Notebook 3

Project: "Intra-Regional Migration and Transportation in New York Metro Area"

This Notebook's Goal:

In this notebook, we focus on our step 5 in our designed research process - to compare transit-area vs. non-transit-area data to see if transit plays an important role in forming local communities in the process of intra-regional migration. This is a new section we decided to do after midterm

In this section, we started to zoom in on the census tract level and involves lots of data comparison on the interactive maps. Therefore, this week, we only applied a part of our data (only one county and one train railroad) to test out the coding stuff. Glad this coding works out, so we wil continue building this coding to apply to all data in the following week.

Research Step 5

In this section, we started to test out how to compare the census data in transit area vs in non transit area by using the fuction "buffer". We first apply both census tract data and transit data as the basemaps. Then we use each station as the point to draw a half mile radius circle and then make those circles to "overlay" on the census data so that we have those average nubmer touched by the circles. Finally, we figured out how to use folium to show the data and finding via different layers.

In [1]:
```
# Import all required modules

import pandas as pd
import geopandas as gpd
import contextily as ctx
import matplotlib.pyplot as plt
import plotly.express as px
import plotly.graph_objects as go
from plotly.subplots import make_subplots
import numpy as np
import folium
from geopandas import GeoDataFrame
from shapely.geometry import Point
```

In [2]:
```
# This is the base census data

NYS_CensusTract_Rawdata = gpd.read_file('data5/cb_2018_36_tract_500k.shp')
```

In [3]:
```
# take some basic data exploration and cleaning.

NYS_CensusTract_Rawdata.head()
```

Out[3]:

	STATEFP	COUNTYFP	TRACTCE	AFFGEOID	GEOID	NAME	LSAD	ALAND	AWATER	geometry
0	36	019	101100	1400000US36019101100	36019101100	1011	CT	583322	57750	POLYGON ((-73.46914 44.69043, -73.46972 44.693...
1	36	021	000402	1400000US36021000402	36021000402	4.02	CT	42294908	1437327	POLYGON ((-73.72088 42.45322, -73.71799 42.470...
2	36	023	970700	1400000US36023970700	36023970700	9707	CT	2082176	0	POLYGON ((-76.20049 42.61248, -76.19596 42.612...
3	36	081	046200	1400000US36081046200	36081046200	462	CT	249611	0	POLYGON ((-73.79203 40.71107, -73.79101 40.711...
4	36	081	048100	1400000US36081048100	36081048100	481	CT	139052	0	POLYGON ((-73.88799 40.74355, -73.88621 40.743...

In [4]:
```
Columns_To_Keep1 = ['AFFGEOID','geometry']
NYS_CensusTract_Rawdata_trimmed = NYS_CensusTract_Rawdata[Columns_To_Keep1]
```

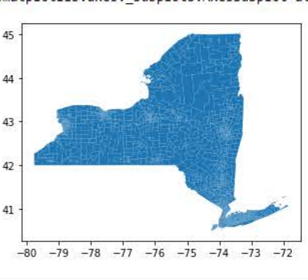
In [5]:
```
NYS_CensusTract_Rawdata_trimmed.head()
```

Out[5]:

	AFFGEOID	geometry
0	1400000US36019101100	POLYGON ((-73.46914 44.69043, -73.46972 44.693...
1	1400000US36021000402	POLYGON ((-73.72088 42.45322, -73.71799 42.470...
2	1400000US36023970700	POLYGON ((-76.20049 42.61248, -76.19596 42.612...
3	1400000US36081046200	POLYGON ((-73.79203 40.71107, -73.79101 40.711...
4	1400000US36081048100	POLYGON ((-73.88799 40.74355, -73.88621 40.743...

