Land of Opportunity: The Use of GIS Network Analyst to Evaluate Transportation Access

What is Opportunity?

The Kirwan Institute for the Study of Race and Ethnicity at Ohio State University has put together several data sets detailing differences in "opportunity" at the Census Tract level. In short, a community's "opportunity" rating, or its 'Z' score (explained in the methodology section) refers to a series of educational, employment, neighborhood, financial, and environmental factors.

This project displays a method of mapping transportation access — by car or by bus — from areas of markedly low comprehensive opportunity to areas of markedly high comprehensive opportunity. GIS Network Analyst, which allows users to map access to locations using existing transportation networks, was utilized to show average time taken to travel from low to high opportunity Census Tracts.

The use of this method in the future could potentially aid planners in improving transportation access in certain communities, and perhaps in spreading opportunity more equally across the board in neighborhoods such as Greater Boston. Note that this project serves as the demonstration of a method rather than as the verification of a hypothesis.

## Comprehensive Opportunity in Eastern Massachusetts
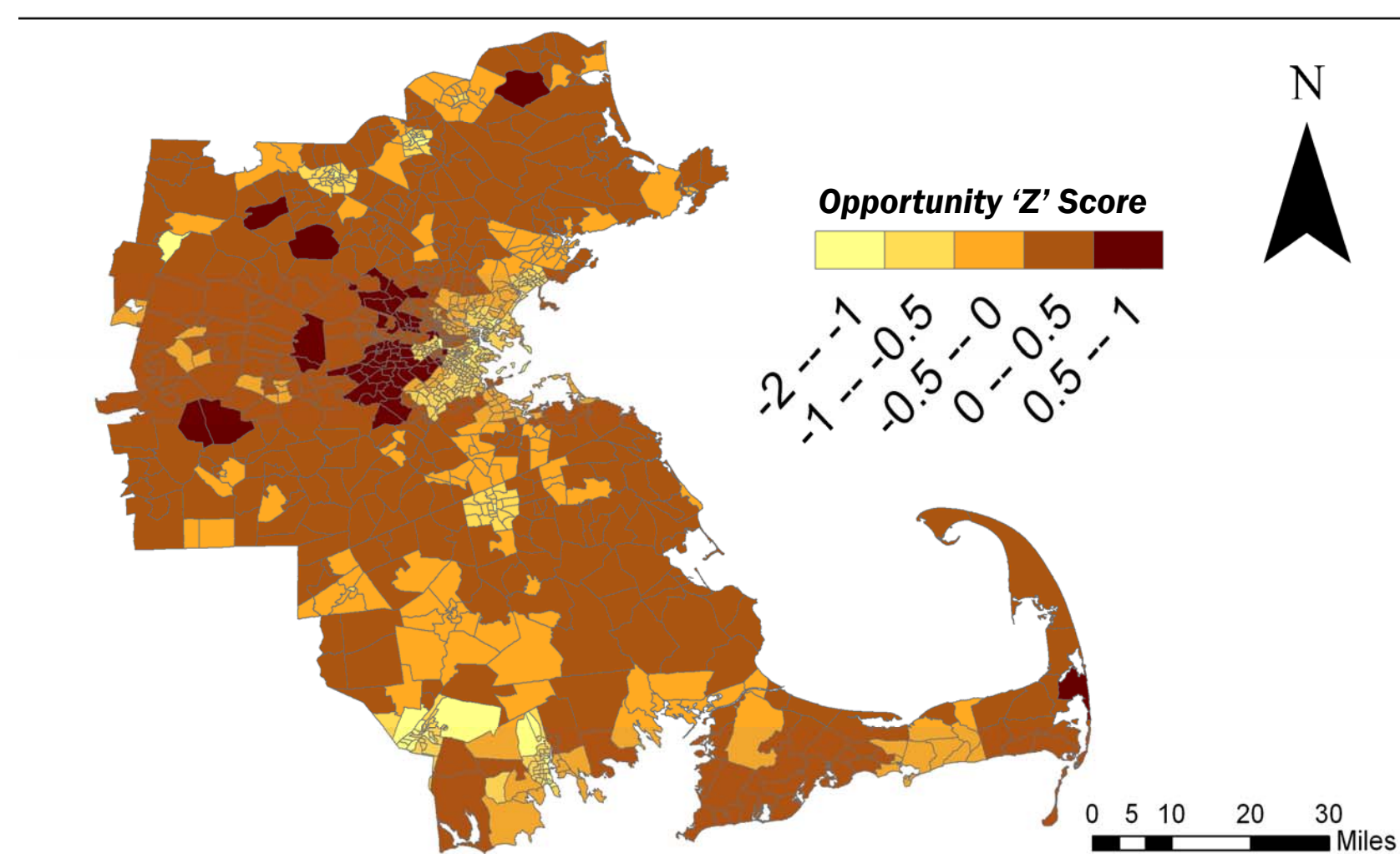
Methodology

The "Comprehensive Opportunity" data layer averages a variety of housing and neighborhood, economic, and educational factors to create a 'Z' score, rated in these maps from –2 to 1. Those Census Tracts in the Greater Boston area possessing Z scores between –2 and –0.5 were given a "low opportunity" rating and marked with a red dot at their centroid, and those Tracts having a Z score between 0 and 1 were given a "high opportunity" rating, as shown by green dots. Two transportation networks — one for roads and one for MBTA buses — were created using the Network Analyst tool. From the total mileage of each road or bus route and their respective speed limits (12 mph for all bus routes), total minutes taken on each stretch of the two networks could be calculated. Using Network Analyst's Origin-Destination Cost Matrix, the total minutes taken to travel from each point of low opportunity to each point of high opportunity was computed. Finally average total travel times from each origin of low opportunity were determined using the two networks.
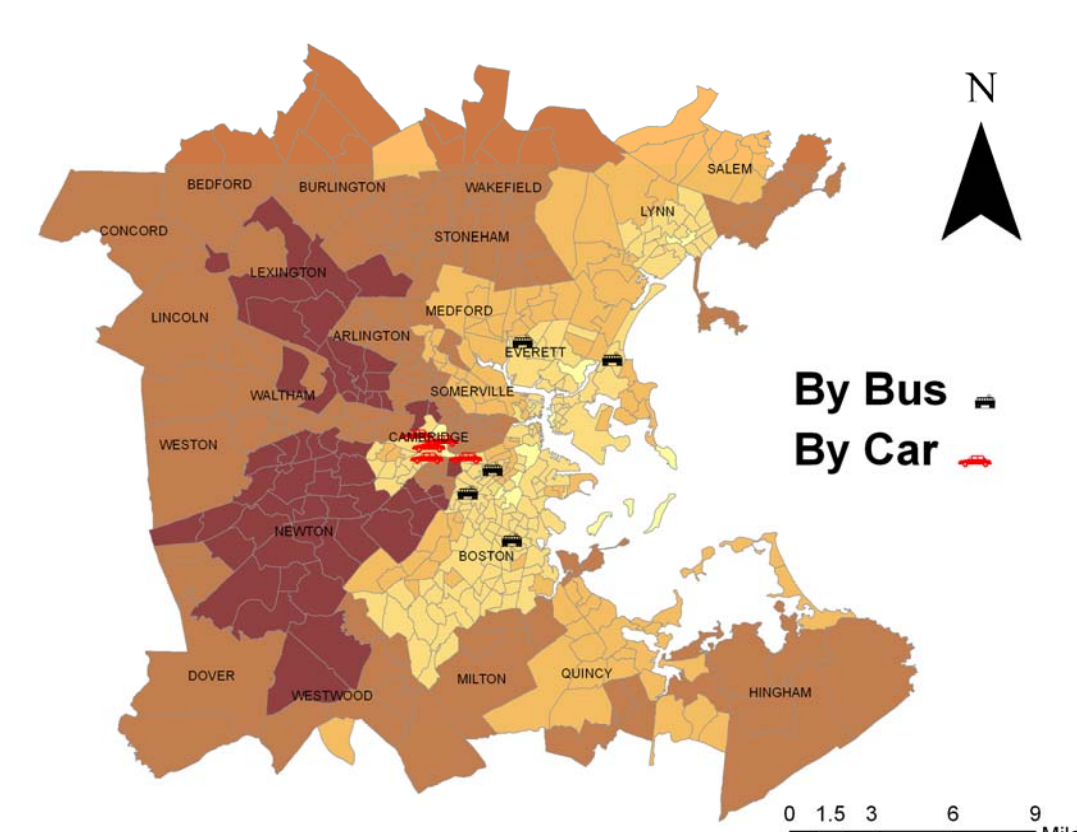
Comprehensive Opportunity in Greater Boston

