Disaster Route Planning

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1 Key idea

Disasters, whether natural or man-made, often disrupt regular transit networks and create a pressing need for efficient and adaptive routing solutions. Our goal is to create an optimization system that can dynamically adjust transit routes by identifying and removing affected nodes during disasters, ensuring the continuity of essential services and minimizing disruption.

2 Data sources

2.1 GTFS feeds

The General Transit Feed Specification (GTFS) is a standardized data format that allows transit agencies to publish their scheduling and routing information. This data format provides extensive details about public transit operations, including routes, stops, schedules, and more. We plan on downloading the GTFS data from Société de transport de Montréal and parsing through bus routes to identify the nodes.

2.2 Disaster data

The Canadian Disaster Database (CDD) is a comprehensive repository that archives significant disaster events across the country. To depict the impact of disaster, we plan to take flooding events as an example. To represent the impacted areas during floods, we'll depict them as bounding boxes, and disable nodes inside the bounding box.

3 Implementation details

For a public transit network, it is crucial to have a robust evacuation plan, especially for citizens without personal vehicles. We will attempt to tackle this by optimizing evacuation routes using buses. Our model extends the **Travelling Salesman Problem** to cater to this unique situation.

3.1 Assumptions

1. The fleet size is predetermined
2. There exists a single, designated drop-off location that is deemed safe for evacuees
3. Bus stops act as both pick-up and drop-off points

3.2 Parameters

1. A list of nodes rendered inaccessible due to the disaster
2. Time required to travel from node i to j
3. Calculated distance between each node (based on geospatial data)

3.3 LP formulation

3.3.1 Decision variables

Binary variables X_{ij} indicating if vehicle should go from node i to j

3.3.2 Objective function

Minimize the travel time from the evacuation point to the safety point, ensuring evacuees are transported in the shortest possible time.

$$\min \quad \sum_i \sum_j T_{ij} X_{ij}$$

3.3.3 Constraints

1. A limited number of buses are available for evacuation.
2. The evacuation route adapts based on the disaster's impact, removing affected nodes from the path.
3. Each pick-up spot is visited only once to prevent redundancy.
4. Subtour elimination to prevent cyclic routes that don't lead to the destination.

4 Conclusion

The above framework represents our initial insights and approach. However, as we delve deeper into the data and understand the nuances of the transit network, our approach may evolve.