Best Neighborhoods for Housing - Massachusetts, USA

Capstone Project - The Battle of Neighbourhoods

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Introduction:

Massachusetts has 14 Counties, 39 Cities and 312 Towns. Mass is well endowed with neighborhoods that are active, vibrant, progressive, thoughtful, diverse, fun, friendly, filled with natural beauty and historic charm. This abundance in choice increases the complexity for home buyers in their decision-making process. While buying a home, the neighborhood matters the most, sometimes even higher than the home itself. With the help of Data Science, we are attempting to help "Young Home Buyers with Kids" to choose a neighborhood that supports an active lifestyle, surrounded by natural beauty, good education, safety, well connected public transport system based on the prevailing Median Pricing. The home buyer can then shop for homes within the neighborhood.

Target Audience:

Home Buyers - Young Family with Toddlers/Kids

Objective:

Our objective is to perform a detailed exploratory analysis and recommend a neighborhood by finding answers to the below:

1. Which Neighborhood has the most Parks & Recreation avenues for a young family with toddlers/kids?

- This covers Trails, Rivers, Beaches, Water fronts, Public Parks that support an active lifestyle in a nature backdrop for the family.

2. Which Neighborhood has the most Top-Rated Schools?

- This covers public Kindergarten, Elementary, Middle & High Schools that provide for good education and wholesome development of children in the family.

3. Which Neighborhood has the best transit score for easy commute?

- This covers public transport systems that enables the family to get around with ease.

4. **Which Neighborhood is safest with the least Crime Rate?**

- This covers the safety of the neighborhoods. Includes a total count of both, violent and property crime counts by city. Crime Rate is derived using total population.

5. Suggest Top 50 Best Neighborhoods in Massachusetts for a "Young Family with Kids" to own a home.

Why it is important?:

Massachusetts has multiple culturally rich, diverse, vibrant neighborhoods with varying home prices, often overwhelming and complicating the home buyer's decision making process. Our system attempts to simplify the process by recommending the Best 50 Neighborhoods in MA for a "Young Family with Kids" to own a home.

Data Sourcing:

1. We would need a list of Median Home Sale Prices of MA nieghborhoods (City/Zip Code level). Data can be sourced from RedFin, a National Real Estate Brokerage, https://www.redfin.com/blog/data-center/

Data Points - Zip Code, City, County, Median Sale Price.
For E.g.: 02148, Malden, 500000

2. We would need neighborhood specific information like Supermarkets, Trails, Parks, Water Fronts, Restaurants, Coffee Shops, Gyms etc. Data can be sourced with help of FOURSQUARE Developer Apps, https://foursquare.com/developers/apps

Data Points - Zip Code, City, Lattitue, Longitude, Venues, Venue Categories
Using Get_Venue API we can source the list of venues and venue category information around 5 KM radius of each Neighborhood.
For E.g.: 01906, Saugus, -71.0110, 42.4651, Breakheart Reservation, Trail

3. We would need list of public schools in a neighborhood and their progress and performance index information. Data can be sourced for the year 2017 from https://www.kaggle.com/ndalziel/massachusetts-public-schools-data

Data Points - Zip Code, City, County, School, School PPI etc.
For E.g.: 02478, Belmont, Middlesex, Belmont High, 100

4. We would need transit scores, walkability scores, bikeability scores of a neighborhood
Data can be sourced from https://www.walkscore.com/MA

Data Points - Zip Code, City, Walk Score, Transit Score, Bike Score etc.
For E.g.: 02138, Cambridge, 88, 74, 96

5. We need crime statistics for Mass by city or zip code
Data can be sourced from https://ucr.fbi.gov/crime-in-the-u.s/2018/crime-in-the-u.s.-2018/downloads/download-printable-files

Data Points - City, Population, No. of Violent Crimes, No. of Property Crimes etc.
For E.g.: Hoyolke, 40470, 191, 1640

6. We would need list of neighborhoods in MA with 1 set of latitude and longitude coordinates
We can source it from: https://public.opendatasoft.com/explore/dataset/us-zip-code-latitude-and-longitude/export/?refine.state=MA

Data Points - Zip Code, City, Latitude and Longitude
For E.g.: 01701, Framingham, -71.4162, 42.2793

7. We would need Zip Codes to City to County crossreference mapping
Data can be sourced from https://www.unitedstateszipcodes.org/ma/#zips-list

