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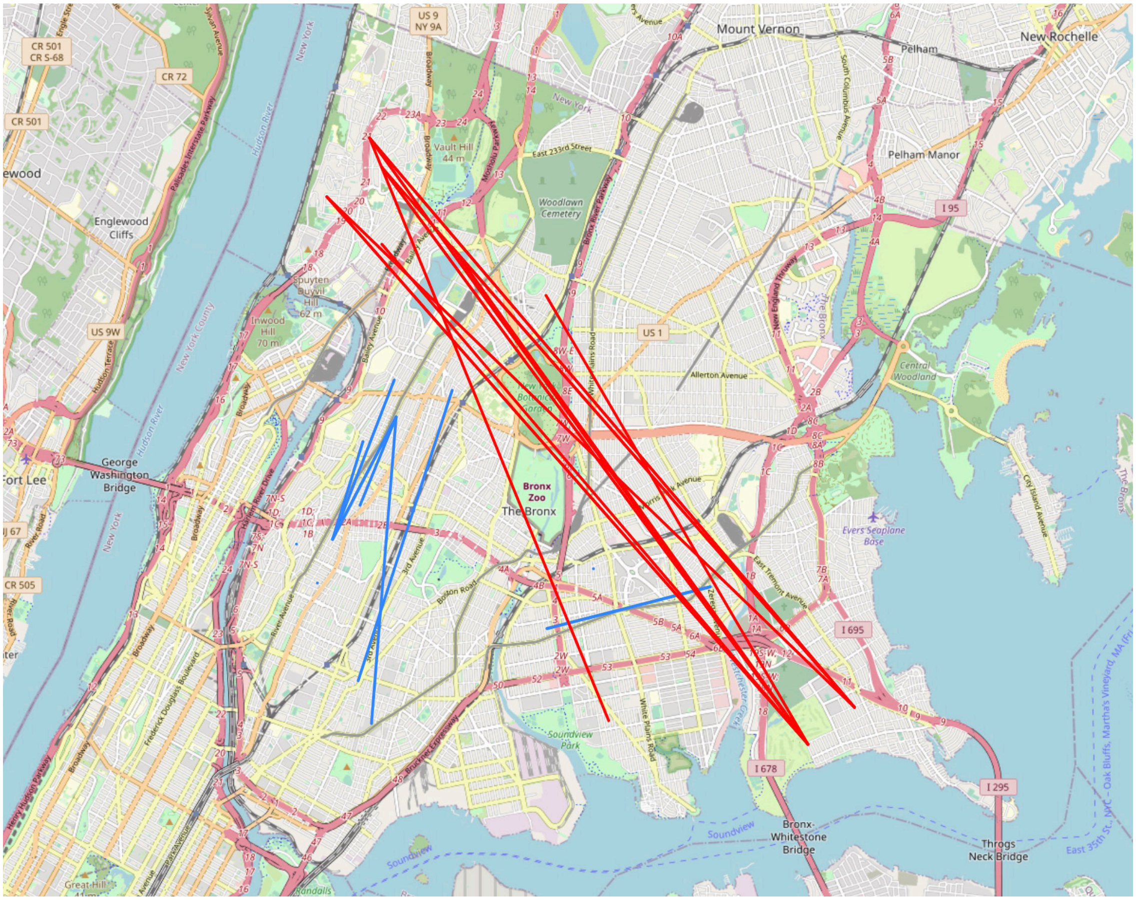
The Long Way Round

by Gabriel Barrett



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ABSTRACT

This project takes a look at the state of public transit in the Bronx borough of New York. The Bronx, by virtue of being served by the New York City subway, has exceptionally good public transit access for as far as American standards go. However, there is still much improvement that can be done. For one, large portions of the borough lie outside of the immediate reach of a transit station. In these "transit deserts" as they are known, residents often have to take the much slower city bus or, if they can afford a car, drive. An additional but less obvious issue with the subway in the Bronx stems from the way the transit network is laid out. The subway system does a remarkable job at taking people from the Bronx to Manhattan and back. However, those wanting to travel within the Bronx will find that they have a lot fewer options to get around if they want to stick to the train.

Using the Google Maps API which relies on GTFS data for transit routing and traffic data for car routing, this project found that there is a statistically significant difference between transit times and drive times when traveling north-south (towards/from Manhattan) than when traveling east-west (perpendicular to Manhattan). Hopefully this can help make the case for better intraborough transportation options within the Bronx.