Points of Low and High Opportunity
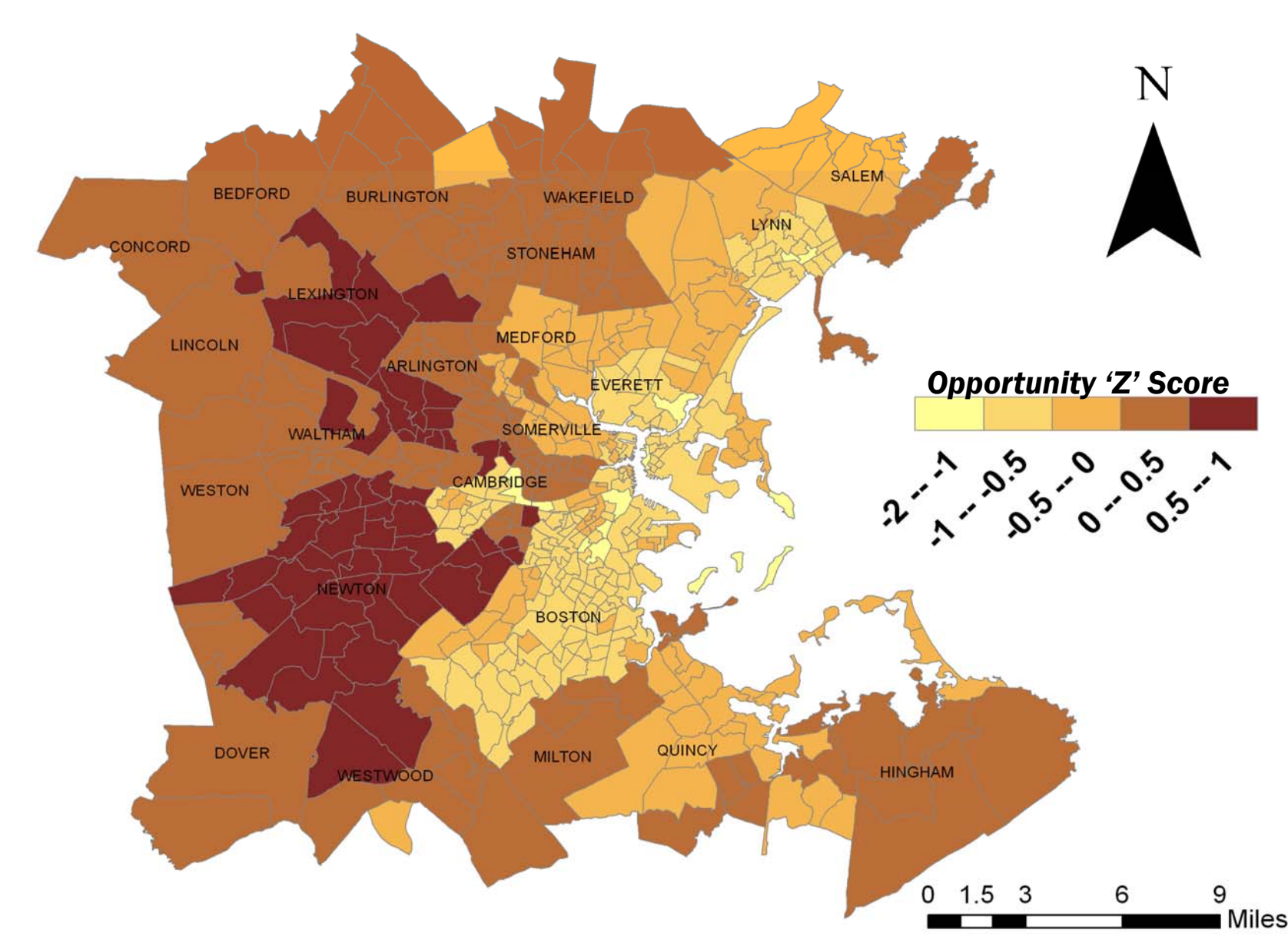
Average Time from Low Opp. To High Opp. by Car (in Minutes)

