.

5. Result

The solution generates routes for each truck, ensuring that all requests are fulfilled while minimizing the overall completion time and travel distance. The output includes the number of routes, the sequence of actions for each truck, and the final stop at the truck's initial location.