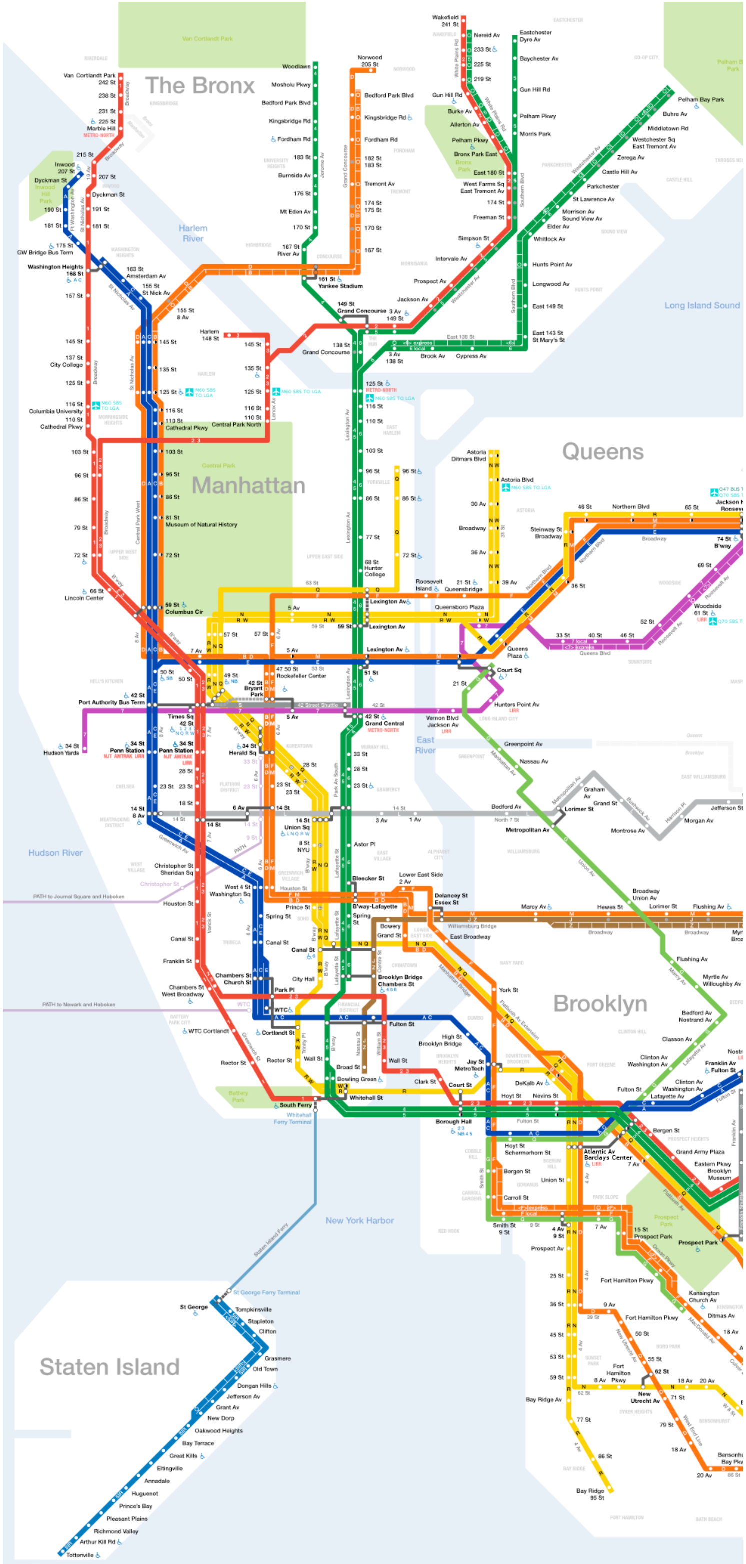
INTRODUCTION

Public transit is an integral part of the urban landscape. No where is that more true than in New York City. Famous for its subway system, in pre-pandemic times, the New York City Subway served over 1.5 billion riders annually. Between the subway and the public bus, also managed by the Metropolitan Transit Authority (MTA), half of all New Yorkers rely on public transit to get around to work. Despite its extensive reach however, the subway does not reach all New Yorkers equally. This project aims to take a look at these forgotten people.

The Bronx is one of the Outer Boroughs of New York lying directly north of Manhattan. Overall, the Bronx has fairly decent transit coverage with a vast majority of the borough falling within a 15 minute walk of a subway station. Areas that fall outside of these walksheds are colloquially known as transit deserts. For people in other parts of the United States being anywhere near a consistent serviced transit station, let alone 15 minutes, may seem like a luxury, but in New York the subway is the way to get around and lack of easy access to transit makes everything much more difficult.

