

# Reducing Bus Route Redundancy

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# Main Goal of Project

We wanted to reduce redundancy between the existing bus routes and BRT routes.

To do this we identified 8 routes, and a number of stops that may be candidates for elimination.

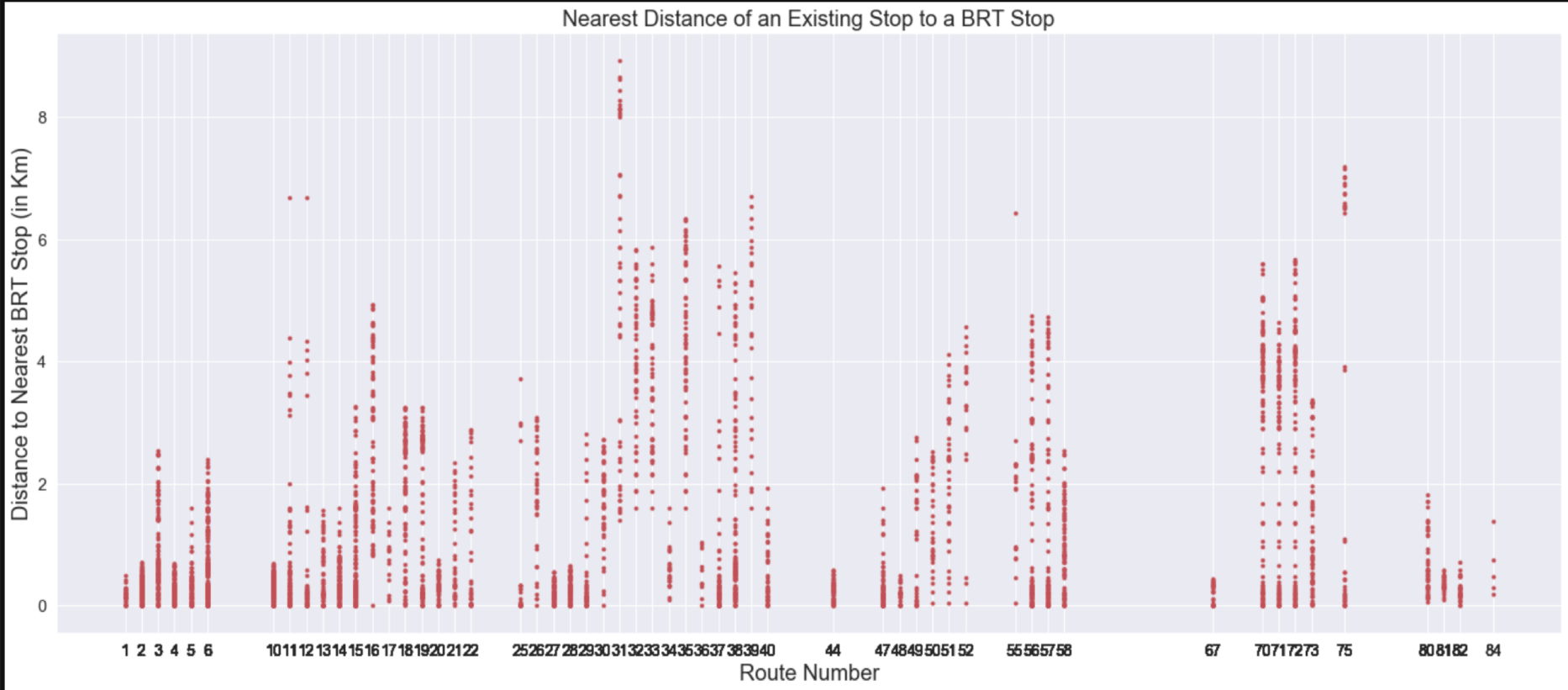
The funds spent on these routes may be better used for other resources.

We define redundant to be distance from existing stop to BRT stop  $\leq 0.5$  Km.

