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Project Proposal

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Background and Problem

The A* algorithm is an extremely popular informed-search algorithm used to find the optimal path between a given start and end node within a weighted graph. However in certain real world applications, the edge weights are stochastic in nature and so the standard A* algorithm is insufficient to find the shortest path. An example of this stochastic shortest path problem is a road network with nodes representing intersections and edges representing time to traverse a particular route. In this instance, the time is dependent on weather, time of day and traffic. One particular approach to solving this problem is to find the most reliable shortest path, known as the Reliable Shortest Path Problem (RSPP). Chen et al. presents one particular approach, the multi-criteria A* algorithm (RSPP-A*) for determining reliable shortest paths in order to allow travellers to plan their trips with a pre-specified on-time arrival probability (when faced with travel time uncertainty) [1].

Project Scope

This project will focus primarily on using the RSPP-A* algorithm to solve the RSPP. In particular, the following will be included as part of the final project report and presentation:

- **Problem Definition**: An overview of the RSPP, variations of the RSPP, and utility of the RSPP in motion planning.
- **Literature Review**: A review of related problems and their solution methodologies such as the alpha-reliable shortest path and multi-criteria label setting.
- **Background**: The relevant mathematical background into the optimization problem, the multi-criteria approach, and two-level hierarchical networks, which are all used to solve the RSPP.
- **Algorithm and Simulation**: A python-based 2D implementation of the multi-criteria A* algorithm to find the most reliable shortest path within a portion of the Toronto downtown area using real-world stochastic traffic data.

Risks

We have identified potential risks for which alternative approaches will be taken if they materialize:

- There may be challenges extracting stochastic traffic data for the city of Toronto. In this case, we intend to generate normally distribution traffic data, which is a common assumption [1].
- If the downtown Toronto area is too large of a problem to simulate, we will reduce the size or choose a smaller location to simulate.

References

[1] Bi Yu Chen , William H.K. Lam , Agachai Sumalee & Zhi-lin Li (2012) Reliable shortest path finding in stochastic networks with spatial correlated link travel times, International Journal of Geographical Information Science, 26:2, 365-386, DOI: 10.1080/13658816.2011.598133