However, just looking at who lives near a subway station is missing the larger picture. Transit networks are only useful insofar as they can take you where you need to go. It only takes a cursory glance at an MTA subway map to deduce one of the principle functions of the network: to take people from the outer boroughs to the commercial and business centers in midtown and lower Manhattan. However, only 38% of Bronx residents work in Manhattan. For the 43% of Bronxites who work within their home borough, or even the remaining 19 percent who work elsewhere in the region, the subway alone likely does not provide adequate means of getting around.

There have been some studies looking into the feasibility of a circumferential line that would better connect New York's outer boroughs. The Regional Plan Association non-profit created the Triboro report in 2016 advocating for a new MTA along existing rail right-of-ways to service previously underserved areas of Brooklyn, Queens, and the Bronx. The MTA is actually currently going ahead with part of this plan on their Interborough express that will connect outer portions of Brooklyn and Queens but noticeably leaves out the Bronx. This project aims to show the need for better transit options within the Bronx.



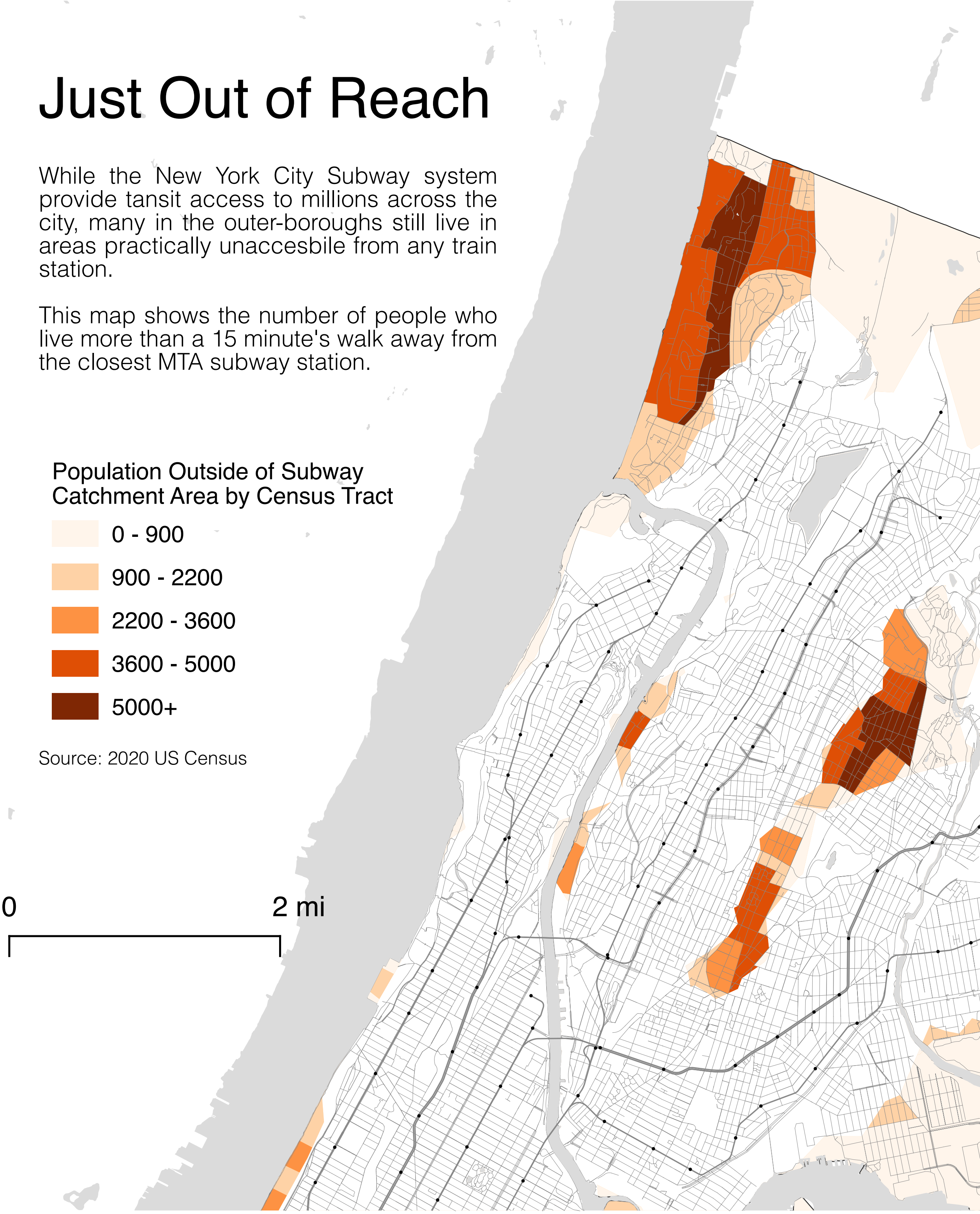
Right: Map of the New York City subway system showing how lines going into the Bronx for the most part all go straight down into Manhattan