Average Time from Low Opp. to High Opp. by Bus (in Minutes)
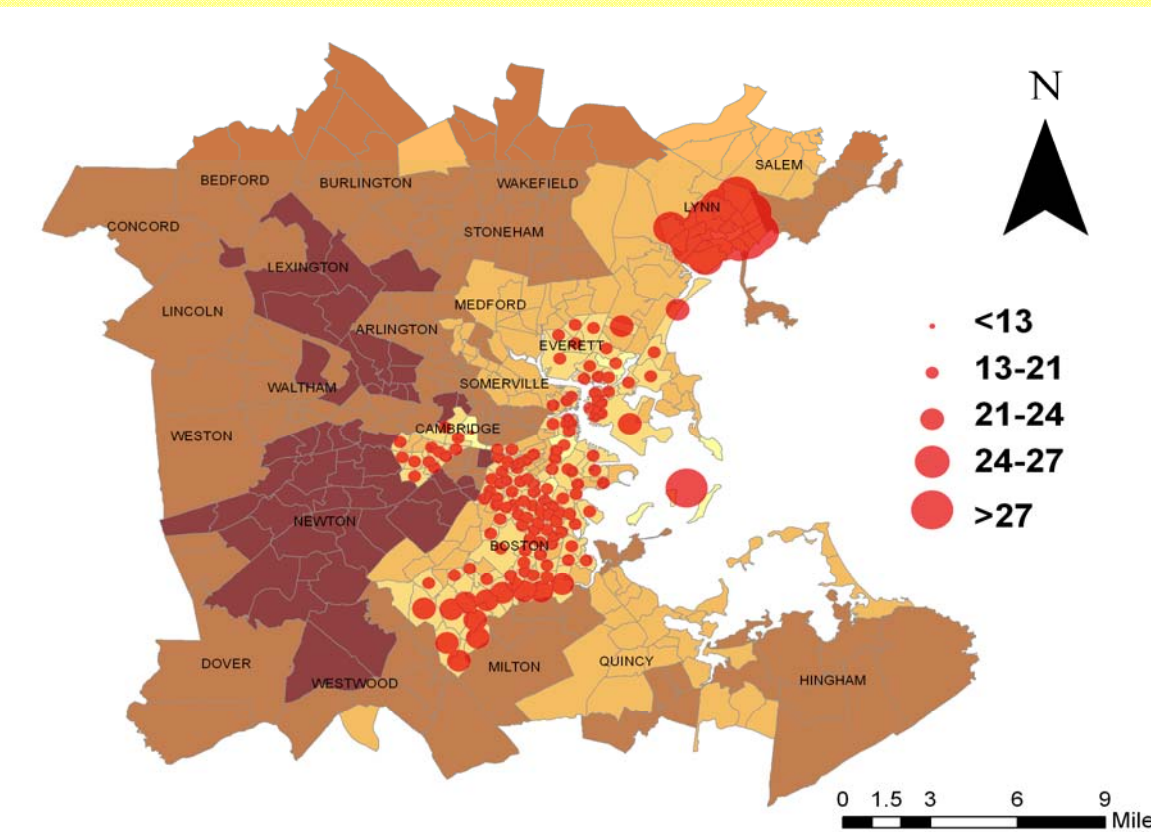
Lowest Average Times

By Bus:

Point Number	Average Time
1	75.121
2	76.191
3	76.196
4	76.877
5	78.001

By Car:

Point Number	Average Time
1	13.872
2	14.142
3	14.152
4	14.363
5	14.621
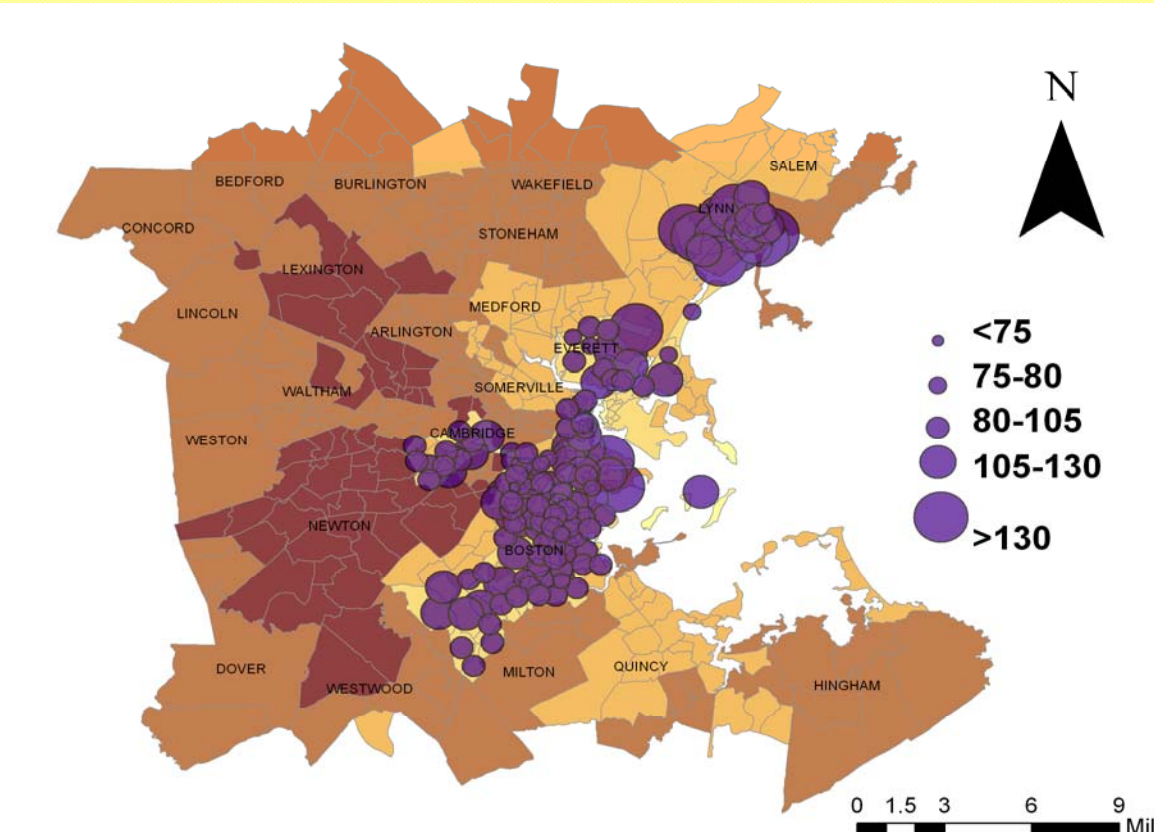
Highest Average Times
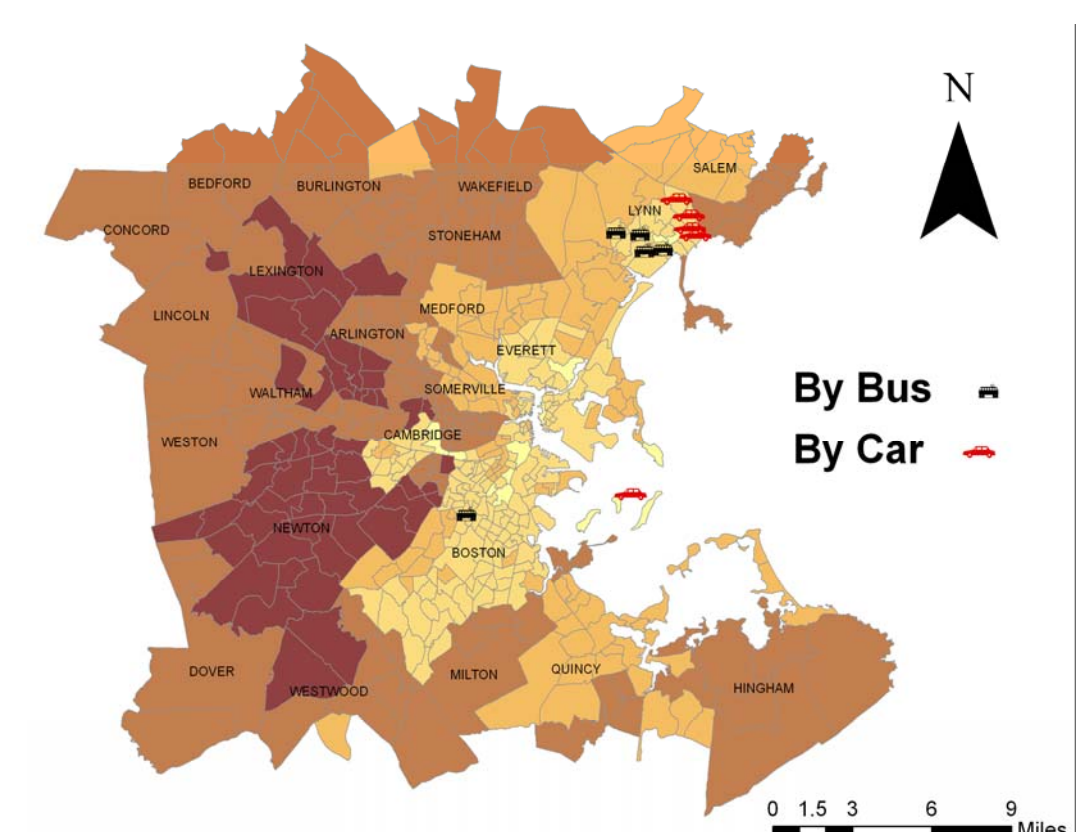
By Bus:

Point Number	Average Time
1	187.729
2	188.665
3	189.568
4	190.524
5	195.115

By Car:

Point Number	Average Time
1	27.884
2	27.902
3	28.875
4	28.622
5	30.861

Discussion

As mentioned, this project serves primarily as the demonstration of a method. As shown in the map below of median family income, this tool can be utilized to show how differing levels of transportation access relate to a household's financial situation. Not surprisingly, comprehensive opportunity and median income are quite related, a finding leading to the conclusion that perhaps opportunity itself should improve along with transportation accessibility in certain areas.
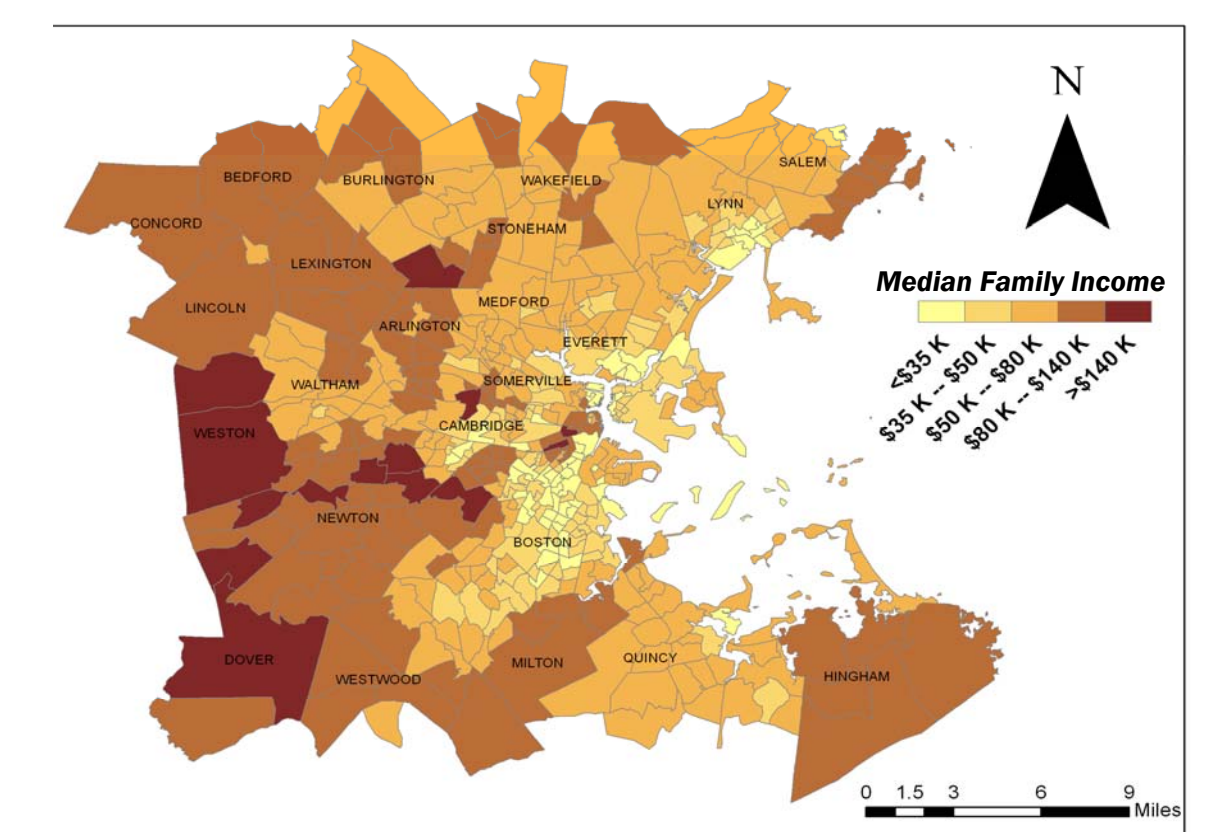
Limitations

Because one is unlikely to take a bus from Lynn to Waltham, and because the MBTA bus system does not stretch as far as does the roads system, true transportation access can only be modeled using a multimodal network including roads, public transit, and commuter trains. For more on methodology and results, see https://wikis.uit.tufts.edu/confluence/x/DOoTAg.

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Introduction to GIS
Data Sources: *Kirwan Institute, MassGIS, U.S. Census Bureau*