In [6]:
```
NYS_CensusTract_Rawdata_trimmed.plot()
```

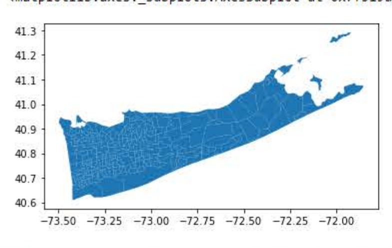
Out[6]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319d7b54f0>



In [7]:
```
Tract_County1 = NYS_CensusTract_Rawdata_trimmed[NYS_CensusTract_Rawdata.COUNTYFP == '103']
```

In [8]:
```
Tract_County1.plot()
```

Out[8]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319d634a30>



In [9]:
```
# Because we are going to do buffering for each point, we want to make sure all our geo measurments are on the same CRS.
#So we convert all following geodata to 2272

Tract_County1_crs = Tract_County1.to_crs(epsg=2272)
```

In [10]:
```
# making sure the change is successful

print(Tract_County1_crs.crs)
```

```
epsg:2272
```

Train Station Dataframe

In [11]:
```
# now we are going to import the transit data as the basemap

LIRR_Railroad_Rawdata = gpd.read_file('data5/LIRR/geo_export_c4344150-8906-4247-ba0d-70c66f79a2cd.shp')

LIRR_Station_Rawdata = gpd.read_file('data5/LIRR/geo_export_cd021d1d-1a5d-46e9-bff6-446db61db8cc.shp')
```

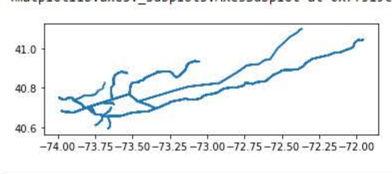
In [12]:
```
LIRR_Railroad_Rawdata.head()
```

Out[12]:

	routename	geometry
0	Babylon	LINESTRING (-73.99309 40.75074, -73.99245 40.7...
1	Babylon	LINESTRING (-73.32470 40.70060, -73.32538 40.7...
2	Babylon	LINESTRING (-73.32470 40.70060, -73.32538 40.7...
3	Babylon	LINESTRING (-73.32470 40.70060, -73.32538 40.7...
4	Babylon	LINESTRING (-73.97736 40.68475, -73.97687 40.6...

In [13]:
```
LIRR_Railroad_Rawdata.plot()
```

Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319cfad640>



In [14]:
```
LIRR_Station_Rawdata_crs = LIRR_Station_Rawdata.to_crs(epsg=2272)
```

In [15]:
```
print(LIRR_Station_Rawdata_crs.crs)
```

```
epsg:2272
```

In [16]:
```
LIRR_Station_Rawdata_crs.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 124 entries, 0 to 123
Data columns (total 2 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   stopname  124 non-null    object
 1   geometry  124 non-null    geometry
dtypes: geometry(1), object(1)
memory usage: 2.1+ KB
```

In [17]:
```
LIRR_Station_Rawdata_crs['lon'] = LIRR_Station_Rawdata['geometry'].x
LIRR_Station_Rawdata_crs['lat'] = LIRR_Station_Rawdata['geometry'].y
```

In [18]:
```
LIRR_Station_Rawdata_crs.head()
```

Out[18]:

	stopname	geometry	lon	lat
0	Long Island City	POINT (3019395.107 535479.309)	-73.95639	40.74128
1	Hunterspoint Avenue	POINT (3022035.576 535994.076)	-73.94679	40.74238
2	Penn Station	POINT (3008955.006 538424.062)	-73.99358	40.75058
3	Woodside	POINT (3034111.720 537779.211)	-73.90297	40.74584
4	Forest Hills	POINT (3050634.467 528924.918)	-73.84481	40.71957

In [19]:
```
# this is the critical part. we are buffer the data point of each station by half mile.
# then we have a new column that contains all buffer geometry data

buffer_distance = 0.5 * 5280

LIRR_Station_Rawdata_crs['geometry_buffer'] = LIRR_Station_Rawdata_crs.geometry.buffer(buffer_distance)
```