Next Page: An example of a pedestrian's path vs the shortest route, and Google Street View images illustrating the difference

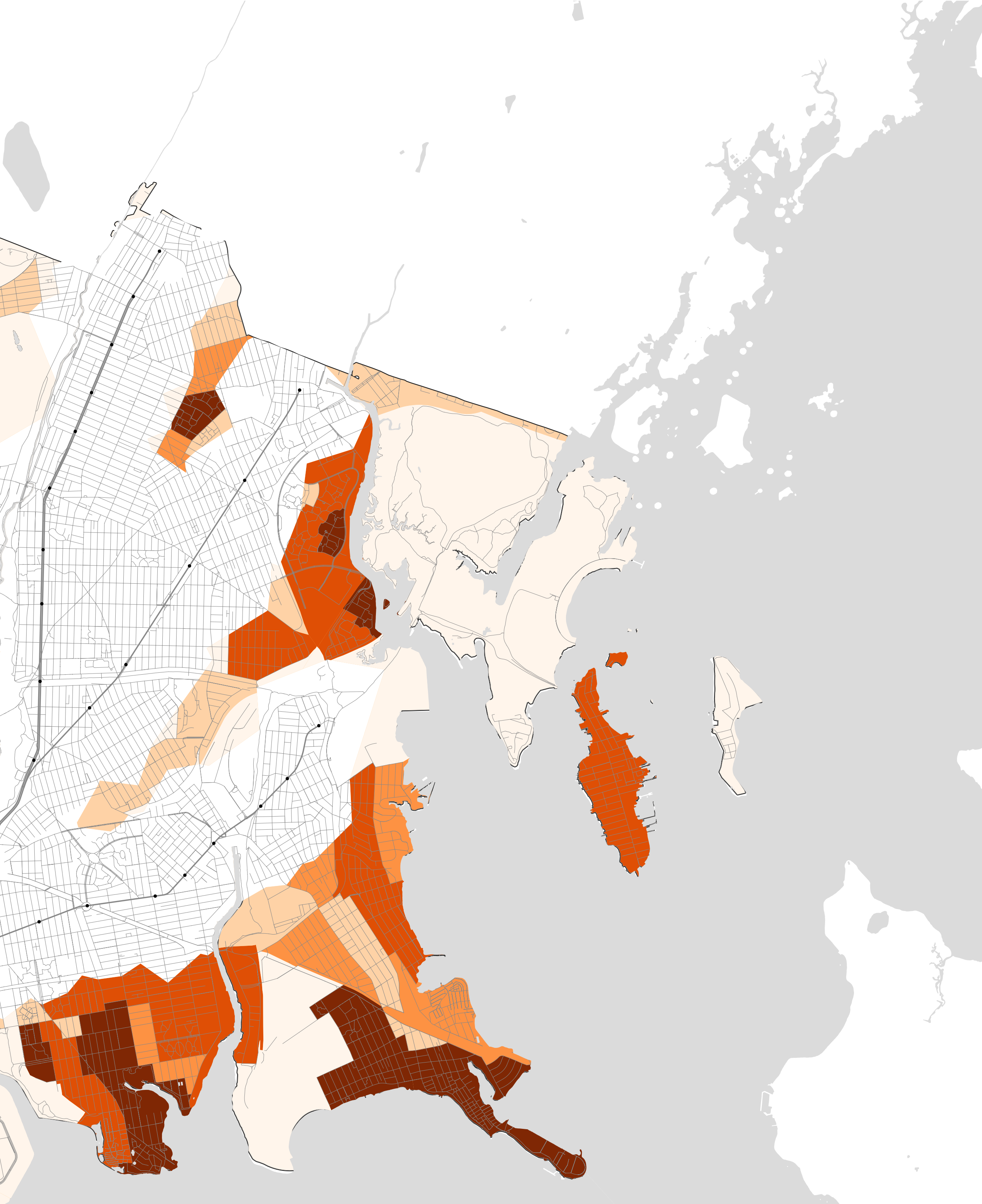
Just Out of Reach

While the New York City Subway system provide tansit access to millions across the city, many in the outer-boroughs still live in areas practically unaccesbile from any train station.

This map shows the number of people who live more than a 15 minute's walk away from the closest MTA subway station.



Source: 2020 US Census

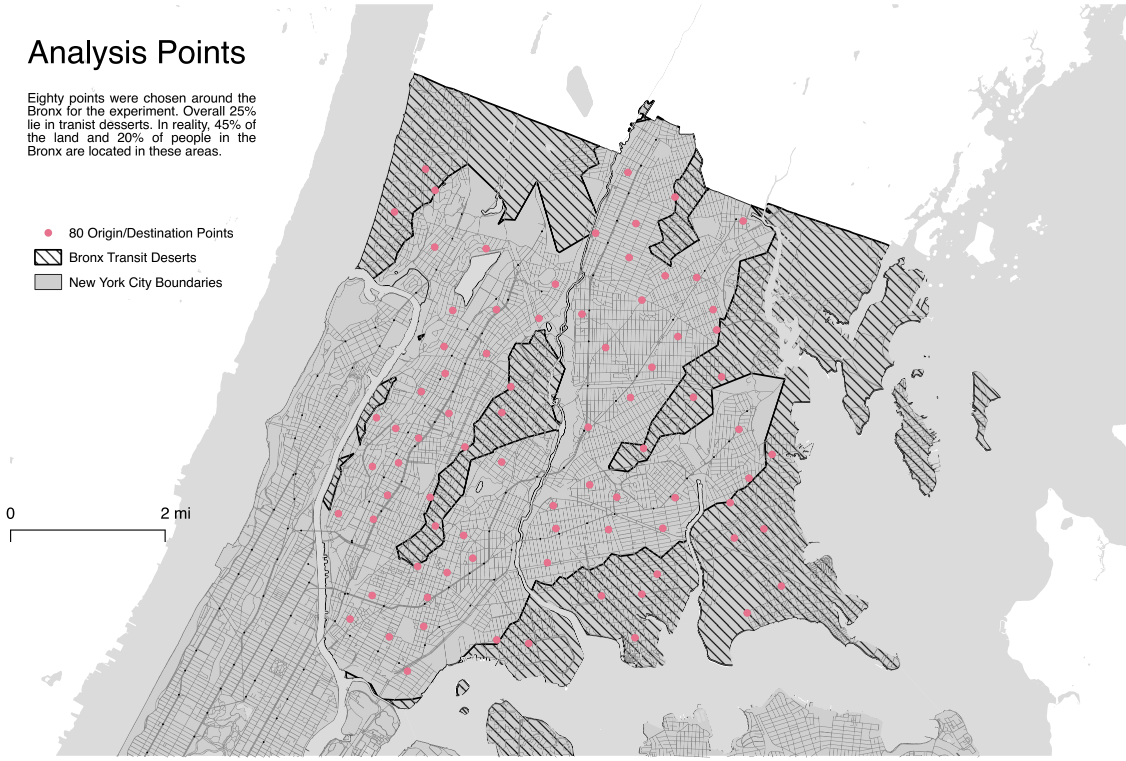


DATA AND METHODOLOGY

The project primarily employed the use of the Google Maps API to get drive and transit times. The first step of the project was to gather points around the Bronx to serve as origin/destinations. Eighty of these points were chosen and were spread throughout the borough manually to get good coverage of the area and make sure that they were not all just spread along a single axis or corridor. For this experiment, it just so happened that 20/80 of the points landed in "transit deserts". Overall in the Bronx, around 20% of people live in transit deserts while 45% of the land area of the Bronx are in transit deserts.

With these points, an 80x80 origin-destination matrix was created. Using the Google Maps API, the time it takes to get from each point to every one of the other points by car and by transit was determined (this includes the time it took when routing to itself but this is just a 0 value for both transit and car). Google allows API calls to be specified for a certain time. By using a date in the future, in the case of the experiment May 21st, 2022 at 11am, the API will take traffic estimates into account. The day that was picked for the experiment was a late weekend morning so traffic was perhaps predicted to not be as heavy as it might have been during rush hour.