# How we identified our redundancy (Methodology)

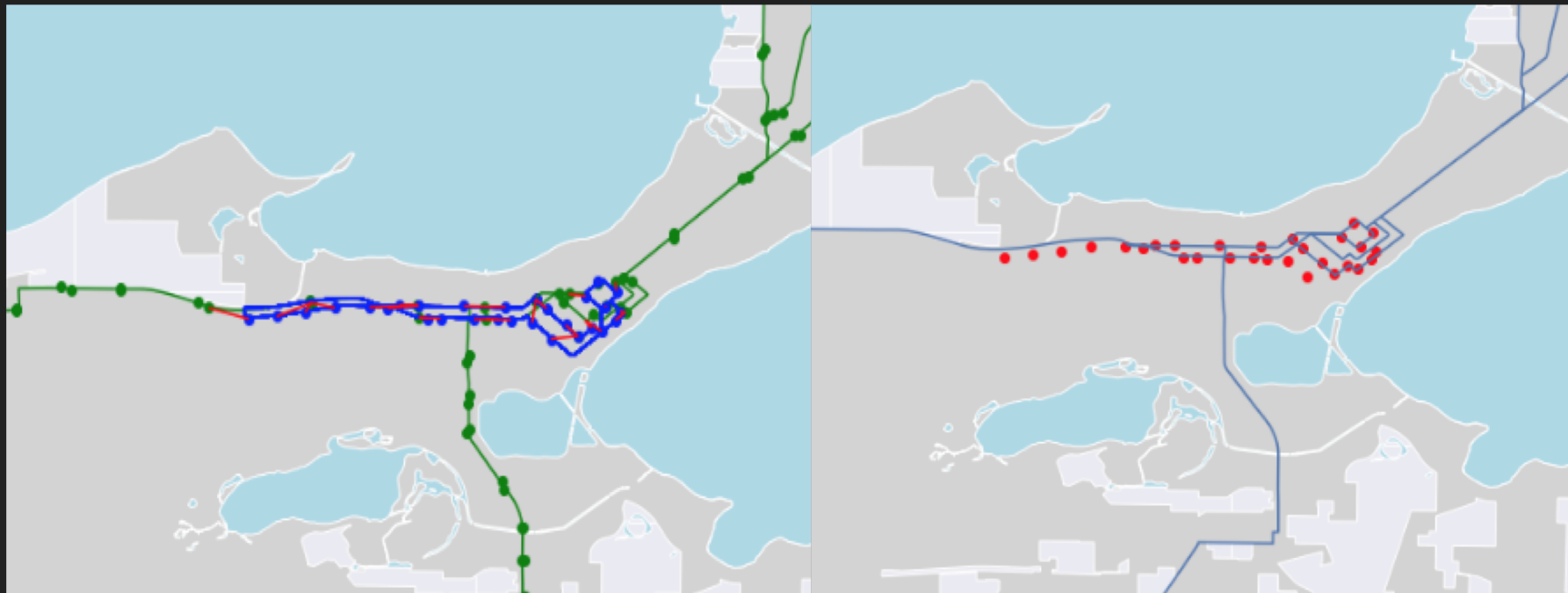
- Mapped individual existing bus stop distance to closest BRT location
  - Point comparison using Point object distance method
- If an existing stop was within a 5-7 minute walk from the nearest BRT stop, it was identified as redundant
  - 5-7 minute walk estimated as 0.5 Km, or about 500 meters away
  - We calculated the distances of all bus stops to the nearest brt stop and then group each stop by route.

# How we Identified the Redundant Routes



In the previous slide, we can see we have routes 1, 4, 5, 27, 28, 44, 48, and 67 which have a disproportionate number of stops close to a BRT stop.

# Route 1



# Route 1

100% of stops along this line were redundant with BRT stops.

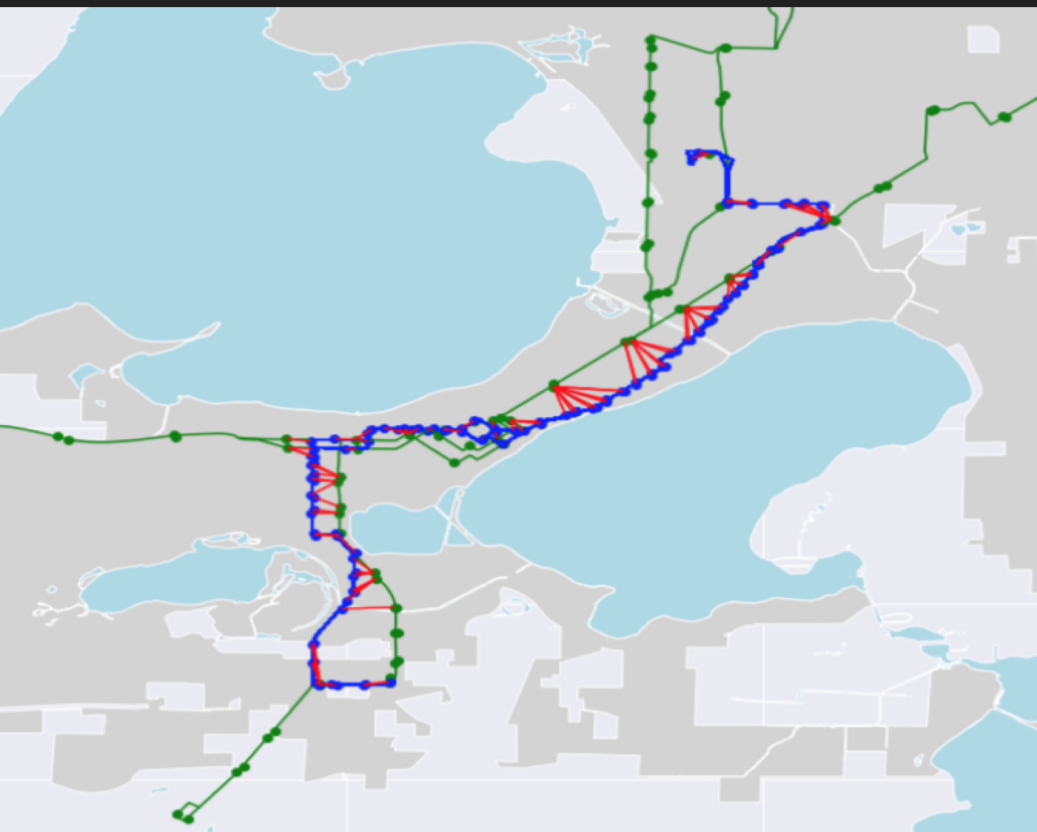
Meaning that 100% of stops are either along the BRT line or are less than .5 Km from a BRT stop.