In [20]:
```
LIRR_Station_Rawdata_crs.head()
```

Out[20]:

	stopname	geometry	lon	lat	geometry_buffer
0	Long Island City	POINT (3019395.107 535479.309)	-73.95639	40.74128	POLYGON ((3022035.107 535479.309, 3022022.395 ...
1	Hunterspoint Avenue	POINT (3022035.576 535994.076)	-73.94679	40.74238	POLYGON ((3024675.576 535994.076, 3024662.864 ...
2	Penn Station	POINT (3008955.006 538424.062)	-73.99358	40.75058	POLYGON ((3011595.006 538424.062, 3011582.293 ...
3	Woodside	POINT (3034111.720 537779.211)	-73.90297	40.74584	POLYGON ((3036751.720 537779.211, 3036739.008 ...
4	Forest Hills	POINT (3050634.467 528924.918)	-73.84481	40.71957	POLYGON ((3053274.467 528924.918, 3053261.755 ...

In [21]:
```
LIRR_Station_Rawdata_crs.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 124 entries, 0 to 123
Data columns (total 5 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   stopname         124 non-null    object
 1   geometry         124 non-null    geometry
 2   lon              124 non-null    float64
 3   lat              124 non-null    float64
 4   geometry_buffer  124 non-null    geometry
dtypes: float64(2), geometry(2), object(1)
memory usage: 5.0+ KB
```

In [22]:
```
LIRR_Station_Rawdata_crs_map = LIRR_Station_Rawdata_crs.drop(['lon','lat','geometry'],axis=1)
```

In [23]:
```
LIRR_Station_Rawdata_crs_map.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 124 entries, 0 to 123
Data columns (total 2 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   stopname         124 non-null    object
 1   geometry_buffer  124 non-null    geometry
dtypes: geometry(1), object(1)
memory usage: 2.1+ KB
```

In [24]:
```
LIRR_Station_Rawdata_crs_map.columns = ['stopname','geometry']
```

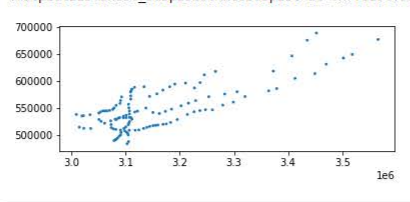
In [25]:
```
LIRR_Station_Rawdata_crs_map.head()
```

Out[25]:

	stopname	geometry
0	Long Island City	POLYGON ((3022035.107 535479.309, 3022022.395 ...
1	Hunterspoint Avenue	POLYGON ((3024675.576 535994.076, 3024662.864 ...
2	Penn Station	POLYGON ((3011595.006 538424.062, 3011582.293 ...
3	Woodside	POLYGON ((3036751.720 537779.211, 3036739.008 ...
4	Forest Hills	POLYGON ((3053274.467 528924.918, 3053261.755 ...

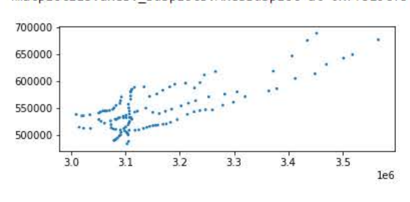
In [26]:
```
LIRR_Station_Rawdata_crs_map.plot()
```

Out[26]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319cf52a90>



In [27]:
```
LIRR_Station_Rawdata_crs_map.plot()
```

Out[27]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319cf34d30>



Map

In [28]:
```
# now we are trying to make some interactive maps with Folium. We are trying to add multiple layers into one map

m = folium.Map(location=[40.730610,-73.935242],
           tiles='OpenStreetMap',
          zoom_start=8.5
          )
```

In [29]:
```
m
```

Out[29]:

In [30]:
```
# create for loop to map all station

for index, row in LIRR_Station_Rawdata_crs.iterrows():
    folium.Marker([row.lat, row.lon], popup=row.stopname).add_to(m)
```

