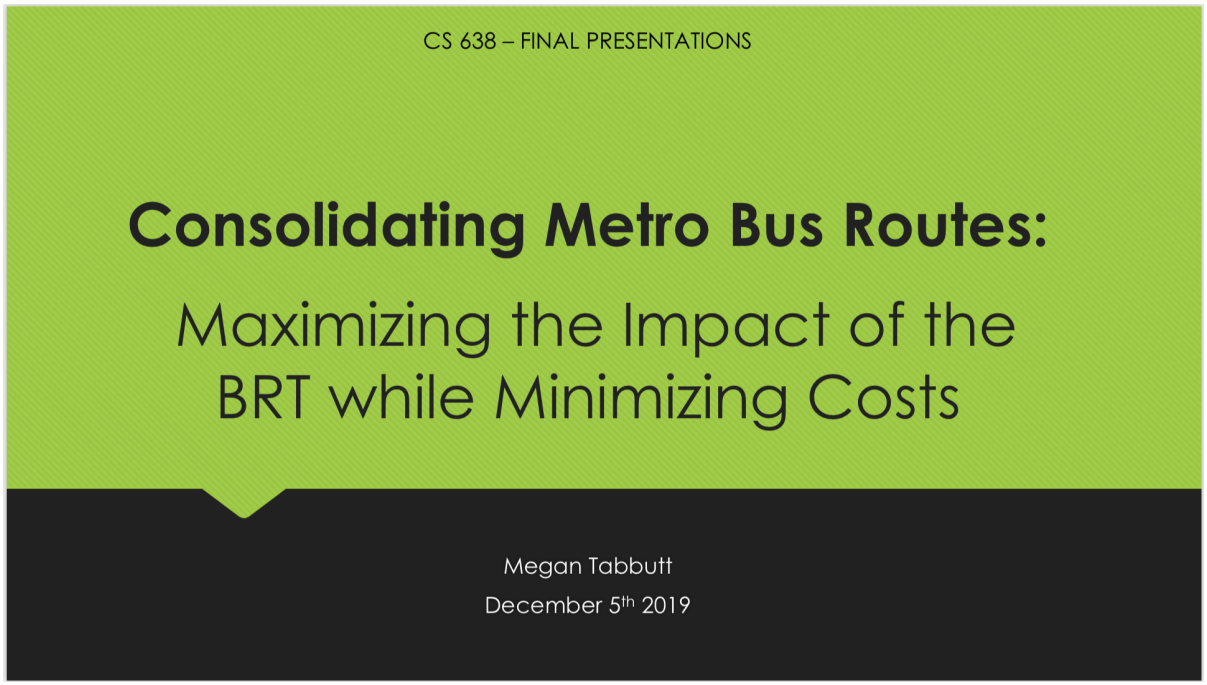
In [1]:

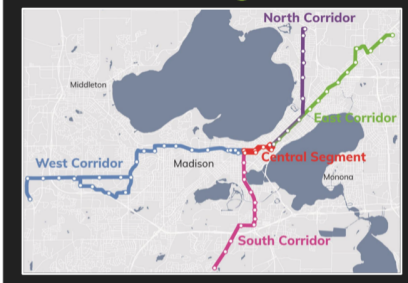
```
from IPython.core.display import display, HTML
display(HTML("<style>.container { width:100% !important; }</style>"))

imagespath = '/Users/megantabbutt/Desktop/CS 638/Final Presentation Write Up/images/'
```