The following table contains the summary statistics of distances from existing stops to BRT stops along the 1 route.

The values in the table are in Km.

<b>count</b>	<b>29.000000</b>
<b>mean</b>	<b>0.179172</b>
<b>std</b>	<b>0.125514</b>
<b>min</b>	<b>0.005439</b>
<b>25%</b>	<b>0.108280</b>
<b>50%</b>	<b>0.173806</b>
<b>75%</b>	<b>0.251085</b>
<b>max</b>	<b>0.492230</b>
<b>Name:</b>	<b>distance_to_brt</b>

# Route 4



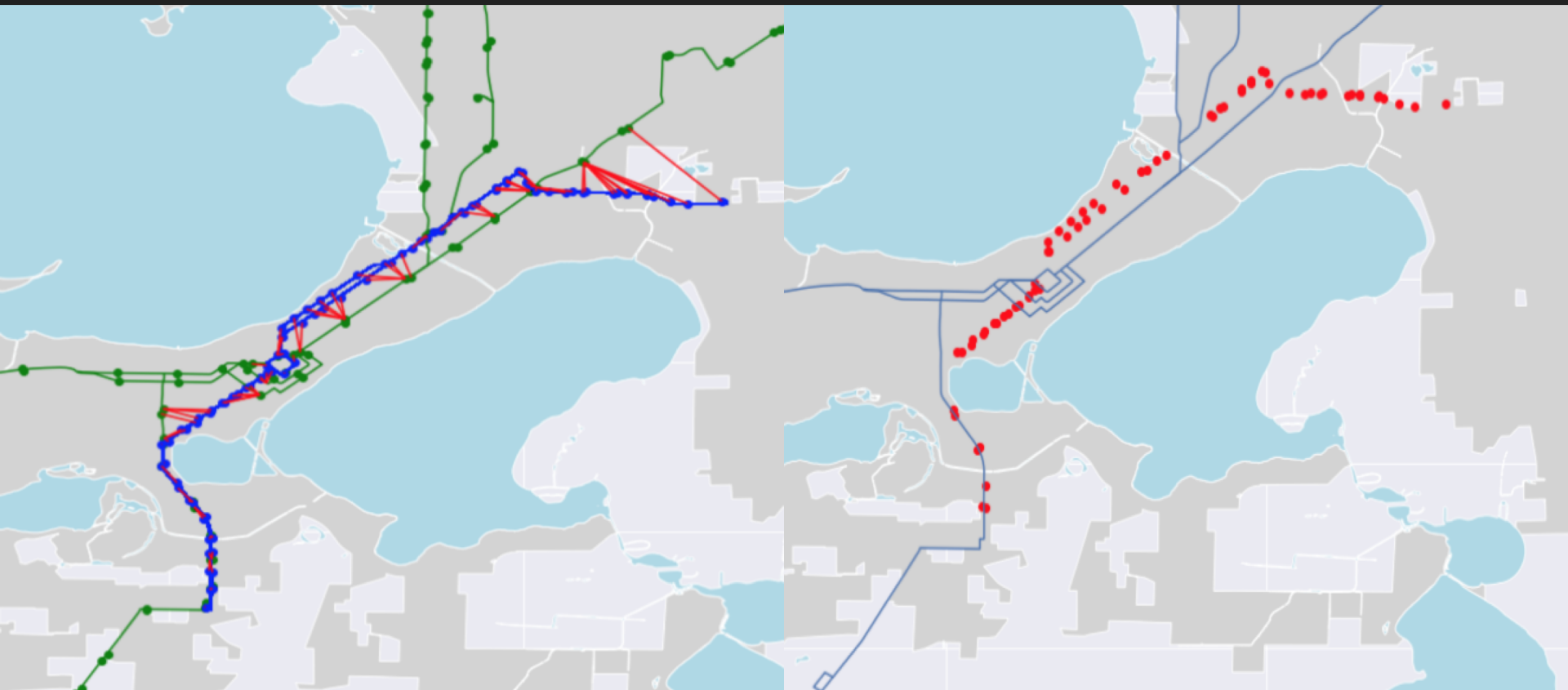


# Route 4

82% of the stops along route 4 are redundant.

```
count      111.000000
mean       0.274405
std        0.179404
min        0.005685
25%        0.130146
50%        0.246896
75%        0.373465
max        0.693609
Name: distance_to_brt
```