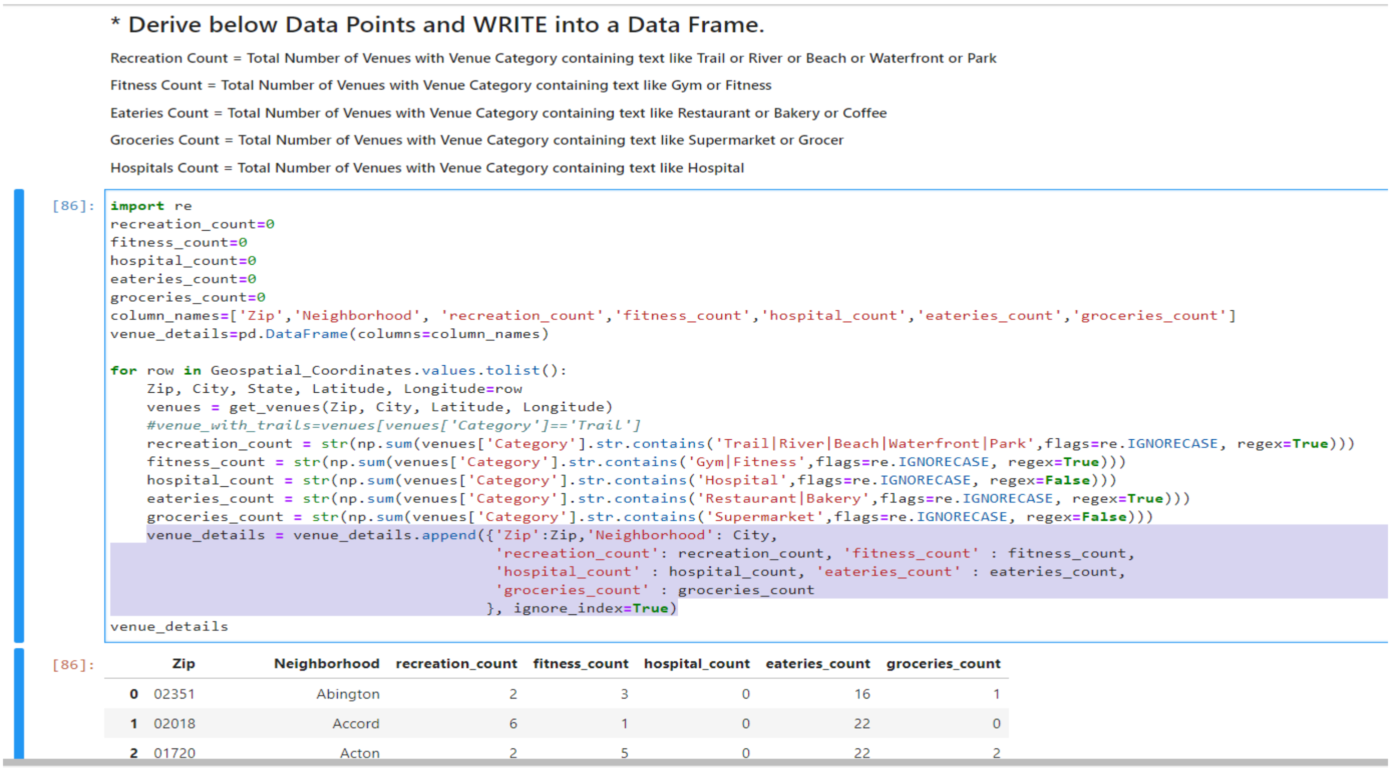
Data Points - Zip Code, City, County
For E.g.: 01020, Springfield, Hampden

8. We would need GeoJSON GeoSpatial Coordinates data of City boundaries for maps, choropleths. Data can be sourced from
http://maps-massgis.opendata.arcgis.com/datasets/43664de869ca4b06a322c429473c65e5_0.geojson

Data Points - City, GeoSpatial Lat, Long coordinates define polygonal shape boundaries of cities
For E.g.: QUINCY, (-70.987520657600399, 42.304533090819092), (-70.987515724246094, 42.304588167507383), (-70.98749032019883, 42.304654946893386), ..., (-70.960227444070043, 42.29578425180248)

Methodology:

1. Import necessary Python Libraries
2. **Data Sourcing, Cleansing & Wrangling – PRIMARY Data Set:**
    a. Source a MA Neighborhood list by Zip, City, Single Set of Latitude and Longitude Coordinates to indicating the Center of the Neighborhood
    b. Source and cleanse data to be used for Foursquare API calls
    c. Make Foursquare API Call, to pull All available Venues within 5Km radius of Center of a Neighborhood
    d. Pass Zip, City, Lat, Long. Source all the Venues and Venue Category data within 5Km Radius
    e. Transform Foursquare Output: Get Number of Recreational Venues. We derive it using the Venue Category information provided by Foursquare.
        i. Recreation Count = Total Number of Venues with Venue Category containing text like Trail or River or Beach or Waterfront or Park
        ii. Fitness Count = Total Number of Venues with Venue Category containing text like Gym or Fitness
        iii. Eateries Count = Total Number of Venues with Venue Category containing text like Restaurant or Bakery or Coffee
        iv. Groceries Count = Total Number of Venues with Venue Category containing text like Supermarket or Grocer
        v. Hospitals Count = Total Number of Venues with Venue Category containing text like Hospital



* Derive below Data Points and WRITE into a Data Frame.

Recreation Count = Total Number of Venues with Venue Category containing text like Trail or River or Beach or Waterfront or Park

Fitness Count = Total Number of Venues with Venue Category containing text like Gym or Fitness

Eateries Count = Total Number of Venues with Venue Category containing text like Restaurant or Bakery or Coffee

Groceries Count = Total Number of Venues with Venue Category containing text like Supermarket or Grocer

Hospitals Count = Total Number of Venues with Venue Category containing text like Hospital

[86]:

```python
import re
recreation_count=0
fitness_count=0
hospital_count=0
eateries_count=0
groceries_count=0
column_names=['Zip','Neighborhood', 'recreation_count','fitness_count','hospital_count','eateries_count','groceries_count']
venue_details=pd.DataFrame(columns=column_names)

for row in Geospatial_Coordinates.values.tolist():
    Zip, City, State, Latitude, Longitude=row
    venues = get_venues(Zip, City, Latitude, Longitude)
    #venue_with_trails=venues[venues['Category']=='Trail']
    recreation_count = str(np.sum(venues['Category'].str.contains('Trail|River|Beach|Waterfront|Park',flags=re.IGNORECASE, regex=True)))
    fitness_count = str(np.sum(venues['Category'].str.contains('Gym|Fitness',flags=re.IGNORECASE, regex=True)))
    hospital_count = str(np.sum(venues['Category'].str.contains('Hospital',flags=re.IGNORECASE, regex=False)))
    eateries_count = str(np.sum(venues['Category'].str.contains('Restaurant|Bakery',flags=re.IGNORECASE, regex=True)))
    groceries_count = str(np.sum(venues['Category'].str.contains('Supermarket',flags=re.IGNORECASE, regex=False)))
    venue_details = venue_details.append({'Zip':Zip,'Neighborhood': City,
                                          'recreation_count': recreation_count, 'fitness_count' : fitness_count,
                                          'hospital_count' : hospital_count, 'eateries_count' : eateries_count,
                                          'groceries_count' : groceries_count
                                         }, ignore_index=True)
venue_details
```