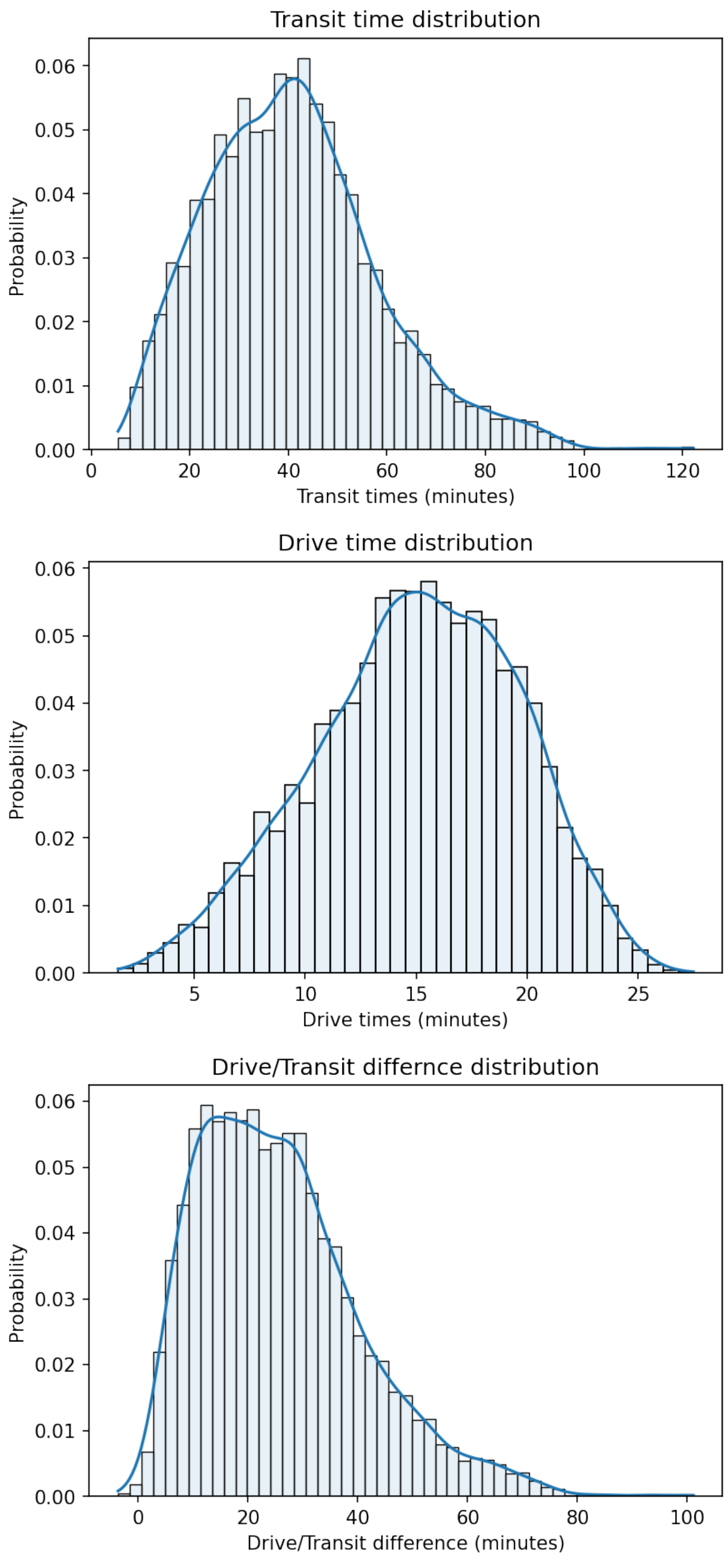
With the distance matrices acquired for both drive and transit, analysis can be performed. The principal question that the research aims to answer is if traveling east-west by transit is significantly harder than traveling north-south. For the purposes of this research, north-south (NS) is taken to mean along the Manhattan Grid lengthwise (about 30° east of North), and east-west (EW) is taken to mean perpendicular to that north-south axis. Unit vectors were then created out of these NS and EW axes. These



unit vectors allowed analysis of the NS and EW component of the time delay of transit with car travel time as the control.

For each origin-destination pair, a vector was created whose angle is the bearing from the origin to the destination and whose magnitude is the time difference of transit time minus drive time. The magnitudes of the projection of the OD vector onto the NS and EW unit vectors will give the components of the delay that are aligned with the Manhattan grid (and as such with the general topology of the subway system) and those perpendicular to the grid. A similar process can be done with travel time rations (transit time divided by drive time) to account for longer trips naturally having larger time disparities.