## SLIDE SUPPLEMENT:

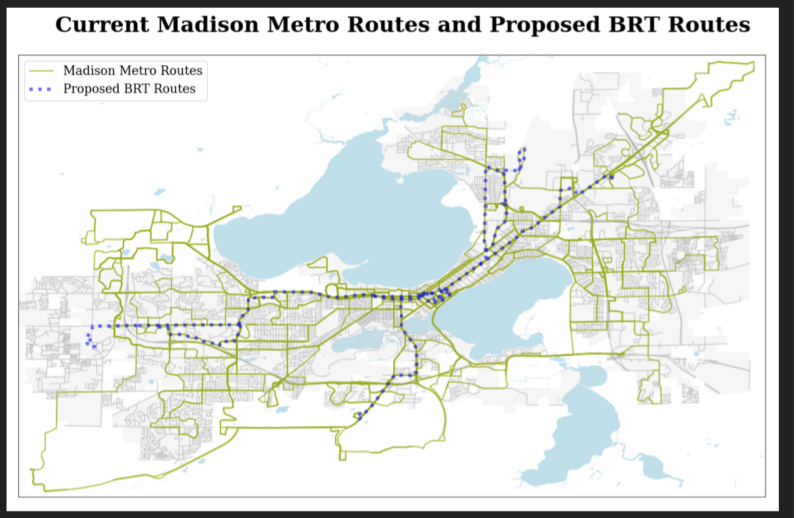



# Planned BRT Routes, Current Metro Routes and Goals:




**Goals:**

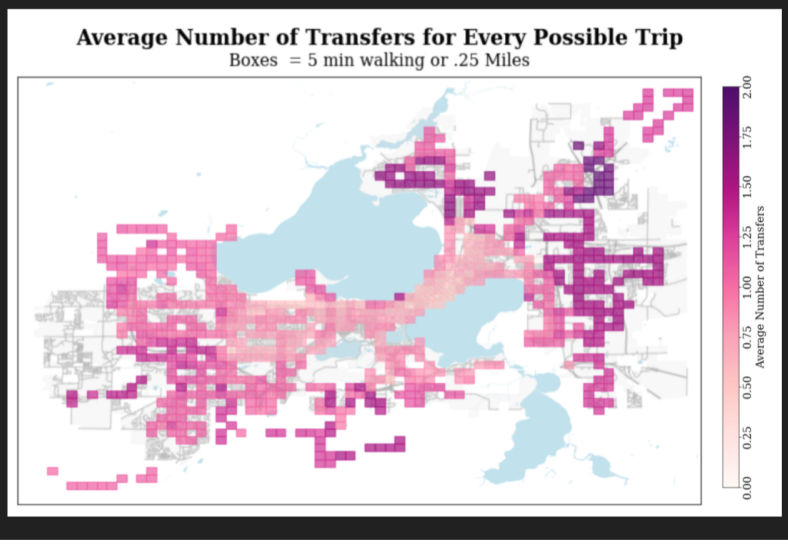
- Reduce route redundancy
- Reduce Madison Metro operating costs
- Provide the same or better service




## What is the current accessibility of Madison via bus and how will the BRT change this?

## Average Number of Transfers to Get Around via Bus:

- Investigate current accessibility with various parameters
- Need to ensure that the new routes are the same or better
- **Reduce Route redundancy be eliminating sections that overlap with BRT, create new routes that intersect the BRT**
- Places with one or more transfers already are best candidates




1. This plot is showing the average number of transfers for a box of size: .25 miles x .25 miles, at 3 mph walking pace that is 5 min x 5 min.
2. Methodology:
   - loop through every stop
   - for each stop, assign it the start, loop through every other stop as a possible end point
   - For each start and stop combination, make a list of starting routes and ending routes.
   - If there is a route in both lists, then you can get there with zero transfers
   - If there are two routes in the list that share a stop then you can do one trasnfer. Note that you are not able to walk to a different stop for the transfer.
   - If neither of these are true then it is 2 transfers. Assume there are no three transfers possible. Looking at route maps by eye, this seems at least reasonable to a good approximation
   - For each stop, average the number of trasfers for all possible end point.
   - For each box, average the average number of transfers for each stop in the box.
   - heat map.

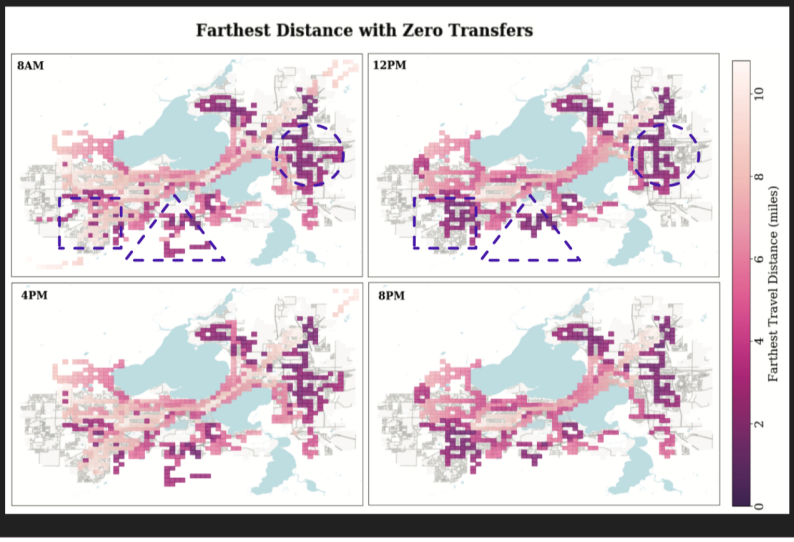
## Farthest Distance Available on a Single Bus:

**Right: Farthest distance you can get on a single bus starting in a given square**

- While still reducing costs can we improve the system for these areas?
- Increase BRT connection service to these areas

**Proposed System Frequency of BRT:**

| Day of Week | Time Period | Hours | Service Frequency |
|---|---|---|---|
| Weekday | Early AM | 5:00-6:00am | 30 min |
| | AM Peak | 6:00-9:00am | 10 min |
| | Midday | 9:00am-3:00pm | 15 min |
| | PM Peak | 3:00-6:00pm | 10 min |
| | Evening | 6:00pm - Midnight | 30 min |
| Saturday | Morning | 7:00-9:00am | 30 min |
| | Midday | 9:00-6:00pm | 15 min |
| | Evening | 6:00-11:00pm | 30 min |
| Sunday | All-day | 7:00am - 11:00pm | 30 min |