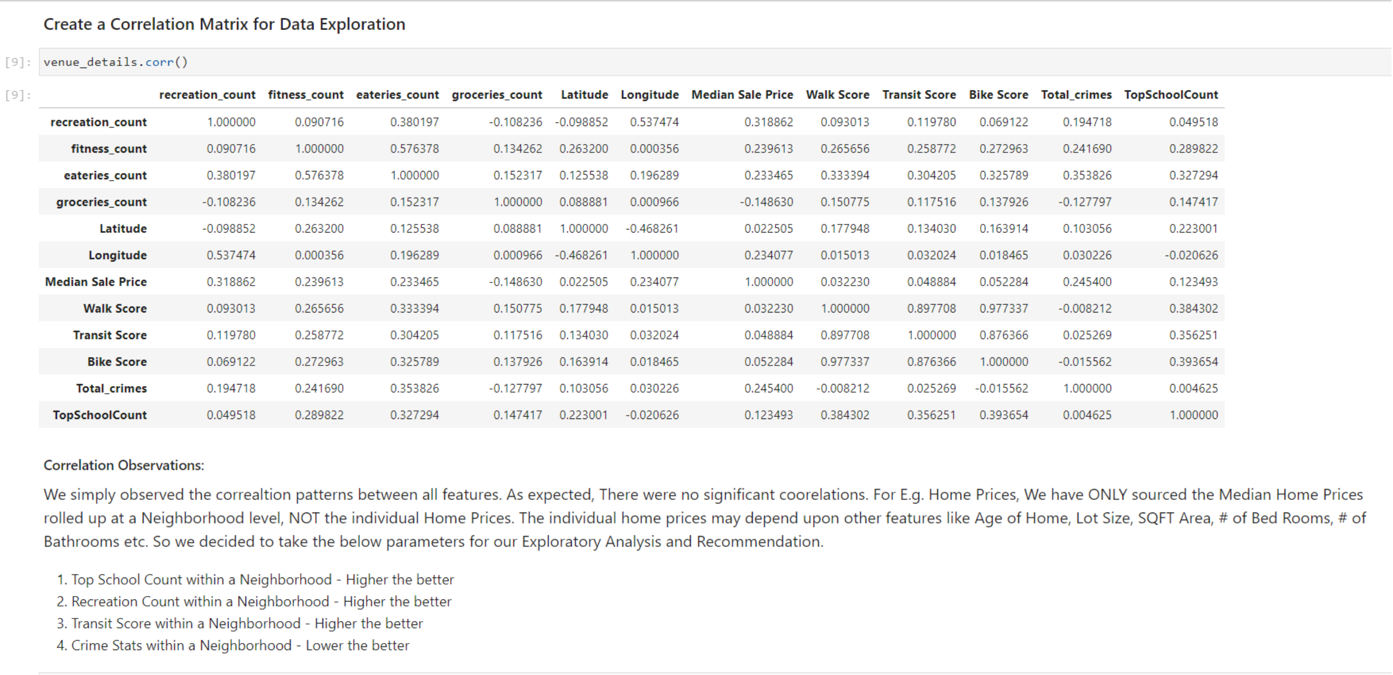
[86]:

	Zip	Neighborhood	recreation_count	fitness_count	hospital_count	eateries_count	groceries_count
0	02351	Abington	2	3	0	16	1
1	02018	Accord	6	1	0	22	0
2	01720	Acton	2	5	0	22	2

3. The resultant Venue Detail Counts with Zip, City, Lat, Long, will be our PRIMARY data set. The PRIMARY data set will be enhanced in the below steps by JOINING with data sets

4. **Data Sourcing, Cleansing & Wrangling – SECONDARY Data Sets:**
   a. Source Median Home Sale Prices for MA Neighborhoods
   b. Cleanse data to get the most recent Median Home Sale Prices at the City, Zip Code level. It's more of macro data rather than the micro individual home sale prices.
   c. Source Public School information for MA Neighborhoods
   d. Source and cleanse data to get the Number of schools and their Performance and Progress Index (PPI) within a neighborhood. Determine if they are best schools by comparing School PPI with Median School PPI (71%).
   e. Source Neighborhood Ratings - Transit Scores, Walkability Scores, Bikeability Scores
   f. Source Neighborhood Crime Statistics for MA Cities
   g. Source and cleanse data. Determine Total Crimes. Derive Crime Rate by using Population number.
   h. Merge/Join the PRIMARY and SECONDARY Data Sets

5. **Data Analysis & Data Visualization:**
6. Perform Correlation Analysis



Create a Correlation Matrix for Data Exploration

```
[9]: venue_details.corr()
```

[9]:

	recreation_count	fitness_count	eateries_count	groceries_count	Latitude	Longitude	Median Sale Price	Walk Score	Transit Score	Bike Score	Total_crimes	TopSchoolCount
recreation_count	1.000000	0.090716	0.380197	-0.108236	-0.098852	0.537474	0.318862	0.093013	0.119780	0.069122	0.194718	0.049518
fitness_count	0.090716	1.000000	0.576378	0.134262	0.263200	0.000356	0.239613	0.265656	0.258772	0.272963	0.241690	0.289822
eateries_count	0.380197	0.576378	1.000000	0.152317	0.125538	0.196289	0.233465	0.333394	0.304205	0.325789	0.353826	0.327294
groceries_count	-0.108236	0.134262	0.152317	1.000000	0.088881	0.000966	-0.148630	0.150775	0.117516	0.137926	-0.127797	0.147417
Latitude	-0.098852	0.263200	0.125538	0.088881	1.000000	-0.468261	0.022505	0.177948	0.134030	0.163914	0.103056	0.223001
Longitude	0.537474	0.000356	0.196289	0.000966	-0.468261	1.000000	0.234077	0.015013	0.032024	0.018465	0.030226	-0.020626
Median Sale Price	0.318862	0.239613	0.233465	-0.148630	0.022505	0.234077	1.000000	0.032230	0.048884	0.052284	0.245400	0.123493
Walk Score	0.093013	0.265656	0.333394	0.150775	0.177948	0.015013	0.032230	1.000000	0.897708	0.977337	-0.008212	0.384302
Transit Score	0.119780	0.258772	0.304205	0.117516	0.134030	0.032024	0.048884	0.897708	1.000000	0.876366	0.025269	0.356251
Bike Score	0.069122	0.272963	0.325789	0.137926	0.163914	0.018465	0.052284	0.977337	0.876366	1.000000	-0.015562	0.393654
Total_crimes	0.194718	0.241690	0.353826	-0.127797	0.103056	0.030226	0.245400	-0.008212	0.025269	-0.015562	1.000000	0.004625
TopSchoolCount	0.049518	0.289822	0.327294	0.147417	0.223001	-0.020626	0.123493	0.384302	0.356251	0.393654	0.004625	1.000000

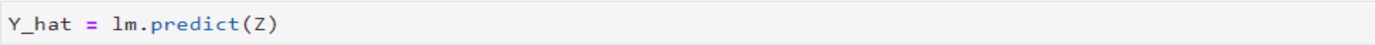
Correlation Observations:

We simply observed the correaltion patterns between all features. As expected, There were no significant coorelations. For E.g. Home Prices, We have ONLY sourced the Median Home Prices rolled up at a Neighborhood level, NOT the individual Home Prices. The individual home prices may depend upon other features like Age of Home, Lot Size, SQFT Area, # of Bed Rooms, # of Bathrooms etc. So we decided to take the below parameters for our Exploratory Analysis and Recommendation.

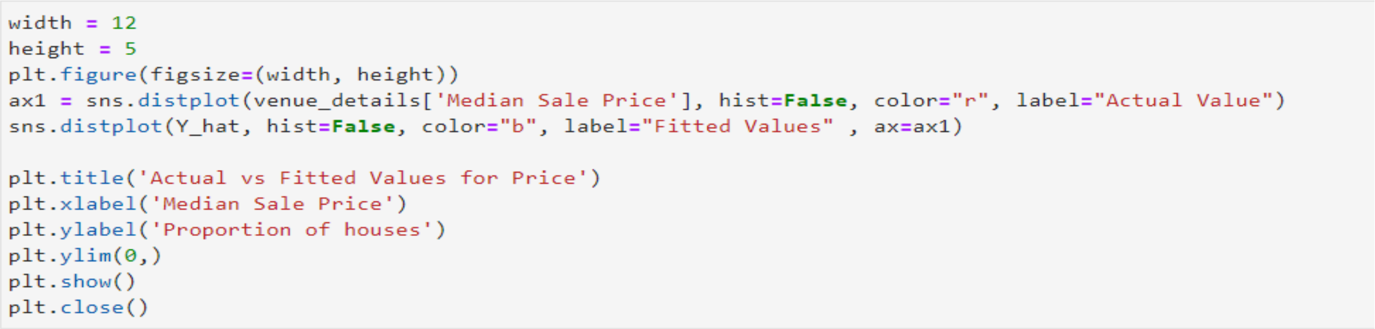
1. Top School Count within a Neighborhood - Higher the better
2. Recreation Count within a Neighborhood - Higher the better
3. Transit Score within a Neighborhood - Higher the better
4. Crime Stats within a Neighborhood - Lower the better

7. Perform Regression Plot Analysis
8. Source GeoJSON file for MA Cities - GeoSpatial Coordinates data of City boundaries for maps, choropleths

9. Multiple Linear Regression

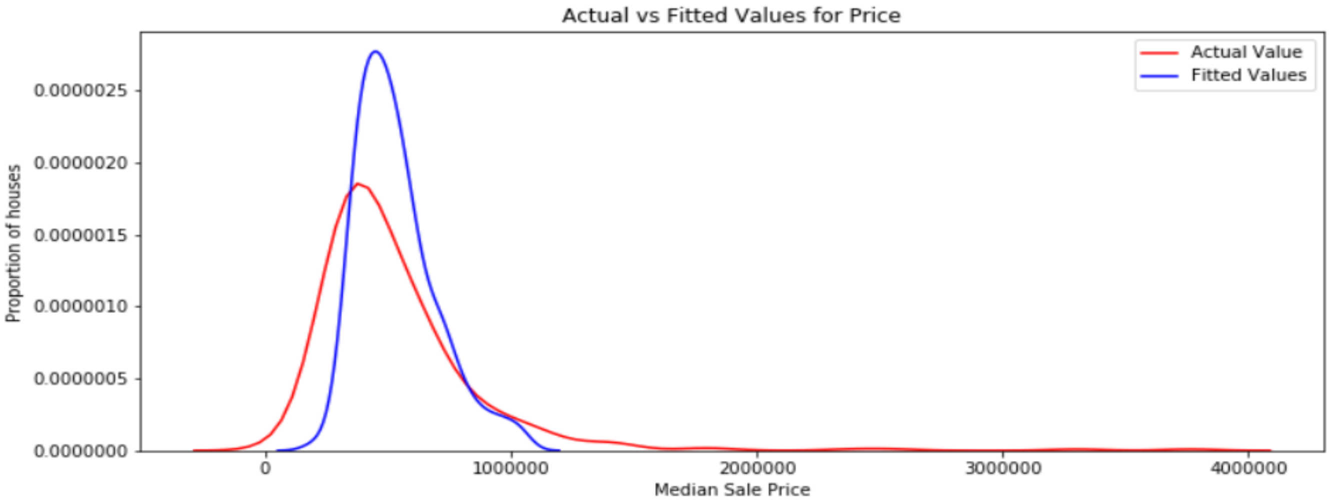


```
Y_hat = lm.predict(Z)
```

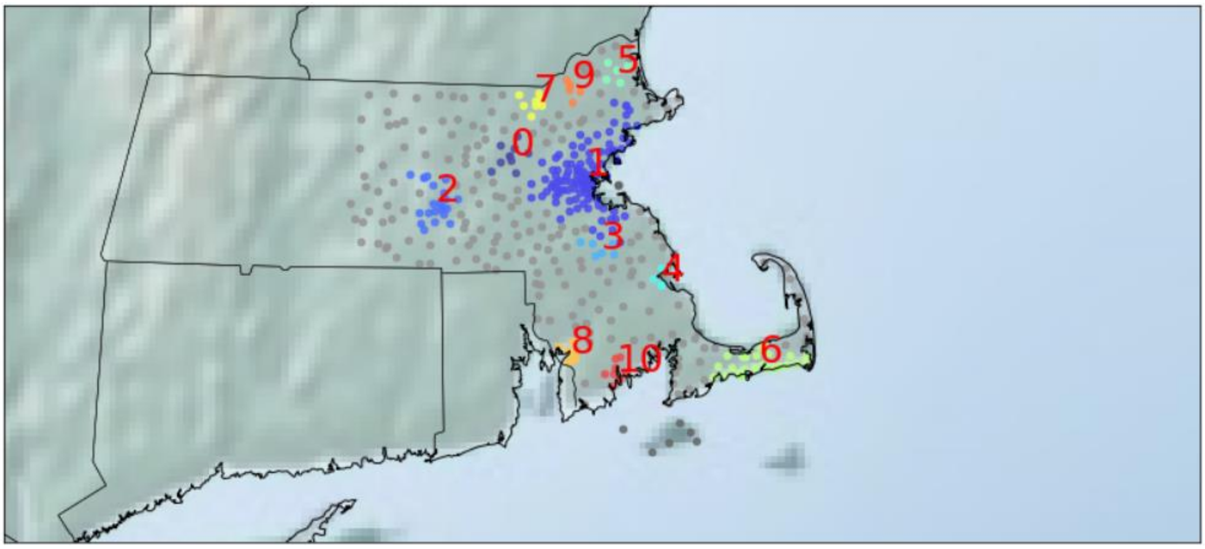


```
width = 12
height = 5
plt.figure(figsize=(width, height))
ax1 = sns.distplot(venue_details['Median Sale Price'], hist=False, color="r", label="Actual Value")
sns.distplot(Y_hat, hist=False, color="b", label="Fitted Values" , ax=ax1)

plt.title('Actual vs Fitted Values for Price')
plt.xlabel('Median Sale Price')
plt.ylabel('Proportion of houses')
plt.ylim(0,)
plt.show()
plt.close()
```