In [31]:
```
Tract_County1_crs['stopname']='No'
```

In [32]:
```
# using for loop to assign the new values if the census data is intersected with the created buffer geometry

for index_s, row_s in LIRR_Station_Rawdata_crs.iterrows():

    for index_t, row_t in Tract_County1_crs.iterrows():
        if row_t.geometry.intersects(row_s.geometry_buffer) == True:
            Tract_County1_crs.at[index_t,'stopname'] = LIRR_Station_Rawdata_crs.at[index_s,'stopname']
```

In [33]:
```
Tract_County1_crs.head(50)
```

Out[33]:

	AFFGEOID	geometry	stopname
6	1400000US36103158804	POLYGON ((3271495.105 563714.033, 3271787.234 ...	No
7	1400000US36103159508	POLYGON ((3324563.715 560527.321, 3324551.669 ...	No
8	1400000US36103190800	POLYGON ((3427592.295 595673.672, 3439372.827 ...	Southampton
9	1400000US36103990100	POLYGON ((3502127.951 667800.745, 3502130.644 ...	No
56	1400000US36103147803	POLYGON ((3256602.714 554005.289, 3257590.937 ...	Sayville
57	1400000US36103158108	POLYGON ((3251874.981 598354.549, 3253210.684 ...	No
58	1400000US36103158309	POLYGON ((3282586.185 596927.891, 3283758.160 ...	No
59	1400000US36103158408	POLYGON ((3299818.880 628358.526, 3300348.502 ...	No
167	1400000US36103111001	POLYGON ((3164442.979 589916.776, 3165164.993 ...	Huntington
168	1400000US36103111703	POLYGON ((3191405.964 594334.279, 3194046.005 ...	Northport
235	1400000US36103112212	POLYGON ((3177983.154 567842.506, 3182559.280 ...	No

In [34]:
```
Tract_WithinStops = Tract_County1_crs[Tract_County1_crs['stopname'] != 'No']
```

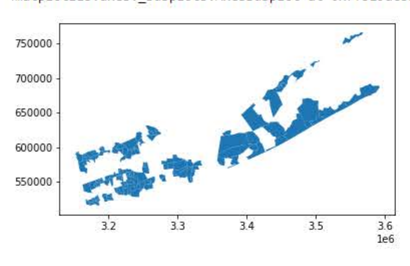
In [35]:
```
Tract_WithinStops.head()
```

Out[35]:

	AFFGEOID	geometry	stopname
8	1400000US36103190800	POLYGON ((3427592.295 595673.672, 3439372.827 ...	Southampton
56	1400000US36103147803	POLYGON ((3256602.714 554005.289, 3257590.937 ...	Sayville
167	1400000US36103111001	POLYGON ((3164442.979 589916.776, 3165164.993 ...	Huntington
168	1400000US36103111703	POLYGON ((3191405.964 594334.279, 3194046.005 ...	Northport
295	1400000US36103145704	POLYGON ((3224519.302 567830.020, 3225701.112 ...	Central Islip

In [36]:
```
Tract_WithinStops.plot()
```

Out[36]: <matplotlib.axes._subplots.AxesSubplot at 0x7f319ac89a60>



Database

In [37]:
```
commutingCSV = pd.read_csv('data5/commuting_time.csv')
```

In [38]:
```
commutingCSV.columns = ['AFFGEOID','Name','2014','2018','Diff','Change']
```

In [39]:
```
alltract = Tract_County1.merge(commutingCSV,
                               on='AFFGEOID',
                               how='right')
```

In [40]:
```
alltract.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 323 entries, 0 to 322
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   AFFGEOID  323 non-null    object
 1   geometry  323 non-null    geometry
 2   Name      323 non-null    object
 3   2014      323 non-null    int64
 4   2018      323 non-null    int64
 5   Diff      323 non-null    int64
 6   Change    323 non-null    object
dtypes: geometry(1), int64(3), object(3)
memory usage: 20.2+ KB
```