# Route 5

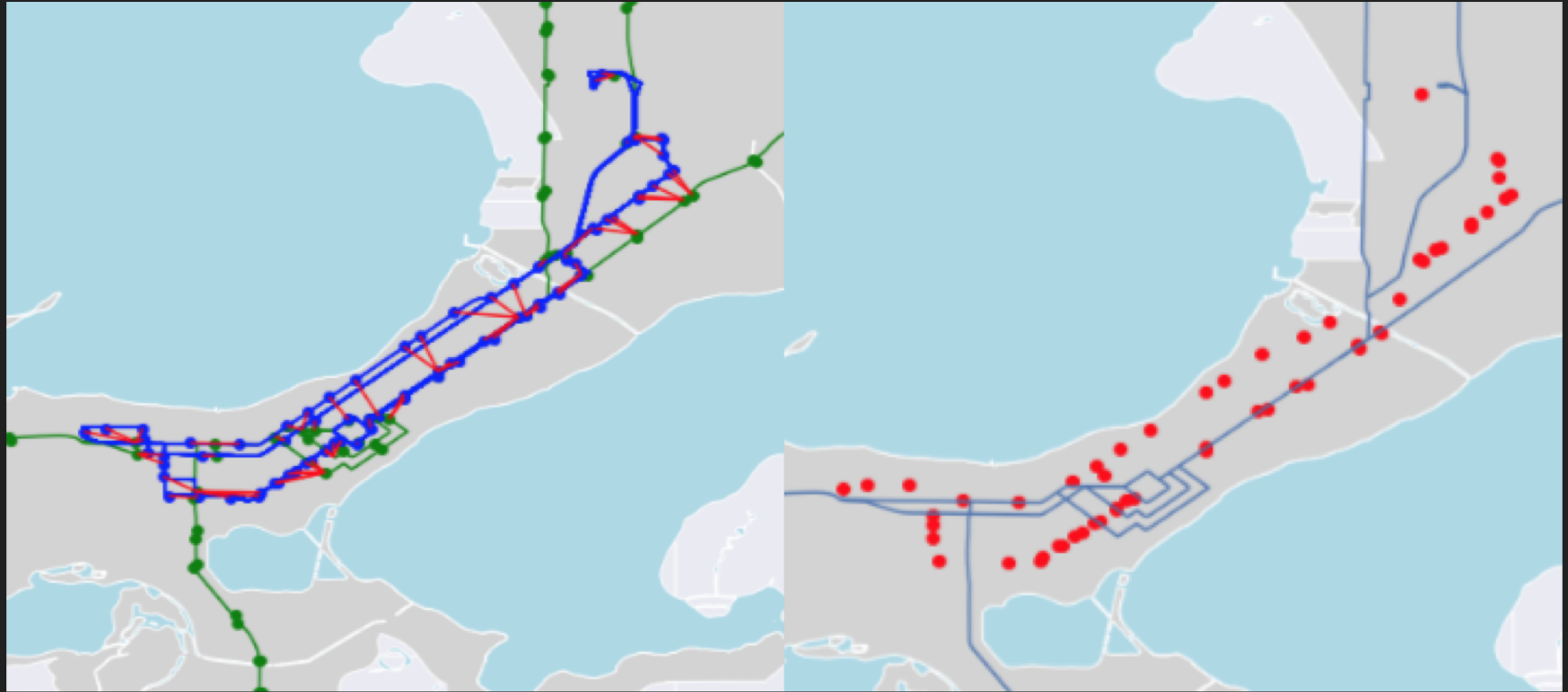


# Route 5

84% of stops are redundant.

```
count      89.000000
mean       0.329965
std        0.293554
min        0.002962
25%        0.125596
50%        0.303264
75%        0.429597
max        1.607489
Name: distance_to_brt
```

# Route 27

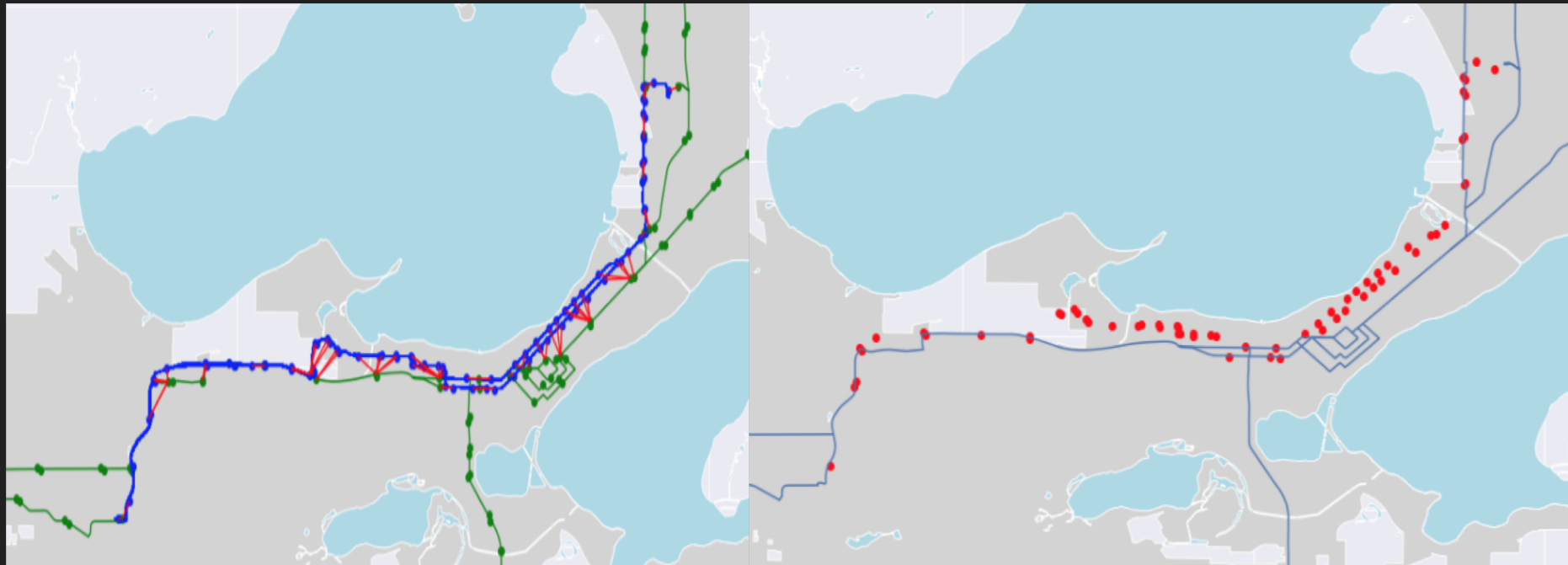


# Route 27

96% of stops are redundant.

```
count      77.000000
mean       0.229680
std        0.151089
min        0.001928
25%        0.109778
50%        0.216637
75%        0.337102
max        0.556839
Name: distance_to_brt
```

# Route 28



# Route 28

87% of routes are redundant.

```
count      86.000000
mean       0.278038
std        0.183415
min        0.000704
25%        0.131553
50%        0.269617
75%        0.422397
max        0.667881
Name: distance_to_brt
```