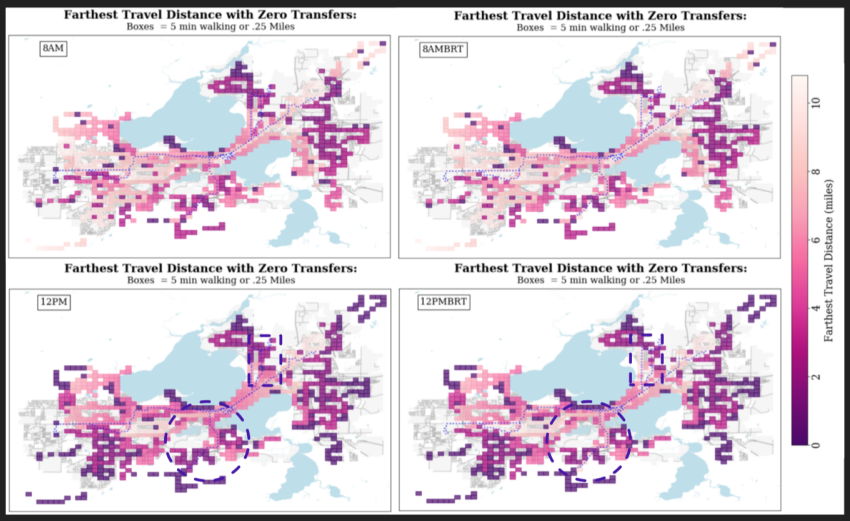

1. This is the same methodology as the last, but now you ask with only the option of overlapping routes in the list of possible starting and

stopping routes, loop through all the stops on that route and see which is farthest in terms of point to point distance (not the total distance travelled by bus, but the farthest straight line distance from your starting point)
2. In order to incorporate the time aspect, need to loop through all of the trips possible, this data set has 35,000 rows. This is a pain. Then as you loop through, you ask is the time that this bus stops at this stop within 15 min of the time I am asking for? if no, skip.

## Farthest Distance Available on a Single Bus Including BRT:

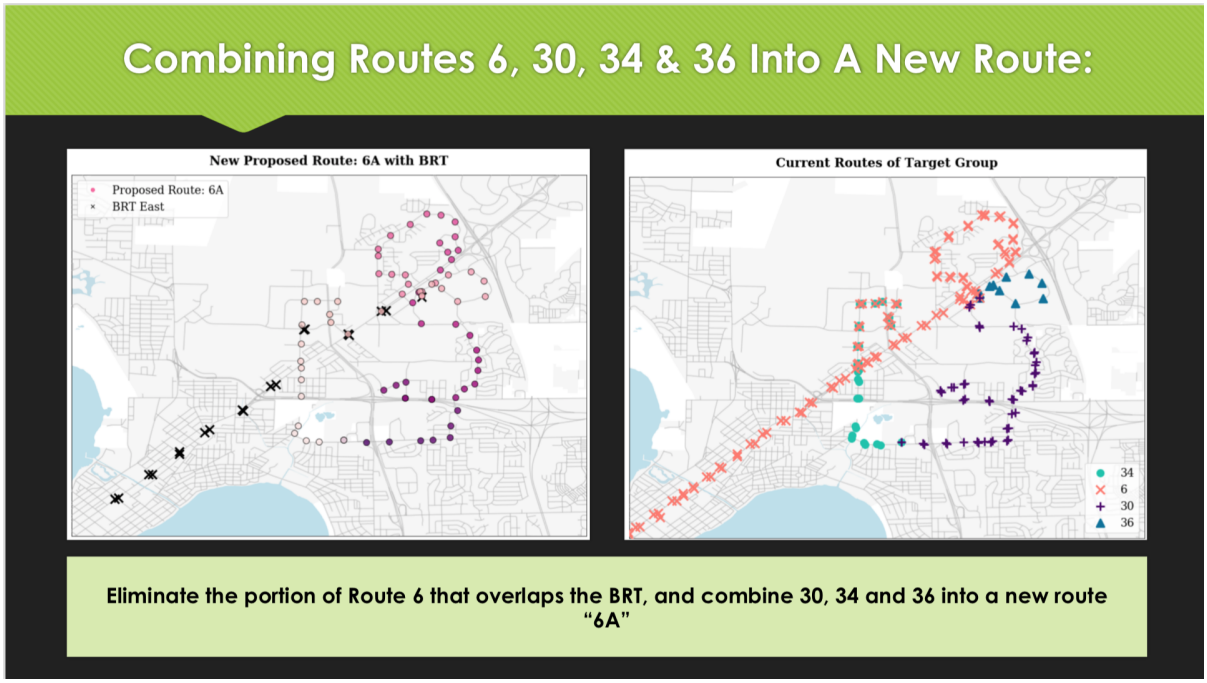
**Right: Farthest distance you can get on a single bus starting in a given square with BRT running**

- Along BRT, more uniform service across the day
- Able to get farther in general on BRT with no transfers
- **Want to take advantage of this more uniform service offering**