In [41]:
```
df_merge = Tract_WithinStops.merge(commutingCSV,on='AFFGEOID',how='left')
```

In [42]:
```
df_merge.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 128 entries, 0 to 127
Data columns (total 8 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   AFFGEOID  128 non-null    object
 1   geometry  128 non-null    geometry
 2   stopname  128 non-null    object
 3   Name      128 non-null    object
 4   2014      128 non-null    int64
 5   2018      128 non-null    int64
 6   Diff      128 non-null    int64
 7   Change    128 non-null    object
dtypes: geometry(1), int64(3), object(4)
memory usage: 9.0+ KB
```

In [43]:
```
df_merge_group = df_merge.groupby('stopname').mean()
```

In [44]:
```
df_merge_group.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 40 entries, Amagansett to Yaphank
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   2014    40 non-null     float64
 1   2018    40 non-null     float64
 2   Diff    40 non-null     float64
dtypes: float64(3)
memory usage: 1.2+ KB
```

In [45]:
```
df_merge_group = df_merge_group.reset_index()
```

In [46]:
```
df_merge_group.head()
```

Out[46]:

	stopname	2014	2018	Diff
0	Amagansett	9.000000	36.000000	27.000000
1	Babylon	250.500000	95.000000	-155.500000
2	Bay Shore	191.000000	87.333333	-103.666667
3	Bellport	71.500000	289.500000	218.000000
4	Brentwood	69.833333	96.000000	26.166667

In [47]:
```
df_merge_group_geo = LIRR_Station_Rawdata_crs_map.merge(df_merge_group,
                                                       on='stopname',
                                                       how='right')
```

In [48]:
```
df_merge_group_geo.head()
```

Out[48]:

	stopname	geometry	2014	2018	Diff
0	Cold Spring Harbor	POLYGON ((3160237.922 576226.224, 3160225.210 ...	372.000000	89.500000	-282.50
1	Huntington	POLYGON ((3171413.448 583109.353, 3171400.736 ...	128.285714	96.285714	-32.00
2	Greenlawn	POLYGON ((3184025.225 589445.519, 3184012.512 ...	182.500000	134.750000	-47.75
3	Northport	POLYGON ((3193300.912 594278.694, 3193288.199 ...	125.750000	81.750000	-44.00
4	Kings Park	POLYGON ((3213193.085 596385.335, 3213180.372 ...	173.500000	144.250000	-29.25

In [49]:
```
folium.Choropleth(geo_data=alltract,
                  name='All Census Tract',
                  data=alltract,
                  columns=['Name','Diff'],
                  key_on="feature.properties.Name",
                  fill_color='YlGnBu',
                  fill_opacity=0.8,
                  line_opacity=0.2,
                  smooth_factor=0
                 ).add_to(m)
```

Out[49]: <folium.features.Choropleth at 0x7f319ac54c40>

In [50]:
```
folium.Choropleth(geo_data=df_merge_group_geo,
                  name='Station Area',
                  data=df_merge_group,
                  columns=['stopname','Diff'],
                  key_on="feature.properties.stopname",
                  fill_color='YlGnBu',
                  fill_opacity=0.8,
                  line_opacity=1,
                  smooth_factor=0
                 ).add_to(m)
```

Out[50]: <folium.features.Choropleth at 0x7f319ac54130>

In [51]:
```
style_function = lambda x: {'fillColor': '#ffffff',
                            'color':'#000000',
                            'fillOpacity': 0.1,
                            'weight': 0.1}
highlight_function = lambda x: {'fillColor': '#000000',
                                'color':'#000000',
                                'fillOpacity': 0.50,
                                'weight': 0.1}
notes2 = folium.features.GeoJson(alltract,
                                style_function=style_function,
                                control=False,
                                highlight_function=highlight_function,
                                tooltip=folium.features.GeoJsonTooltip(
                                    fields=['Name','Diff'],
                                    aliases=['Cencus Tract: ','Average Commuter Decrease: '],
                                    style=("background-color: white; color: #333333; font-family: arial; font-size: 12px; padding
                                )
                            )
m.add_child(notes2)
m.keep_in_front(notes2)
```

