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| **Transit Equity/ Bus Routes - Fall 2020** | |
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| **Organization** | Office of Representative Nika Elugardo  Suffolk 15th District |
| **Organization Description** | Nika Elugardo is a State Representative who represents the 15th Suffolk District in the Massachusetts House of Representatives. She represents the towns of Boston and Brookline. |
| **Project Description** | We know that poor people rely on public transportation and the rising costs have a significant impact on their budgets. Representative Elugardo would like to explore the feasibility for expanding free bus lines in Massachusetts for both the MBTA and regional bus authority lines.  This project will identify all bus stops in Massachusetts serviced by the MBTA and regional bus authorities. It will then evaluate which stops and bus routes are serving different income levels, with a goal of identifying the routes that most serve low income areas. The second part of the project will focus on the potential cost and benefit of establishing free bus lines based on ridership and fares. |
| **Strategic Questions to be Answered** | 1. What bus routes and stops, if made free, would most benefit low income riders in Massachusetts? 2. Which towns (and districts) would most benefit by a policy change to the fare change to these routes? 3. What would the cost be to the MBTA and regional transit authorities for each proposed bus route/ stop/ zones (based on ridership and fare costs)? 4. What would the cost be to make an entire regional transit area free and how would this compare? (note: the purpose of this would be to enable policymakers to calculate the cost from maintenance, fare management, etc. of a differentiated approach vs. a holistic approach) 5. Other TBD with client |
| **Data Sets** | [**Regional bus routes - Mass DOT**](https://geo-massdot.opendata.arcgis.com/datasets/pati-bus-stops?showData=true)  [**Ridematch - Transit API**](https://massridematch.org/) **for Massachusetts**  [**List of Regional Bus Transit Authorities**](https://www.mass.gov/info-details/public-transportation-in-massachusetts#map-of-transit-authorities-in-massachusetts-)  [**MBTA Fare calculator**](https://www.mbta.com/fares)  [**MBTA Data for Developers**](https://www.mass.gov/lists/mbta-and-transit-data-for-developers)  [**Road Network: TIGER line files**](https://www.census.gov/cgi-bin/geo/shapefiles/index.php)  **Census: See Tools and Approaches for more info.**  **Ridership data**  [**MBTA Open Data Portal**](https://mbta-massdot.opendata.arcgis.com/search?tags=bus)  [**MBTA**](https://mbtabackontrack.com/performance/#/detail/ridership/2020-04-01////)  [**Mass DOT open data portal**](https://geo-massdot.opendata.arcgis.com/)  **Transportation APIs:**   * MBTA: <https://docs.digital.mass.gov/dataset/massgis-data-mbta-rapid-transit> * Bus Routes: <https://docs.digital.mass.gov/dataset/massgis-data-mbta-bus-routes-and-stops> * Look up access to transportation threshold to evaluate transportation access. Here is an API that might be useful for this exercise: <https://www.walkscore.com/professional/walk-score-apis.php> |
| **Approach** | **Step One:** [Read this report to understand the issue](http://www.wrrb.org/wp-content/uploads/2019/05/WRRB-FareFree-Transit-Report.pdf).Collect data - create a spreadsheet of all the different bus stops in Massachusetts including MBTA, Regional Transit Authorities, and City/Town buses.  **Step Two:** Assign an income level to each stop based on the census tract data  **Step Three:** Determine average fare for each transit stop based on fares for  **Step Four:** Calculate bus ridership for each transit authority  **Step Five:** Identify which bus routes, stops, or zones would have the most positive effect on low income riders if free. Identify which towns would be impacted?  **Step Six:** Generate visualizations: TBD with client using software such as ArcGIS or tableau as a final deliverable along with the list data. |
| **Tools and approaches** | Tract Data:  [Link to Shapefile](https://catalog.data.gov/dataset/tiger-line-shapefile-2019-state-massachusetts-current-census-tract-state-based) (tl\_2019\_25\_tract)  def add\_census\_tract(dataframe):  polygons = gpd.read\_file("data/tl\_2019\_25\_tract/tl\_2019\_25\_tract.shp")  polygons = polygons.rename(columns={"TRACTCE": "census\_tract"}, index=str)  polygons = polygons.to\_crs("EPSG:26986")  gdf = dataframe  df = gpd.sjoin(gdf, polygons[['census\_tract', 'geometry']], how='left', op='within')  df.drop(columns=['index\_right'], inplace=True)  return df  Where, the input dataframe is a shapefile containing the land parcels, having the geometry column as the geographic identifier.  EPSG:26986 is the Massachusetts State Plane, akin to EPSG:4326 (GPS Coordinate system). This is the coordinate format that most Massachusetts State datasets use. The coordinate numbers will look weird, but they represent an actual point on the Massachusetts State Plane.  Census Data:  def get\_median\_hh\_income():  '''  Returns Pandas DataFrame representation Median Household Income Estimate by Census Tract for MA.  American Community Survey (ACS) 2018 Census data used.  Specific table: ACS 2018 5-year detailed table "B19013\_001E"  '''  URL = "https://api.census.gov/data/2018/acs/acs5?get=B19013\_001E&for=tract:\*&in=state:25"    response = requests.get(url = URL)  data = response.json()    median\_income\_df = pd.DataFrame(data[1:len(data)-1], columns = data[0])    return median\_income\_df  Scitkit Learn and spaCy for basic machine learning and regression tools.  Tableau and ArcGIS for mapping the results. |
| **Other Readings** | [Study on free buses for Worcester](http://www.wrrb.org/wp-content/uploads/2019/05/WRRB-FareFree-Transit-Report.pdf) **(READ THIS FIRST)**  [Livable Streets Alliance Report on Bus Equity](https://www.livablestreets.info/64_hours_report)  [Article on Free Buses Trend](https://www.boston.com/news/commute/2020/01/15/cities-like-boston-and-worcester-look-to-lawrence-in-debate-over-free-public-transit)  [Another article on free buses in Mass](https://www.bostonglobe.com/metro/2020/01/06/the-wild-idea-making-mbta-buses-free-gaining-traction/A5mw1bOfykqS9JdY6vXNIJ/story.html)  More background:  [Transit Equity: Research and Advocacy Inspires Government Action | Data-Smart City Solutions (harvard.edu)](https://datasmart.ash.harvard.edu/news/article/transit-equity-research-and-advocacy-inspires-government-action)  [Transportation Equity | Massachusetts Public Health Association (mapublichealth.org)](https://mapublichealth.org/priorities/transportation/)  National perspectives  [Access to Public Transit is a Matter of Racial Equity | Center for Social Inclusion (centerforsocialinclusion.org)](https://www.centerforsocialinclusion.org/access-to-public-transit-is-a-matter-of-racial-equity/)  Way long but has great resources list at end! [Evaluating Transportation Equity (vtpi.org)](https://vtpi.org/equity.pdf)  Note: MBTA is a semi-autonomous transit authority serving mostly Eastern Mass. |