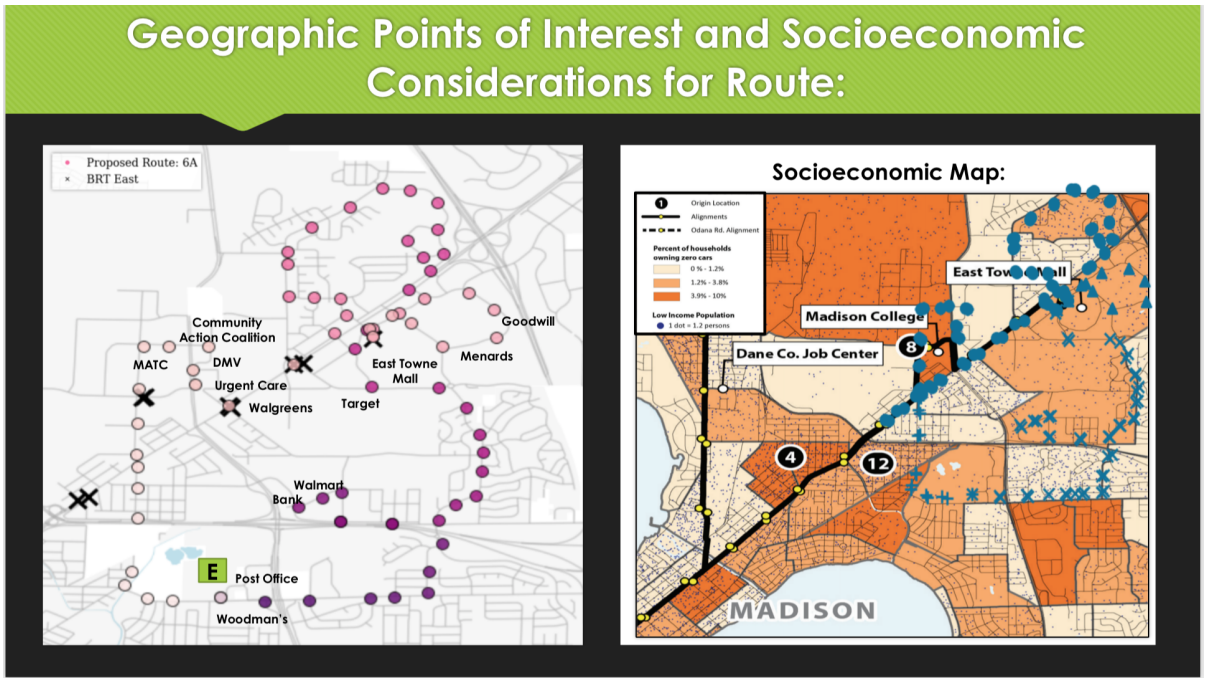



1. Same thing as slide above, but now you add in an option to get on the BRT. Since the longest time between BRT is 30 min, you are satisfying the +/- 15 min condition from above always, so no time dependance.
2. Act like all BRT is one route. Bit of a lie, since there are 4-5 corridors.

## Is there a new route we can propose to address some of these issues and goals?

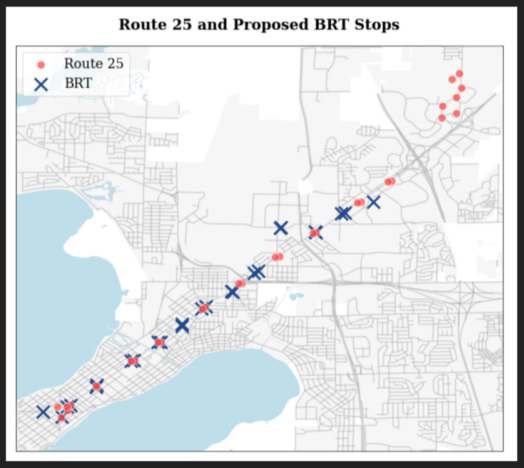


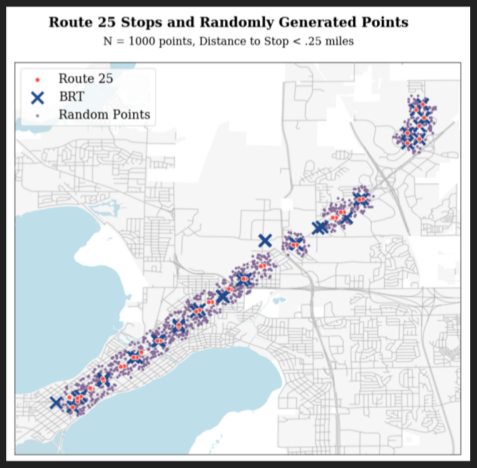

1. Here I spent a long time on the back end finding a route that had a large overlap from teh BRT and then other routes near by that could be combined.
2. The graph on the left is in a heat scale with dark purple being the start of my proposed route and the lightest being the end of the route. Features:
    - Go to the north side of E wash before the mall as that is residental so those people dont have to wait a whole ride around the route to go to the mall
    - loop around Waltmart, to do both loops of 30, right now people have to choose a via option and one goes to Milwaukee street, one goes to Waltmart, never both.
    - Overlap BRT several times, although these are all in similar times of sequence not as ideal.



## Can we evaluate the effect of combining a route with the BRT in a more simple situation first?

## Combining the Current Route 25 with the BRT to create a new route with 1 Transfer

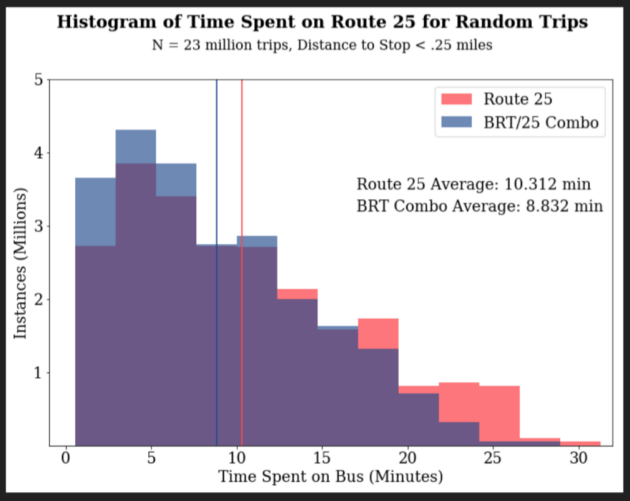



1. Combine route 25 and BRT, so that you ride the BRT up to east towne mall and then transfer onto the 25, no transfer time.
2. sample 1000's of points around the current route 25 stops to sample current clinetel

# Combined Route 25 Simulation Results:

- Run 23 million random trips for locations within .25 miles walking distance (5 min) from current route 25 stops
- Assume no transfer time onto the BRT at the East Towne switching point
- Assume that the BRT East is 19% faster than riding the metro along the same route
- **Combined route is 1.48 minutes faster on average than route 25**
- **14.4% faster than a typical route 25 trip**



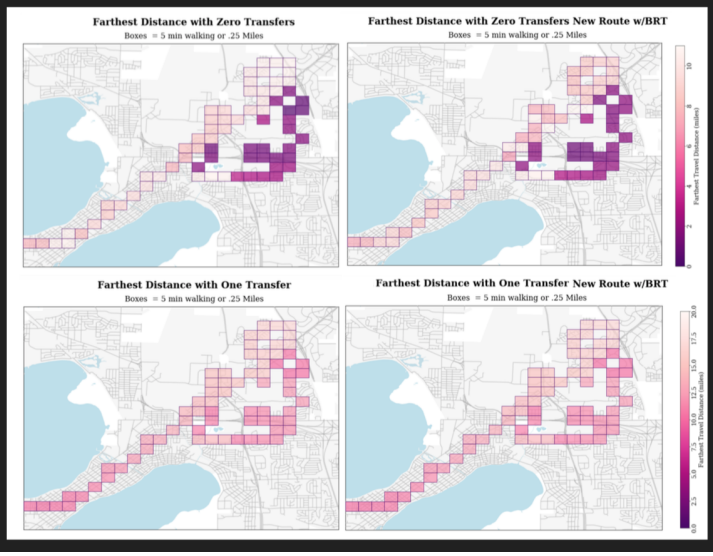

# How will the accessibility of Madison change for route 6A?

## Farthest Distances Reachable with Variable Transfer Numbers for Route 6A:

- Number of transfers stays approximately the same
- By transferring to BRT instead of #6, get a boost of 19% faster route for that portion

**Percent of Travel Time Saved Using BRT:**

| Corridor: | Percent |
|---|---|
| West | 17-23% |
| South | 21% |
| East | 19% |
| North | 42% |




1. Exact same map and technique as above, but only consider boxes with a current 6, 30, 34, 36 route stop in them.
2. Percent travel times for BRT taken from Report from city

## Summary of the Benefits of the 6A Route:

**Speed Up Benefits:**

- Same number of transfers as before on average
- Zero transfers for East Side loop
- Able to get to West, South and North sides on BRT, and more quickly
- Route #6 comes much more frequently than the 30, 34, 36, so get availability boost

**Socioeconomic Benefits:**

- Taking 3 routes that currently service lower income and lower car availability households
- Routes stop at fundamentally necessary places:
  - Urgent Care, pharmacy, bank, grocery, DMV, etc.

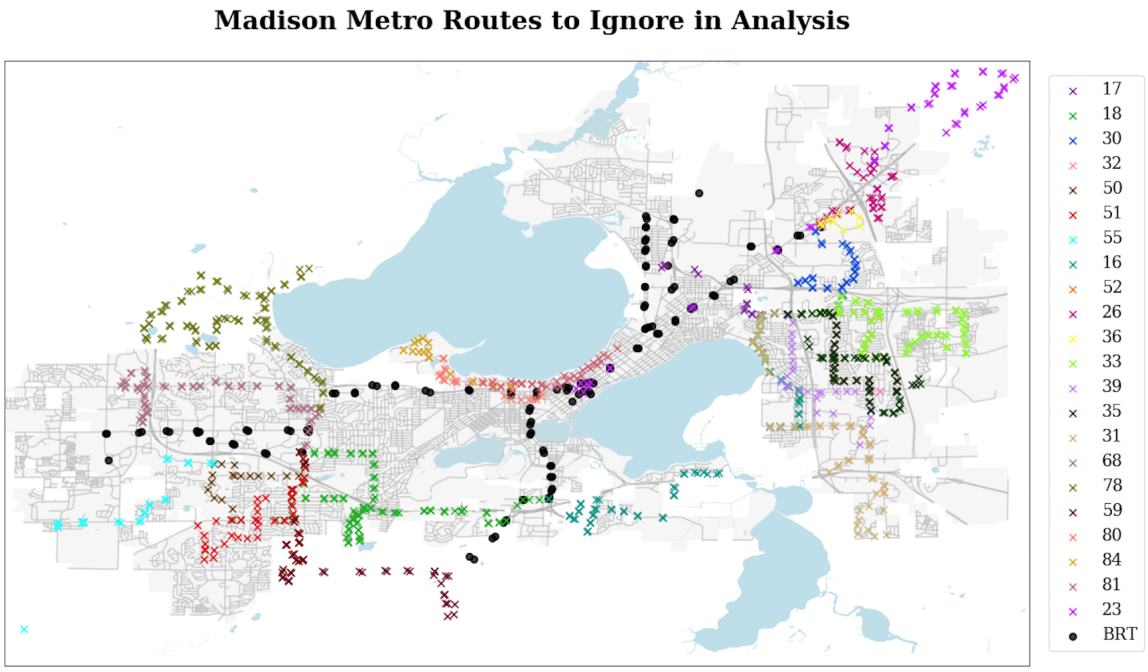
**Operating Cost Benefits:**

- Current route 6 has 78 stops, this proposed route has 75, essentially the same
- Would be same cost to run 6A with the same schedule as current #6
- Eliminate three routes: 30, 34, 36

## Future Prospects of the Project:

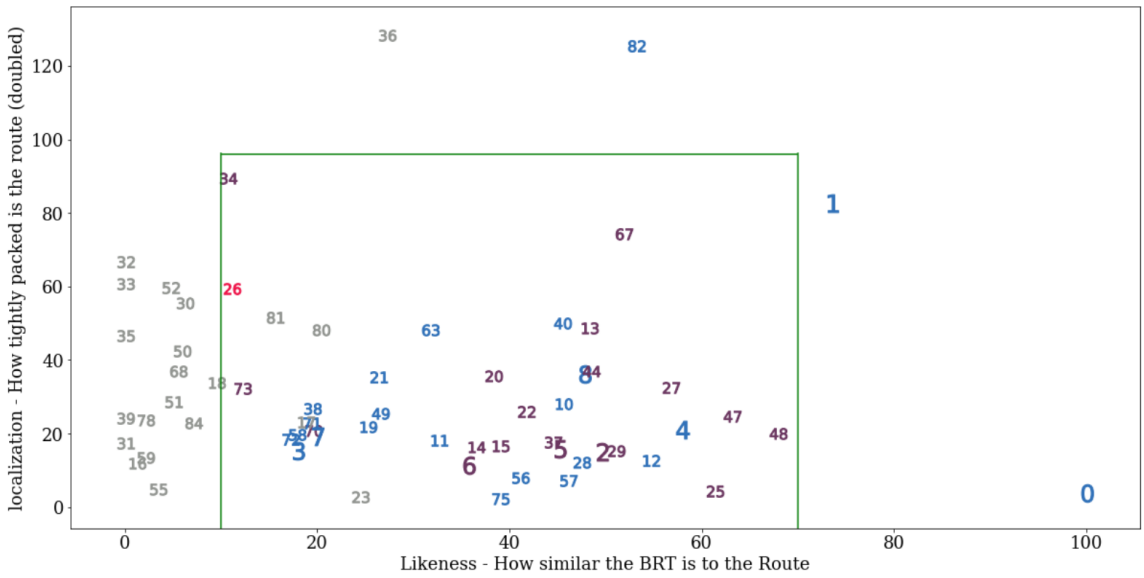
- Continue this plan of combining existing routes to eliminate BRT overlap on all bus routes
- Create new routes such that you increase the accessibility of Madison via bus while still reducing operating costs
- Run simulations and analyze the effects on the accessibility of Madison as well as the commute times on more complicated routes

# EXTRA PLOTS:




**Q: What routes can we ignore by considering a lack of overlap with the BRT? Or by considering specialized routes?**

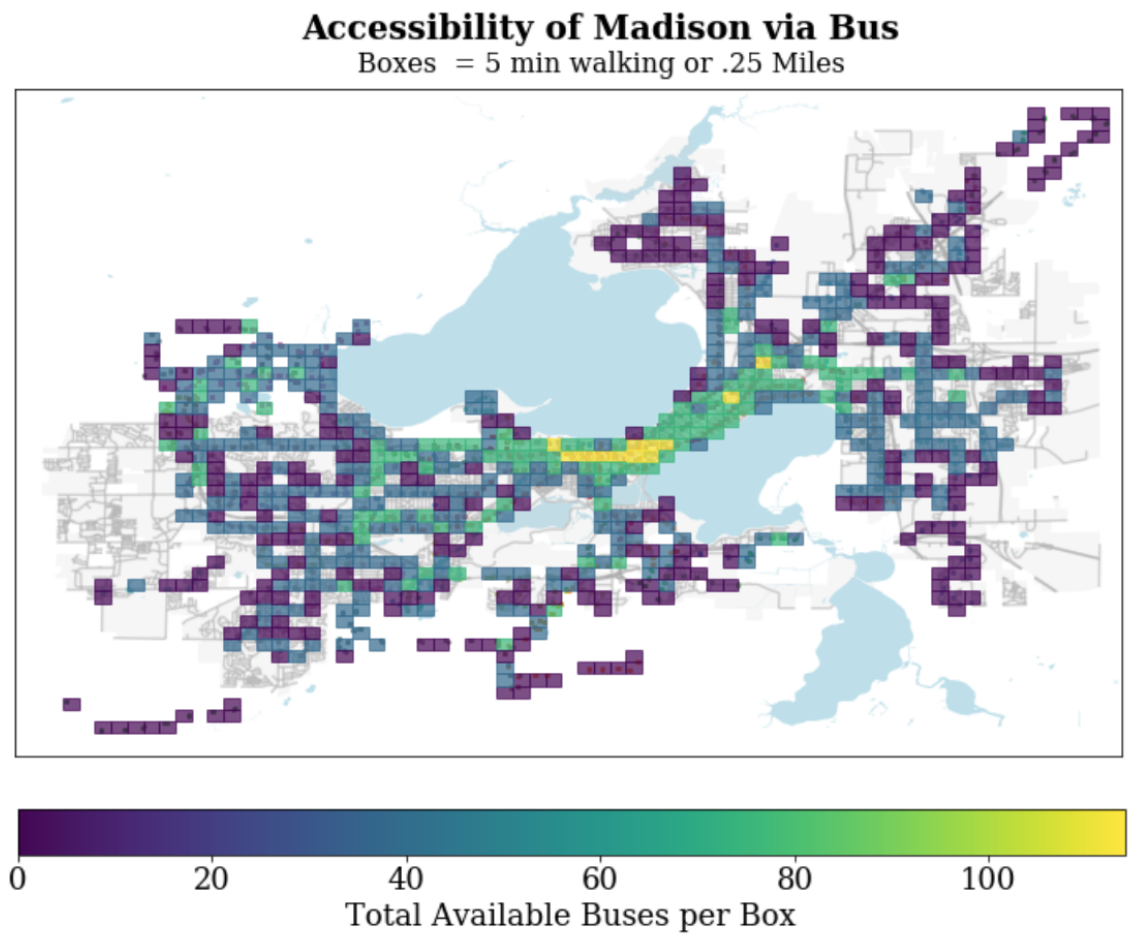
**A: These routes! But not really. Initially I just wanted to take a simple approach of eliminating overlapping routes to cut costs. As I considered the accessibility maps more in the middle of the semester I decided this is not the most effective in balancing citizen needs with city needs. We should be creating all new routes as I propose in the final. But still maybe this map helps guide what routes are not going to be the anchor routes. For eample with 6A, 6 is the anchor route that overlaps with BRT and I propose to add on three of the complimentary routes, 30, 34, 36. Two of the complimentary routes are on this list. The anchor route is not.**




**Q: Can we define a set of parameters that will help us pick routes to eliminate b/c of overlap with the BRT?**

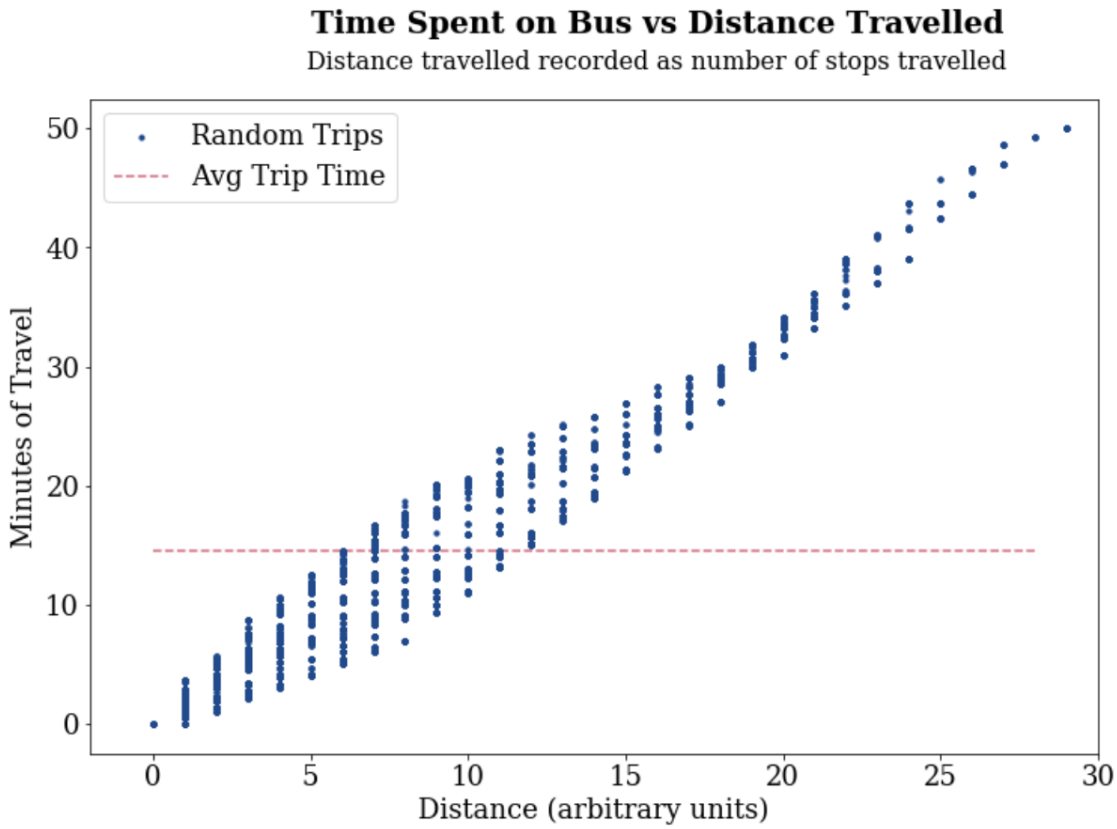
**A: Kind of. We can at least narrow down the parameter space that we need to look in. this is the same argument as above. In the end I go a different route, but maybe this can still inform our decisions and would be helpful in larger systems. Notice the 30, 36 are outside the box and 34 is on teh edge. These are the complimentary routes. The 6, the anchor is in the heart of the box. Again showing the utility of this plot.**

1. The x-axis is likeness, how similar the route is to the BRT
2. The y-axis is the localization or density of the route.
3. The green box is suggesting routes that have a high enough overlap with the BRT, but then are also more localized.