# Route 44



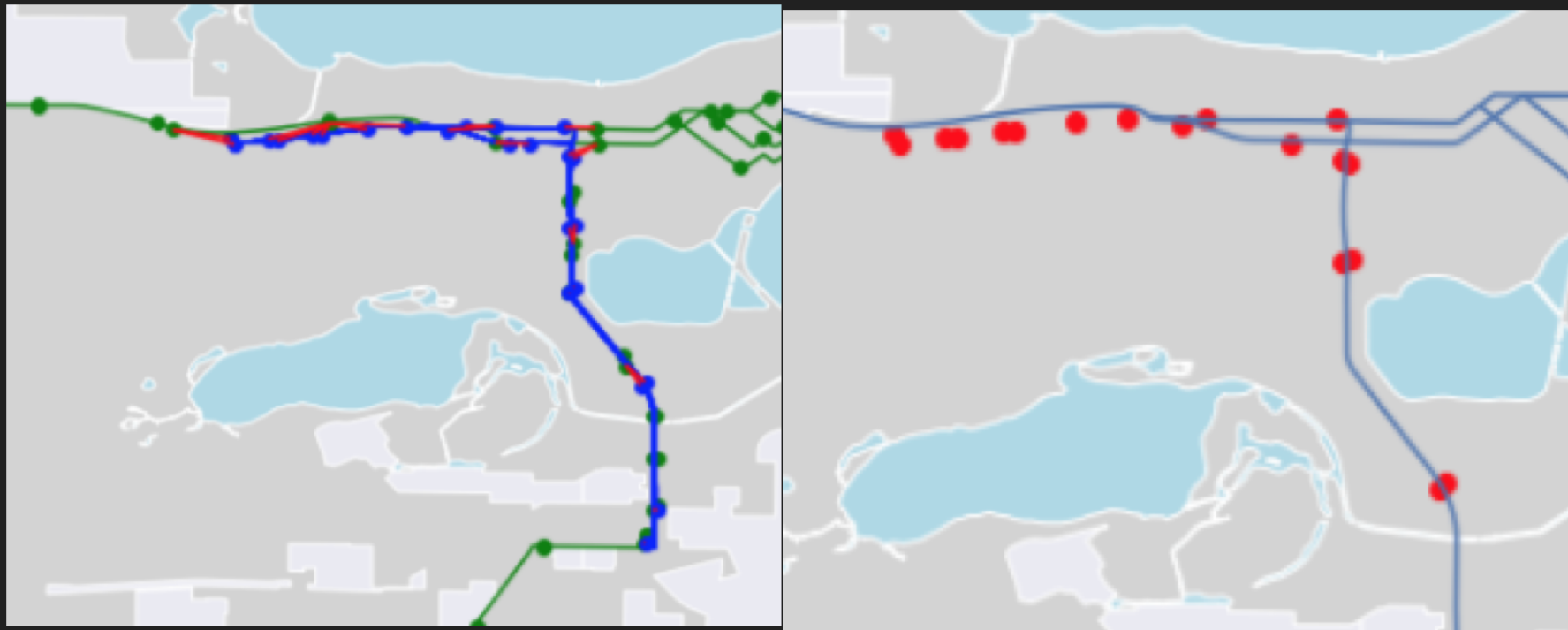


# Route 44

89% of routes are redundant.

```
count      59.000000
mean       0.263933
std        0.157645
min        0.005707
25%       0.121640
50%       0.264354
75%       0.368011
max        0.593601
Name: distance_to_brt
```

# Route 48

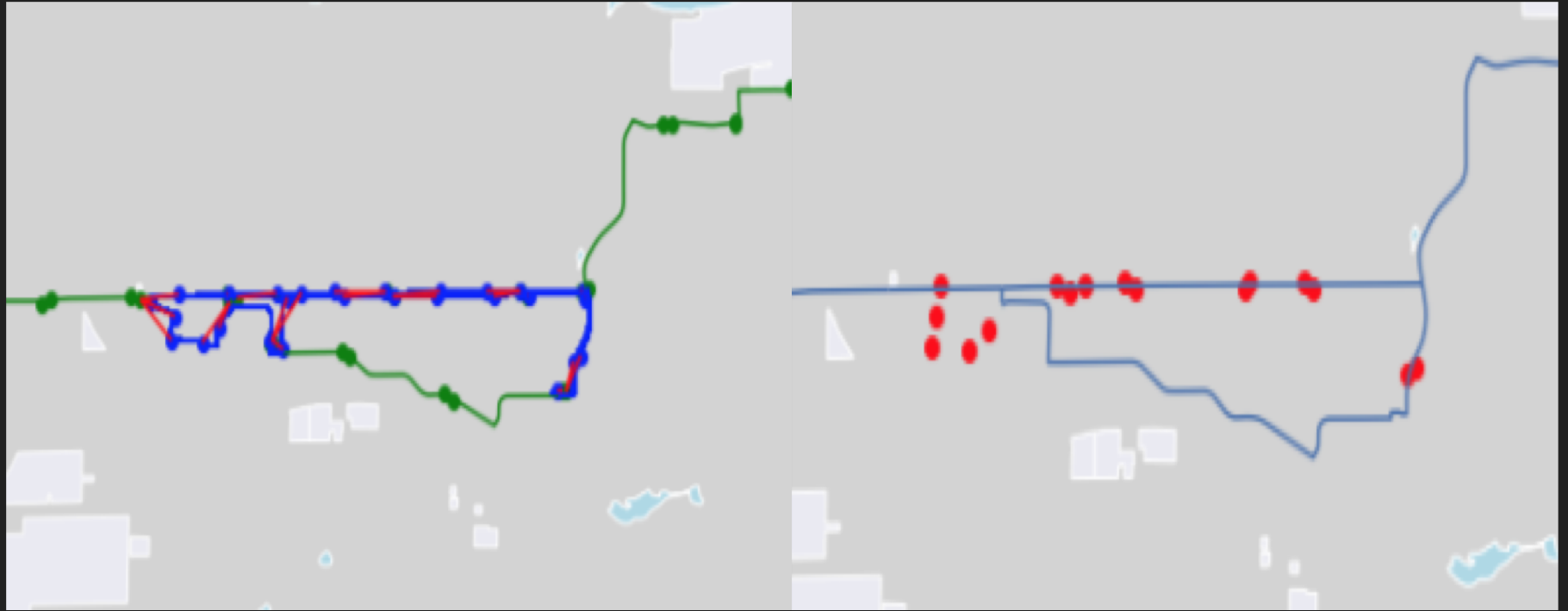


# Route 48

95% of routes are redundant.

```
count      24.000000
mean       0.204634
std        0.144732
min        0.005439
25%       0.116809
50%       0.201166
75%       0.264903
max        0.502822
Name: distance_to_brt
```

# Route 67



# Route 67

100% of stops on this route are redundant.