**11/12 Notes**

Looking at people impacted by bus line

Working on population data - identify average income and number of people living around a given stop by drawing a buffer around a stop and taking a weighted average of income.

**11/5 Notes**

[Great data source on demographic information for bus routes](https://www.ctps.org/apps/mbtasurvey2018/#)/ train on MBTA

**Team Jamie**

* Conclusion: just calculate the fare for particular bus route \* the average riderage (don't bother with discounts at this stage)
* Ignore stops with negative household incomes (7, 810 stops - 70 stops show negative income?)
* [Spreadsheet with list of stops](https://docs.google.com/spreadsheets/d/1r8Pnc_yptAiei-7-hqLQQFU4Vq1OjKz97JG9oIGx_Xg/edit#gid=480226639)
* API.Census.Gov

**Notes from 10/29**

* Team 1: Curtis, Justin, Kelly
* RTA: Brockton, Worcester, MetroWest, Berkshire, covers several regions (15 total)
* Ridership for only 10 RTAs
* Able to isolate Brockton, but
* Data from different transit authorities in different formats
* Manual mapping of 10 RTAs
* Stop and route data from one data set
* Different data for ridership
* Discrepancy with how named RTAs
* Data visualization on how much revenue by RTA - all modes
* Ridership - isolate specific fares
* Have info on what fare by stop is
* Get key for different transit modes e.g. DR = ?
* # of stops per RTA
* Have data for cost overhead for the entire route for specific RTA
* Funnel data to make case
* How much revenue each individual bus stop generates and map to income bracket levels then citywide government
* First cut - find a route and check the census blocks
* Identify top 10 low income routes (based on lowest income routes (not average)
* Isabel - see if she can get ridership data per bus stop
* Ridership for the entire RTA (regional transit authority)
* Assuming stops are uniformly distributed- Large assumption (Ask MAPC)
* Could do weighing based on population density
* Can’t find fare cost per
* Total revenue by # of bus stops (average by bus stop)
* Rishab gave code - income bracket by neighborhood - need to schedule time with Rishab, unfamiliar with geopandas

Jamie/ MBTA:

* Data more robust for stops
* Worcester - cost of operation vs. revenue
* Only able to find overall cost - could average out
* CSV - average “ons” for each stop
* How much fare costs at that bus stop and hope it aligns with overall revenue
* No granularity of cost for operation
* Figure out # of buses on a route
* Found a data set of different census tracts and MBTA stops - used geopandas, if this point in polygon then maps to specific census tract
* More granular information on buses: cost of maintaining a bus, machine cost, this route costs X
* Thinking of putting in new machines - that would be an extra cost (system wide)
* Look at .5%
* Imagine the headline: 25,000 people living within a .5 miles of a stop would benefit from free bus far - draw radius - take average of census tracts (hint: take a look a6t Buffer from GeoPandas)
* Add race, ethnicity, age (elders take the bus)
* Example from Philadelphia: <https://frameworks.ced.berkeley.edu/2014/the-economic-benefits-of-transit-service/>

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Just multiply it by the base rate (full price)

Isabel:

* Rep Elugardo - what are 5 statements/ headlines she would like to be able to say
* Ridership data for RTAs

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Original source of the median household income: <https://data.census.gov/cedsci/table?t=Income%20%28Households,%20Families,%20Individuals%29&g=0400000US25.140000&d=ACS%205-Year%20Estimates%20Data%20Profiles&tid=ACSDP5Y2018.DP03&moe=false&hidePreview=true>

Find the tracts that each bus route passes through and find the median household income from there

Who is using it now?

Who could benefit if it’s free