Theoretical Mobility Observations and Thoughts

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Theoretical average trip length within a disc

From a conversation with Marc Timme, Andreas Sorge, and Matthius:

Our goal is to

- Find the distribution of trip lengths for all points within a disc.

- Find the same distribution, with an added 'time constraint' of total time travel per day.

We can also thinking about finding the average of these distances:

1. Choose point A.

2. Point A' can lie anywhere in the circle. For each point, there is a $\frac{1}{Area}$ probability A' will be at that point. Thus we need to find the total distance of all points A' to A and normalize by 1/Area.

For the discrete case:

$$\overline{Dist(A, A')} =$$

3. This is the average distance of all points A' to a particular point A, so now we need to sum all of these average distances to all possible point As, and normalize once again by the 1/Area.

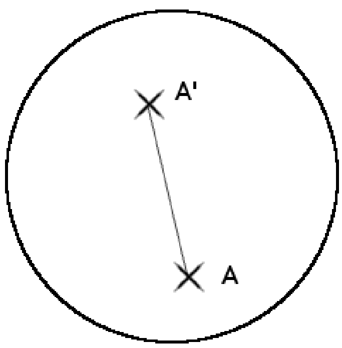

Figure 1: Finding average distance between any two points in circle. Choose point A, then find distance to all other points and weight by 1/area.

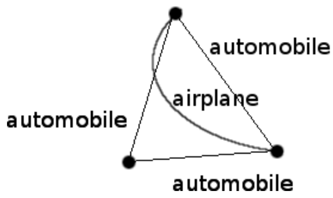

Figure 2: Mode links between cities of different sizes.

To find the distribution, in the discrete case, we need to create a histogram of all distances for each A, A' choice.

1. Again, starting with a particular (random) location for A.
2. For each possible A', we record the distance.

$$p(r_i|r_{circle}) \propto \frac{2\Pi r - cutoffpoints + bonuspoints}{(\Pi r_{circle}^2)^2}$$

Shortest-path distance by time, energy between locations in a network.

From a conversation with Christian at MPG. Here we consider an area. This area has a distribution of large and small cities (perhaps use a power law distribution or other based on real cities). We can discretize this area, then add edges corresponding to various modes. Let's first suppose there are 2 modes: 'automobile', and 'airplane'. We now add edges between nodes proportional to their size. For example, if a city is large, there is a high probability one can fly to another large city. If the city is small, there is a lower probability of flying, but a higher probability there is a highway directly to neighboring cities. If a town is very small, there is an even smaller probability, and there are only direct connections to neighboring nodes.

We can then say that there are several modes of transportation, which have average velocities and energy consumption per distances. Now, based once on time, then again on energy, we can re-weight edges and find all-pairs shortest paths.

Shortest paths between all pairs become new edges, and we can now re-draw the network using these new weights.

From a public-policy perspective, policymakers want convenience as well as energy savings, and the ability to reduce the average shortest paths in both of these networks. In some sense, the ideal would be a 'point mass', since that is an minimal state of time and energy consumption.

Genetic algorithms for optimal route finding

Based on Matthius, Andreas and Marc Timme's work at Max Planck Goettingen, which does the following:

- Route generation - collectivization - embedding - Optimization

Now, instead, for a particular request, generate many routes based on simple rules.

Routes/rules can be selected using the fitness function of 'shortest travel time'.

Genetic algorithms can be used in two different ways here:

1. Route finding - For a particular set of requests, generate many candidate routes and find the shortest.
2. Rule finding - Over time, evolve a set of rules to make optimal routes.