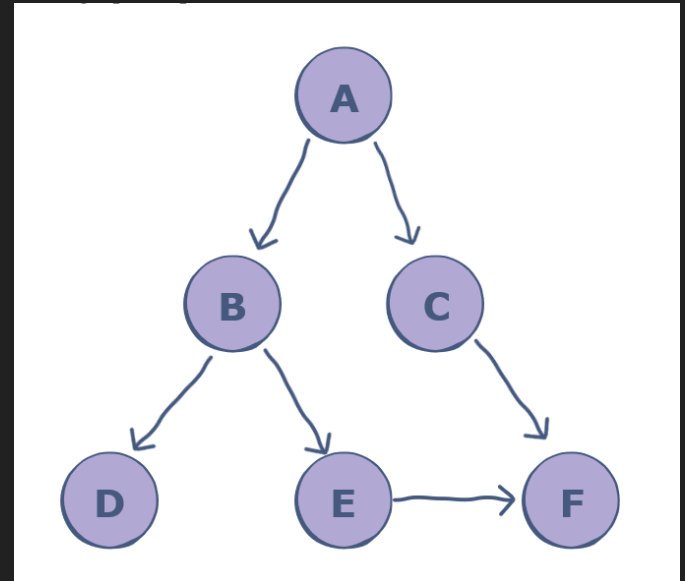
```
count      27.000000
mean       0.209379
std        0.164134
min        0.003276
25%       0.012247
50%       0.248623
75%       0.351522
max        0.449064
Name: distance_to_brt,
```

# Total Effect of Redundant Bus Stops

- Redundant bus stops had on average 16.8% more boardings per stop compared to stops not covered by BRT
- Total ridership on existing redundancies: 13,343 daily boardings
- Estimated annual total cost of maintaining redundancies: \$1,597,500
  - 639 bus stops costing an estimated annual \$2,500 each to maintain (Salt Lake City, City Council Archives)

# Finding Inefficiencies

- Create a Deep For Search function for bus
- Depth-first search (DFS), is an algorithm for tree traversal on graph or tree data structures. It can be implemented easily using recursion and data structures like dictionaries and arrays.




```
{'1379_25260': [{'destination': '1717_25301',  
  'travel_time': 41,  
  'trip_id': 884545,  
  'bus_name': 2,  
  'full_bus_name': '2_NORTH TFR PT'}],  
'1717_25301': [{'destination': '1923_26296',  
  'travel_time': 995,  
  'trip_id': 884531,  
  'bus_name': 2,  
  'full_bus_name': '2_NORTH TFR PT'}],  
{'destination': '1923_25352',  
  'travel_time': 51,  
  'trip_id': 884545,  
  'bus_name': 2,  
  'full_bus_name': '2_NORTH TFR PT'},
```

- Created a graph of the current nodes next possible node
- Times set between 7 – 9 am when people are going to work.
- Made to avoid 'drop off only' buses

