MINeD HACKATHON

NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY
NAAC ACCREDITED 'A+' GRADE

BINGHAMTON UNIVERSITY | SCHOOL OF SYSTEMS SCIENCE AND INDUSTRIAL ENGINEERING

Track 3: Intech Smart Route
Team Name: ML Mavericks

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INTECH
THE DESIRE TO PERFORM

Current Challenges :

- Inefficient manual trip planning
- Underutilized vehicle capacity
- Increased operational costs
- Delays due to poor route optimization

Goal :

- Automate and optimize delivery planning to enhance efficiency, reduce costs, and improve customer satisfaction.

COMPUTE MINIMUM SPANNING TREE (MST)

- Objective: Find the minimum cost connection between shipment locations.
- Algorithm: Kruskal’s Algorithm.
- Process:
  - Construct an MST using Kruskal’s algorithm.
  - Compute the sum of edge weights in the MST.
  - Use Union-Find (Disjoint Set Union, DSU) for cycle detection.
- Benefit: Ensures efficient route connectivity with minimal total distance.

SOLVE TSP WITH NEAREST NEIGHBOR HEURISTIC

- Objective: Determine an optimized delivery sequence.
- Algorithm: Nearest Neighbor Heuristic.
- Process:
  - Start from the depot (index 0).
  - Select the closest unvisited location iteratively.
  - Continue until all locations are visited.
  - Return to the depot, forming a closed tour.
- Benefit: Provides a fast, heuristic solution for optimizing delivery order.

CHECK VEHICLE CAPACITY CONSTRAINTS

- Objective: Ensure vehicles are efficiently loaded while avoiding underutilization or overload.
- Rules:
- Each vehicle should carry between 50% and 100% of its capacity.
- Benefit: Ensures optimal vehicle utilization and avoids inefficiencies.

OPTIMIZE ROUTES

- Objective: Assign shipments efficiently to vehicles while considering constraints.

- Process:
  - Group shipments by time slot.
  - Iterate through shipments and assign them to available vehicles based on:
  - Capacity constraints (check_capacity_constraints).
  - Distance constraints (MST distance).
  - Time constraints (delivery time slots).
  - Benefit: Ensures deliveries are efficient, cost-effective, and time-sensitive.

STATISTICS

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Summary Statistics:
Total number of trips: 248
Average capacity utilization: 77.88%
Average time utilization: 69.68%
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Detailed Statistics per Vehicle Type:
              Number of Trips  Avg Shipments per Trip  \
Vehicle_Type
3W                         25                    4.00
4W                        198                    4.77
4W-EV                      25                    7.00

              Avg Capacity Utilization
Vehicle_Type
3W                                0.80
4W                                0.76
4W-EV                             0.88

Vehicle Distribution Percentages:
4W: 79.84%
4W-EV: 10.08%
3W: 10.08%
```

LIMITATIONS & CHALLENGES

Assumptions:

- MST-based routing does not consider real-time traffic, Uniform delivery timeslot durations

Limitations:

- Algorithm struggles with guaranteeing full utilization of priority vehicles
- Vehicle reallocation strategies may need refinement
- Multi-slot trips require careful handling to avoid overlapping deliveries

REINFORCEMENT LEARNING APPROACH & CHALLENGES

- Techniques Used
- Q-Learning and Deep Q-Learning (DQN) were implemented to optimize vehicle routing.
- The agent was trained to select vehicles dynamically based on rewards.

Challenges Faced (Non-Static Environment):

- The number of available vehicles was not predefined, making it difficult to establish a stable learning environment.
- The presence of unlimited 4W vehicles led to the agent always selecting 4W vehicles, as they provided the most immediate reward.

REINFORCEMENT LEARNING APPROACH & CHALLENGES

Reward Function Issues:

- The model favored vehicle selection based solely on minimum cost, ignoring operational constraints.
- The instructions specified:
- Vehicles should only be 50%–100% filled.
- Routes must not exceed a predefined distance.
- However, the RL model often violated these constraints.

OUTPUTS

Shipment Input

Upload Excel Shipment File Choose File input data.xlsx

Shipment ID

Latitude

Longitude

Delivery Timeslot (HH:MM-HH:MM)

Add Shipment

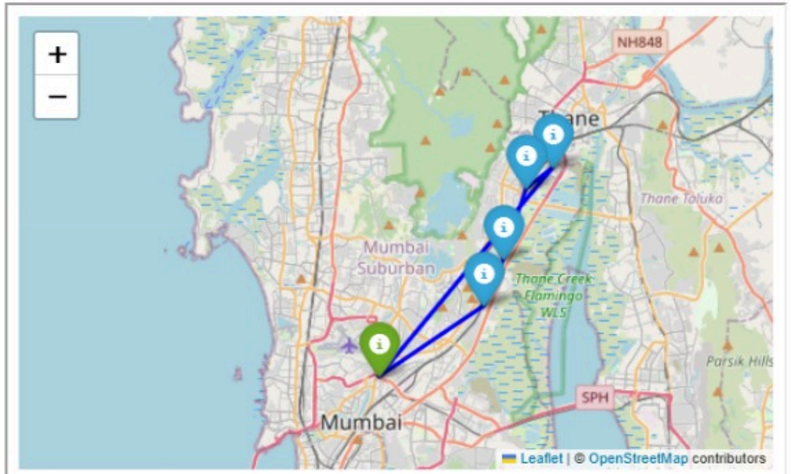
Shipments: 2438

1	19.0802676, 72.850804	09:30:00-12:00:00
2	19.1121104, 72.8983546	09:30:00-12:00:00
3	19.0581451, 72.8343773	07:00:00-09:30:00
4	19.176505, 72.962189	12:00:00-14:30:00
5	19.1489669, 72.9316651	09:30:00-12:00:00
6	19.0719625, 72.8347505	09:30:00-12:00:00

Optimize Routes

Optimization Results

View All Trips



Trip Details

Trip ID: T059_1	Shipment: 861	Vehicle: 3W	Timeslot: 12:00-14:00
Trip ID: T059_1	Shipment: 884	Vehicle: 3W	Timeslot: 12:00-14:00
Trip ID: T060_1	Shipment: 912	Vehicle: 4W-EV	Timeslot: 12:00-14:00
Trip ID: T060_1	Shipment: 923	Vehicle: 4W-EV	Timeslot: 12:00-14:00
Trip ID: T060_1	Shipment: 947	Vehicle: 4W-EV	Timeslot: 12:00-14:00
Trip ID: T060_1	Shipment: 939	Vehicle: 4W-EV	Timeslot: 12:00-14:00

THANK YOU