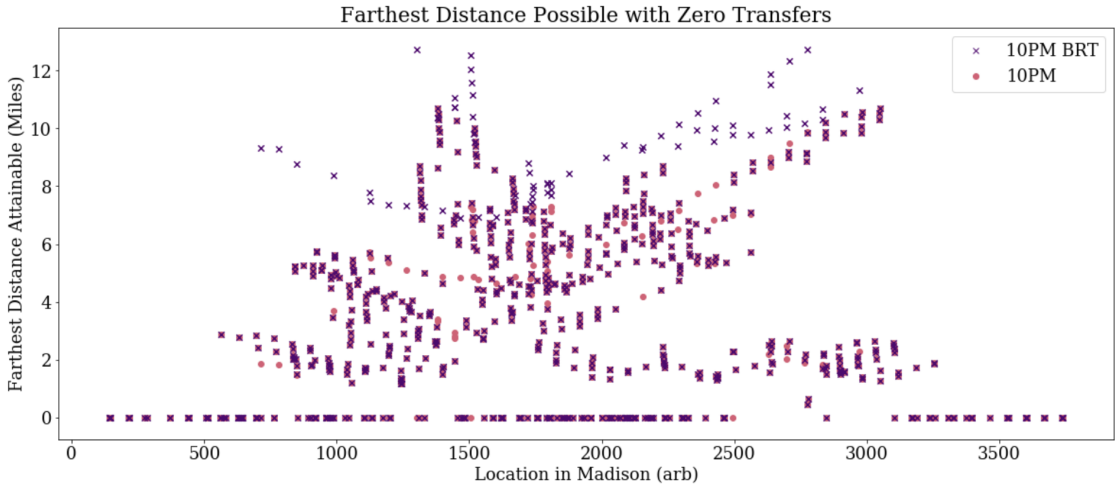

**Q: Can we define an accessibility for an area and then make a heat map of it around Madison?**

**A: Yes. The accessibility is defined as the total number of possible buses you could take from any given area. While I know that we refined this map later to be more specific, I still think this map does get across unique information about down town. While the farthest distance you can go may be similar to other parts of town there are just such an enourmous number of buses that run down there and that you have the option of getting on.**




**Q: What does the distribution of time spent on the bus to distance travelled look like for the simulation with thousnads of trips for the current Route 25 analysis?**

**A: It looks as you would expect. This was more just a sanity check that my simulation was running correctly, but I thought that it was interesting nonetheless. It also shows that picking random start and stop locations favors shorter trips. In reality the nature of the route 25 might be that most people ride it end to end from downtown to American Family. This is not data that we have but might influence the analysis as seen here.**




**Q: What is the farthest distance possible for arbitrary "boxes" or places around madison at 10pm, with the BRT system in place and without?**

**A: The farthest distance you can go with zero transfers with the BRT is farther than without the BRT for many places around Madison. For many places however, it is exactly the same. Showing the need that I express in the final project to really focus in the areas not being affected by BRT and linking them up to the BRT in a meaningful way to utilize that more binifical schedule**

# DOCUMENTATION:

1. You need the mmt_gtfs folder from the city open data portal. Files contained in (that I found useful) are:

    - routes.txt: this gives the Route_ID to route short name conversion. Important for general data understanding and comparing with Madison Metro website about route data.
    - stop_times.txt gives you the stop times and sequance for every possible trip.
    - stops.txt gives you the stop_ID and coordinates for every possible stop. I made a dictionary for this to look up stop_ID and return lat, lon for easy use.
    - trips.txt lists every possible trip for each route.
2. The structure is that you have many stops. For each stop, you can look under each route and wee which routes stop at this stop. With a list of routes you can ask what trips each route runs, those have codes for weekday, peak trips, etc. Then for each trip you can look at the trip data to see what stops it hits and when throughout the day.
3. It is possible to also access the boarding information for the averaging boarding numbers. That is here: https://data-cityofmadison.opendata.arcgis.com/datasets/metro-transit-ridership-by-route-weekday (https://data-cityofmadison.opendata.arcgis.com/datasets/metro-transit-ridership-by-route-weekday)
4. I found a parsing notebook to be a useful tool. I would make dictionaries and dataframes and save them as CSV/JSON, then upload them into my programs. Here are some examples of dictionaries and such I made and saved:

    - "Stop ID Look Up" take a stop_Id code and then return the lat and lon of that stop
    - "route stops" take a route and list all the possible stops for that route given the trip information.
5. For the discritized maps, it was a lot of data to go through, So I would write a program that counted things, like average transfers for each stop, then save that dictionary, that never changes. Then I go look at the map, discritize it into any number of squares I want and then ask what stops are in each square and pull from that dictionary I made before. Then I can just read the dictionary for each different type of discritization and not make a new one each time.

In [ ]:
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