Finally analysis can be done between the collected EW and NS components for travel difference and travel ratio to test for a statistical significance difference between the two.



Opposite: Map of all the points used as origins/destinations in the study

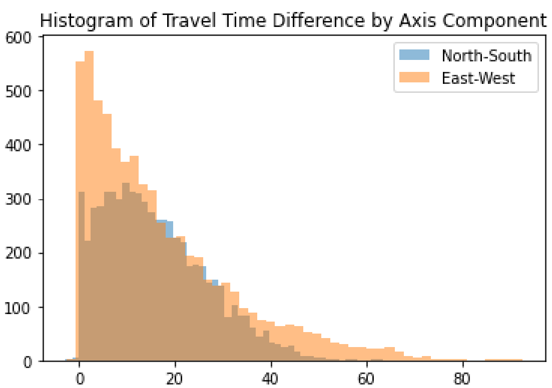
Right: Histograms of the transit, drive, and drive-transit time values from the study

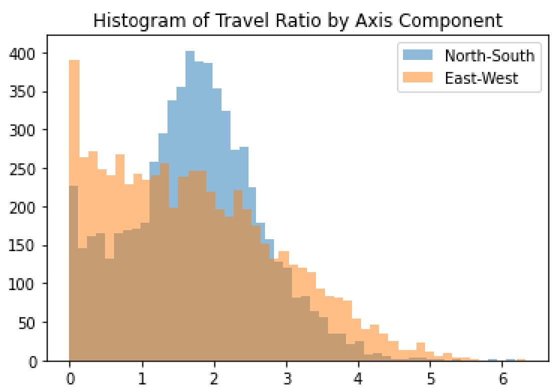
RESULTS AND DISCUSSION

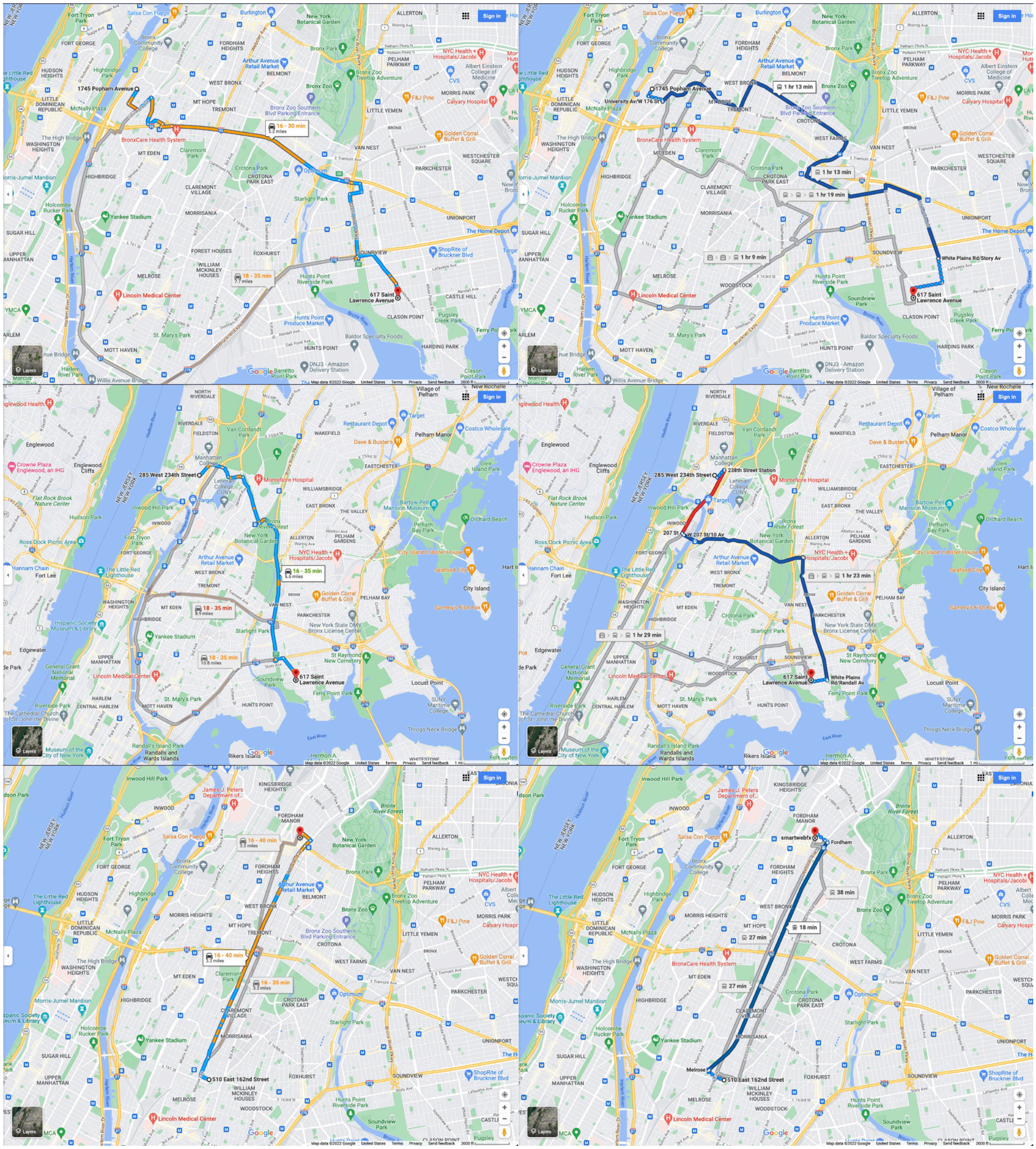
After placing all 80 points and calling the Google Maps distance matrix API, the average drive time from one point to another was 14 minutes 50 seconds and the average transit time was 40 minutes and 20 seconds. This means that the average transit trip was almost three times as long as the average car trip. A result that would be expected as many of these points were either only near transit stations that were on different lines or were not near transit stations at all. As discussed in the methods sections, the drive and transit may have been closer if travel times were calculated for a rush hour period rather than 11am on a saturday as was used.