In [52]:
```
style_function = lambda x: {'fillColor': '#ffffff',
                            'color':'#000000',
                            'fillOpacity': 0,
                            'weight': 2}
highlight_function = lambda x: {'fillColor': '#000000',
                                'color':'#000000',
                                'fillOpacity': 0.50,
                                'weight': 0.1}
notes = folium.features.GeoJson(df_merge_group_geo,
                                style_function=style_function,
                                control=False,
                                highlight_function=highlight_function,
                                tooltip=folium.features.GeoJsonTooltip(
                                    fields=['stopname','Diff'],
                                    aliases=['Station Area: ','Average Commuter Decrease: '],
                                    style=("background-color: white; color: #333333; font-family: arial; font-size: 12px; padding
                                )
                            )
m.add_child(notes)
m.keep_in_front(notes)
```

In [53]:
```
 folium.GeoJson(LIRR_Railroad_Rawdata,
               name='Long Island Railroad',
               style_function=lambda feature: {'color' :'red'}
              ).add_to(m)
```

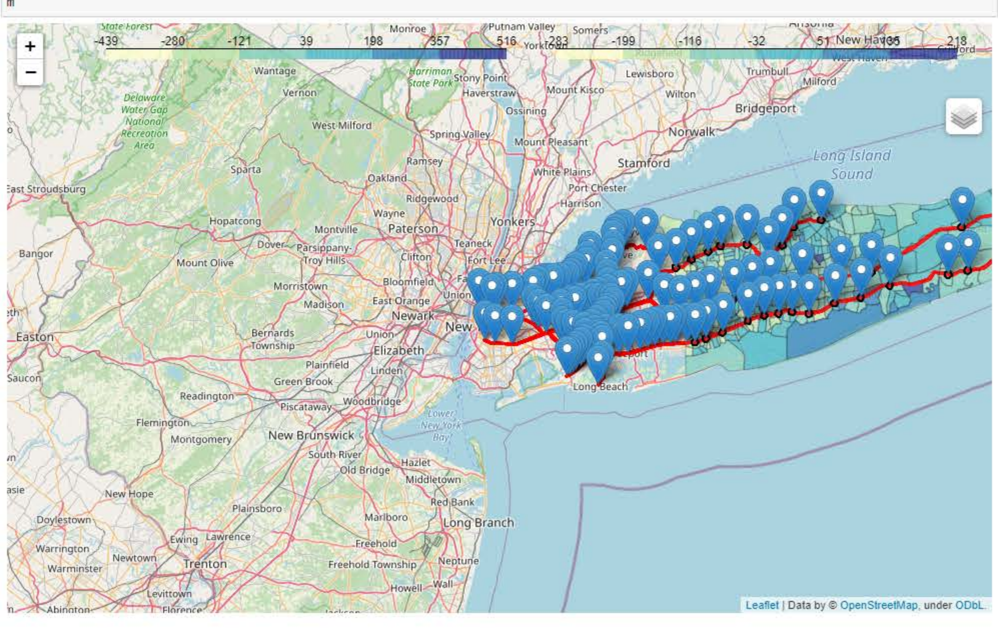
Out[53]: <folium.features.GeoJson at 0x7f319d0b9760>

In [54]:
```
folium.LayerControl().add_to(m)
```

Out[54]: <folium.map.LayerControl at 0x7f319cf5fbb0>

In [55]:
```
m
```

Out[55]:



Conclusion

Although we are testing out this coding stuff, we think it works! Now we can see the data of transit-area census and other non-tranist area census in one map. There's a lgend on the right we can use to select the layers. Also, every time we click the census, there would be pop out windows as well. For the next step, we are going to adopt this coding to all our dataset

In [ ]: