International Institute of
Information Technology Bangalore

Software Design Document
DS 703 Geographic Information Systems

Multimodal Route Planning

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March 15, 2017

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1 Problem Description

For a traveller it is often reliable when it comes to use different modes of transport for a single travel whenever it is available. But there lacks efficient systems to find out, even though there are systems that aid traveller to choose different modes of transport, such as Google Transit.
Multimodal Route Planning(MRP) is system that provides the traveller with optimal, feasible and personalized route plan between a given source and destination. The system is designed to provide various public travel approaches (like bus riding, metro travel) and provides traveller the flexibility to choose from different modes of transport.

2 Data Collection and Preprocessing

The bus and metro schedules are collected from the Bengaluru Metropolitan Transport Corporation (from GPS records) and Bengaluru Metro departments. It is then represented as graphs (transportation networks) from the longitude and latitude data. The graphical representation of unimodal networks are done using software's likes qgis.

3 Building the multimodal network model

3.1 unimodal network construction

3.1.1 Bus network model

The bus network model is build from the co ordinates of the bus stops obtained from the data collected from bmtc. It is then fed into the software like Qgis to build a unimodal graph network.

3.1.2 Metro network model

The metro network modal is build from the GPS records of the metro network. A unimodal graph network is constructed from it using software like Qgis.

3.2 Merging and linking to form multimodal network model

3.2.1 Merging

The merging operation is performed using nearest neighbour algorithm. It uses linear search to find out the nearest location in the given two unimodal network considered for merging.

3.2.2 Linking

The unimodel network that are being merged are linked by two types of link, walk_link or bicycle_link for the completion of multimodel network model. The walk_link or bicycle_links are added based on the shortest harvesine distance (for a predefined threashold, T_d) for a transit between the two modes of transport.

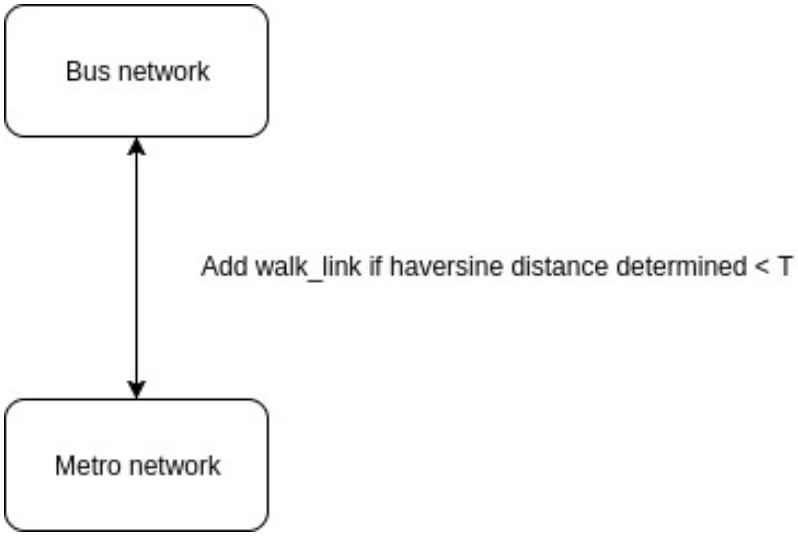

Figure 1: Add link if its less than a Threshold, T

4 Algorithm for multimodal route planning

In the simplest form the algorithms for journey planning is a shortest path problem from the given start location to the destination. MRP helps traveller combine various modes of transport like bus riding and metro travel for a single trip by using heuristics approach.

The algorithm proposed here uses A^* graph search with acceptable heuristics(Expected time of Travel, ETA estimated from historical data) to provide a deterministic solution to mutlimodal routing problem from the multimodal transportation network data gathered from merging unimodal graph networks. The general solution is NP Hard since there is always a level of non determinism for example. boarding of the bus (can succeed or fail).

In MRP there are multiple quality criteria such as travel time, number of interchanges, cost etc.

4.1 A^* Graph Search with Admissible Heuristics

The step by step approach for solving the multimodal routing problem is as follows:

- Build the unimodal network for each modality of transport. (here, for bus network, metro network).
- Merge unimodal network using nearest neighbour and link the unimodal network using alternative means of travel like (walking, cycling etc)
- Apply A^* graph search to find the shortest path between given destination from the traveller location.

4.1.1 Admissible Heuristics

We uses Expected Time of Travel (ETA) from historical data as a admissible heuristic metric.

4.2 Input description

The spatial data can be plotted on OpenStreetMap or Google Maps using WGS 84 datum via softwares like QGIS and corresponding network is generated from it. This network is used to find the shortest feasible route to travel from a given location.

4.3 Algorithms

The algorithm use probabilistic heuristics to find out optimal path between source and destination by incorporating various modes of travel selected by the traveler.

4.4 Output

An optimal route is returned by the system as the output.

5 Flow Diagrams

5.1 End user flow

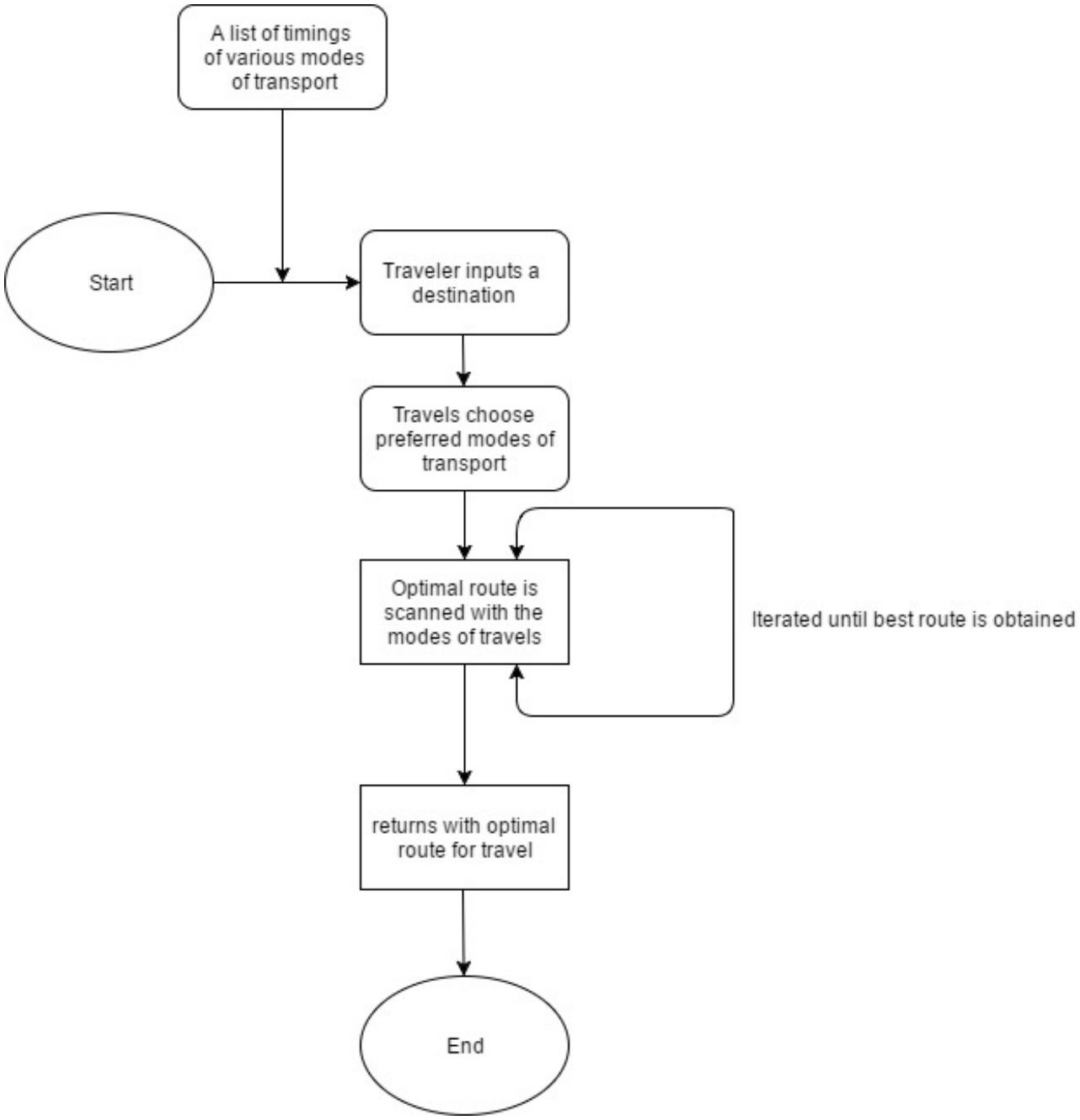

Figure 2: End user

5.2 Back end flow

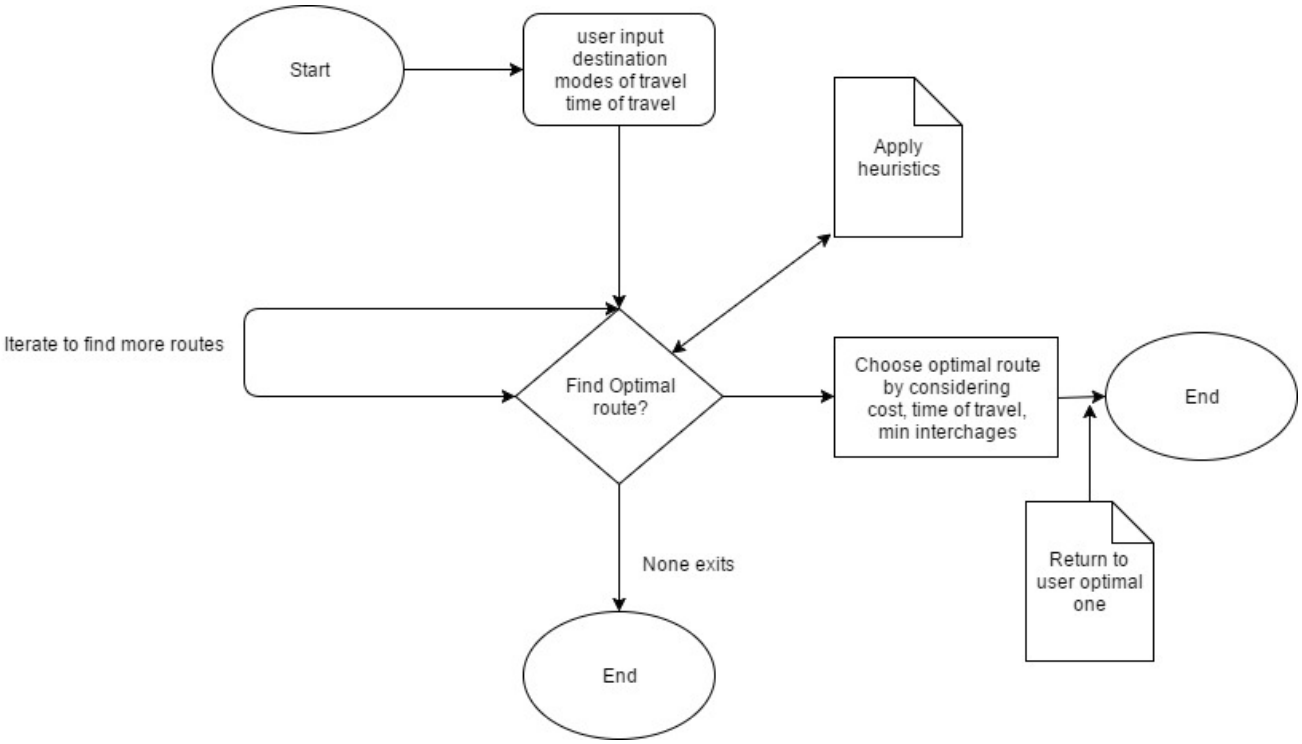

Figure 3: backend