Then performing the component analysis as was described in the methodology section, it was found that the NS component for travel difference was 15.80 and the EW component was 16.80. With a p-value of 4.4e-21, this result is significant. Again, this is what would be expected if it is true that east-west trips are longer than north-south ones. However, for travel ratios, the NS component was 1.73 and the EW component was 1.71. Here the null hypothesis cannot even be rejected as the values are so close. It is possible that all of the very short trips between nearby O-D pairs just add a lot of noise to the results.

To remedy the noise issue, the top 75% of O-D pairs in terms of travel time difference were selected. Among these pairs, the NS and EW components of travel difference were 18.91 and 20.97 respectively, and the NS and EW components of travel ratio were 1.87 and 1.97 respectively. In both cases, the difference between the EW component and the NW component was statistically significant. Limiting to the top 75% of trips by travel difference on this data set meant keeping any trip where transit was at least 13.9 minutes slower than driving.







Opposite: Histograms of North-South and East-West components of travel difference and ratio

This page: Example routes that were generated for three different pair of points in the analysis. The top two pairs of images show example of a trip that was much longer on transit than by car. The bottom pair shows one of the few trips where transit beat driving

CONCLUSION

The result, especially once filtering out the shorter trip, seemed to confirm the original hypothesis that traveling along east to west (or west to east) is more difficult than traveling north to south (or vice versa). A deeper analysis into the Google transit routing showed that often when two points were out opposite ends of the Bronx east-west, routing was done by bus rather than train. Most buses of course get stuck in traffic that cars do in addition to having to stop at intermediary stops so having to take a bus to get from point A to B can impose major delays. While in any other American city, having ample access to buses alone is luxury, in New York, anything short of having an easily accessible train station nearby imposes large barriers to mobility.

Identifying that a problem exists is just the first step of a problem. Seeing who and how many people are affected by the problem would be the logical next step. Originally, this project planned to try to use social media data, specifically twitter location data, as a proxy for demand data. Seeing where people commute to in the mornings and go back home to in the afternoon would be useful to see just how many human-hours are lost from east-west commuting in the Bronx. On the other hand, it is possible that not many people commute east-west precisely because it is so difficult. This is the classic chicken and egg problem of transit: it's hard to justify increased service when there's little demand but at the same time there is often little demand because of poor service. Either way, demand data would be useful to get a better sense of transit needs in the borough.

In conclusion, there is a need for better transit connectivity in the Bronx. In post-pandemic age where the idea of a central business district full of office buildings that only sees people on weekdays from 9-5 is seeming more and more like a thing of the past, it is important that transit systems shift away from the commuting vehicles that planners in the mid-late 20th century saw them as. The Interborough express that is currently in the works is a good first step in making a more pluricentric transit system and hopefully a sign the MTA wants to help make it so locals and visitors can travel anywhere and the city and not just Manhattan.