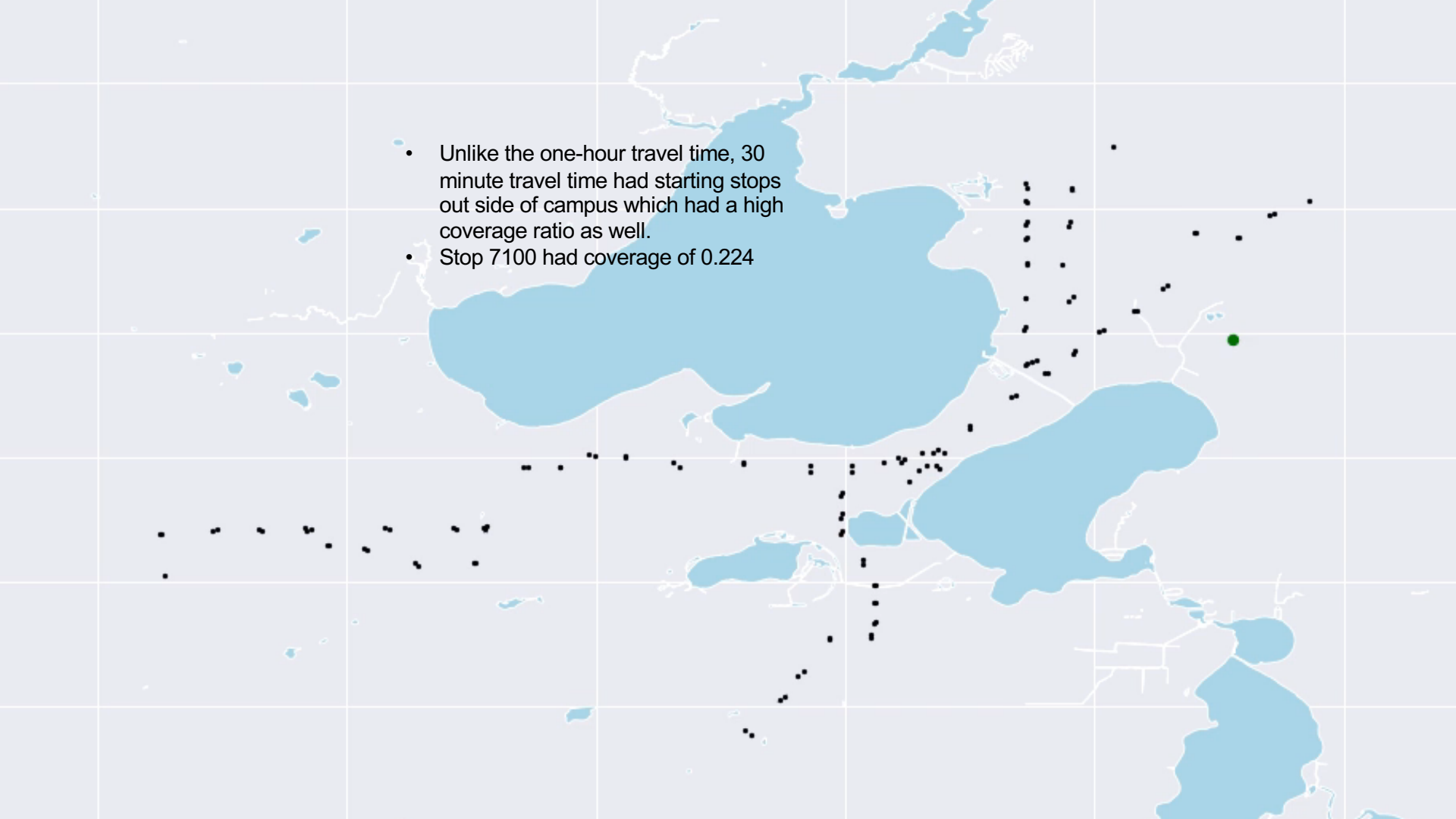


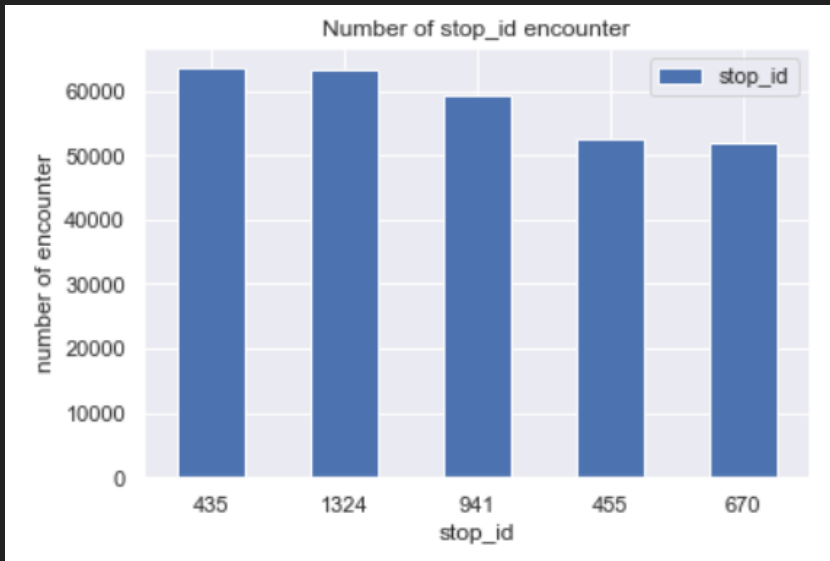
- Travel time for an hour
- Starting at stop 1787 covered the highest ratio of covered stops/all stops with 0.799
- Most of the other starting stops with higher ratio near the campus



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- A map of the Great Lakes region (Superior, Michigan, Huron, Erie, and Ontario) overlaid with a white grid. Numerous small black squares are scattered across the landmass, representing various stops. A single green dot is located on the southern shore of Lake St. Clair, representing Stop 741. The text is positioned in the upper-left quadrant of the map.
- Reduced travel time to 30 minutes
  - In the US, Average commute time for people is 26.6 min.
  - Stop 741 had the highest stop coverage ratio with 0.226

- Unlike the one-hour travel time, 30 minute travel time had starting stops out side of campus which had a high coverage ratio as well.
- Stop 7100 had coverage of 0.224





- The top encountered stop ID for the 30-minute travel

## How to go forward...

- Future work
  - Use distance covered instead of stops covered as measurement
  - Compare how the BRT would change the graph output

