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Belief Revision on Train Networks

The problem we have selected for modeling a problem involving belief revision was can a rider travel from one station to another. The modeling world will consist of train stations, train routes, and a commuter. Each station will include at least one route, and the routes will connect at least two stations together. The problem we are trying to solve is what if we are the rider and we are trying to get from one station to the other. We will have to start at one station accompanied by a set of beliefs that help us to decide which routes and trains are best suited for traveling to the destination. And these beliefs can be revised when we gather more information along the way, such as if a train is too crowded then we might want to wait for the next train, or if we learn that a certain route is closed for whatever reason then we might want to rethink what routes to take.

This problem is basically a graph problem, as each component of the world we are modeling can be simplified down to graph elements. Just to clarify, in this context the graph does not refer to the most common ones we see in business presentations or in data comparisons where a diagram with x axis, y axis, and plotted points are shown to better represent the relationship between quantitative variables. Instead we are referring to the graphs in mathematical graph theory, where "A graph in this context is made up of vertices (also called nodes or points) which are connected by edges (also called links or lines)" (Graph theory). Our train stations can be represented by vertices, and our train routes can be represented by edges since they serve the same purpose. As of the rider's status all we need to represent is an hypothetical idea of where he is at. In graph theory there is also a distinction between directed and undirected graphs, since our abstract route is going to run two ways so our graph representation will be undirected. As of the rider's best route it can be represented by the shortest edge between vertices, and the edge in this sense will be the fastest route.

Fortunately for us graph theory has been studied way earlier than us and by people way smarter than us, what's even more fortunate is that the applications of it have already been in use. Such as directional guide of GPSs, YouTube's recommended videos, FaceBook's friend recommendations, and many more. Now it may seem like just finding paths between train stations has nothing to do with YouTube's algorithms, but usprisinging they indeed follow the same fundamental concept that derived from

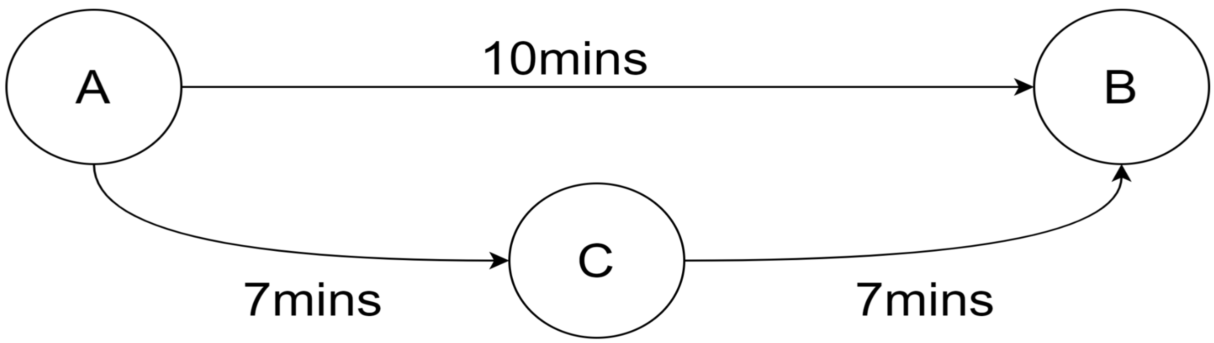
Dijsktra's algorithm. Computer scientist Dijsktra's "original algorithm found the shortest path between two given nodes, but a more common variant fixes a single node as the 'source' node and finds shortest paths from the source to all other nodes in the graph, producing a shortest-path tree" (Dijkstra's algorithm). In GPSs case, they use the speed as the criteria to determine the shortest path, for YouTube each video is a node and some algorithm that determines its similarity with other videos gives the criteria for measuring the shortest path, in our case it's a lot simpler just being the distance between stations.

Believe revision in our situation is when the rider receives new information and uses it to determine if a route is still the best route to take. Fortunately GPSs already have this system implemented well, for example google collects data from cell phone users, and then "analyze the total number of cars, and how fast they're going, on a road at any given time." (Stenovec). From this the shortest path or the best route to take is influenced and subsequently recalculated, and updates the user the best path which google believes the user should take. In our case when the rider learns something such as a crowded train or announcements of a closed route, he will have to rethink his believed best path with the new information he has.

While we were searching for research projects that are related to our research proposal we came across an interesting research article from MIT about belief propagation and networks with loops. The research paper discusses how, today, we already have proposed belief propagation rules to generate optimal beliefs for singly connected networks, and there have been a number of researchers who have already come up with good performing belief propagation rules to deal with networks with loops. However, the theoretical understanding of the belief propagation rules for networks with loops has yet been achieved. Therefore, the goal of the research project is to "lay a foundation for an understanding of belief propagation in networks with loops" (Weiss). In their project the researchers have experimented with networks with a single loop and networks with multiple loops. While working with networks with a single loop, they have discovered "an analytical relationship between the steady state beliefs in the loopy network and the true posterior probability" (Weiss). For networks with multiple loops, the research team has developed a concept called "balanced network" and illustrated simulation results by comparing belief revision and update in networks with multiple loops (Weiss). We have selected this research paper because it relates to our project in the sense that our project also involves working with networks, specifically a train network. We plan on using the MTA train map as a model to construct our network and we assume that our network will involve loops. We hope that we can utilize this research paper as a reference to develop a train network involved in our belief revision project.

Since our problem is for subway users to find the shortest path. There is an interesting article about time-dependent stochastic shortest path(s) from Nottingham

Trent University. They said that finding the shortest path in an optimal way requires multiple algorithms. For this they used a method called time-dependent stochastic shortest path(s), which is a combination of time-dependent path and stochastic path.The time-dependent path literally means finding the shortest path according to time. For example, let's say we are at location A and there are two ways to get to location B.If we go directly from location A to location B, it will take 10 minutes, and if we go from A to C through B, it will take 14 minutes. If so, the shortest time would be the first one.



Stochastic path is a probability variable that influences our decisions. For example road construction in the subway, congestion, absence of drivers,etc.If so we need to choose another path. Therefore, The time-dependent stochastic shortest path(s), which combines these two methods, is related to our Believe revision and we will refer to this research.

Works Cited

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