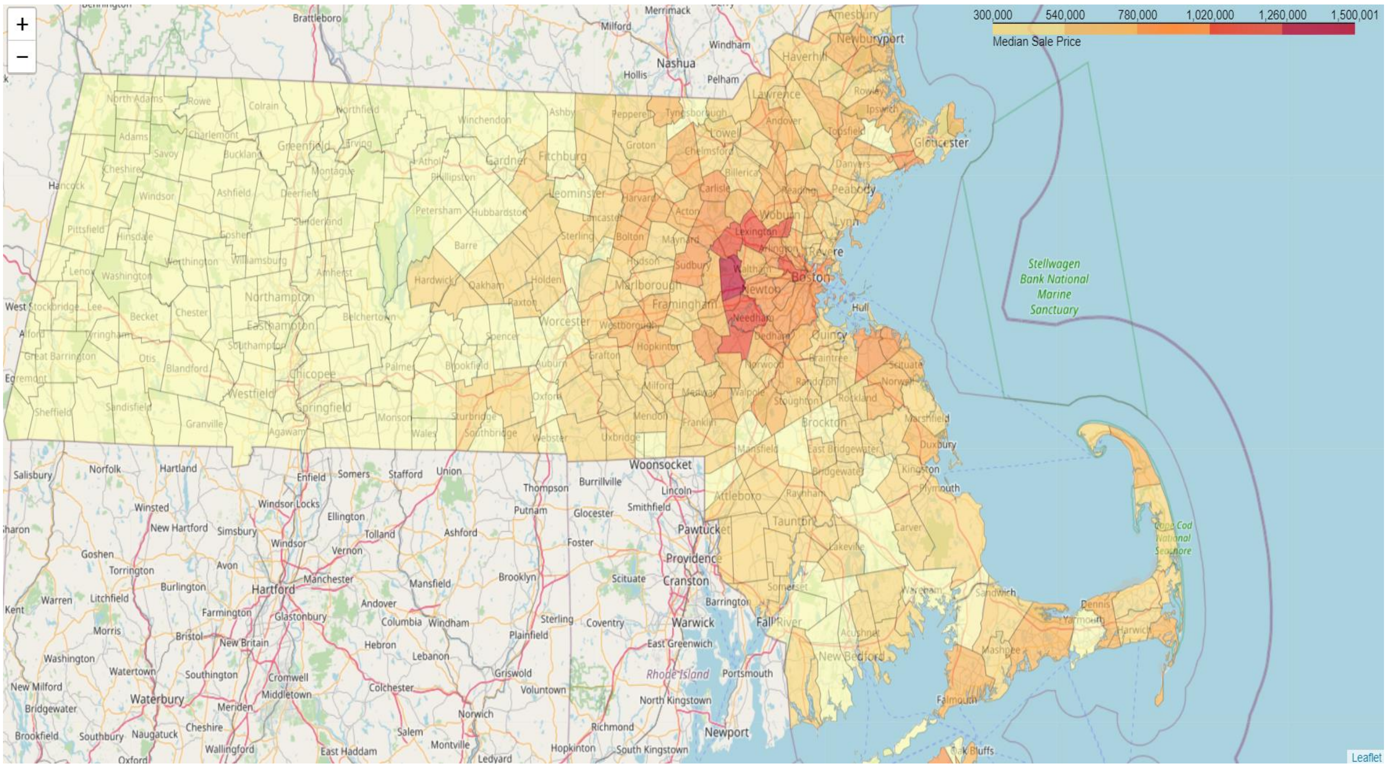


10. Plot Density Based Spatial Clustering (DBSCAN) Results - Based on Latitude & Longitude to show Median Home Prices

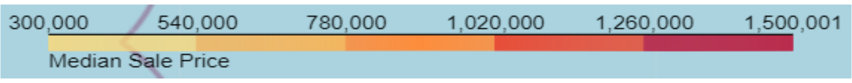


11. Create Choropleths to Show Median Home Prices per City

bos_map_home_price
.html



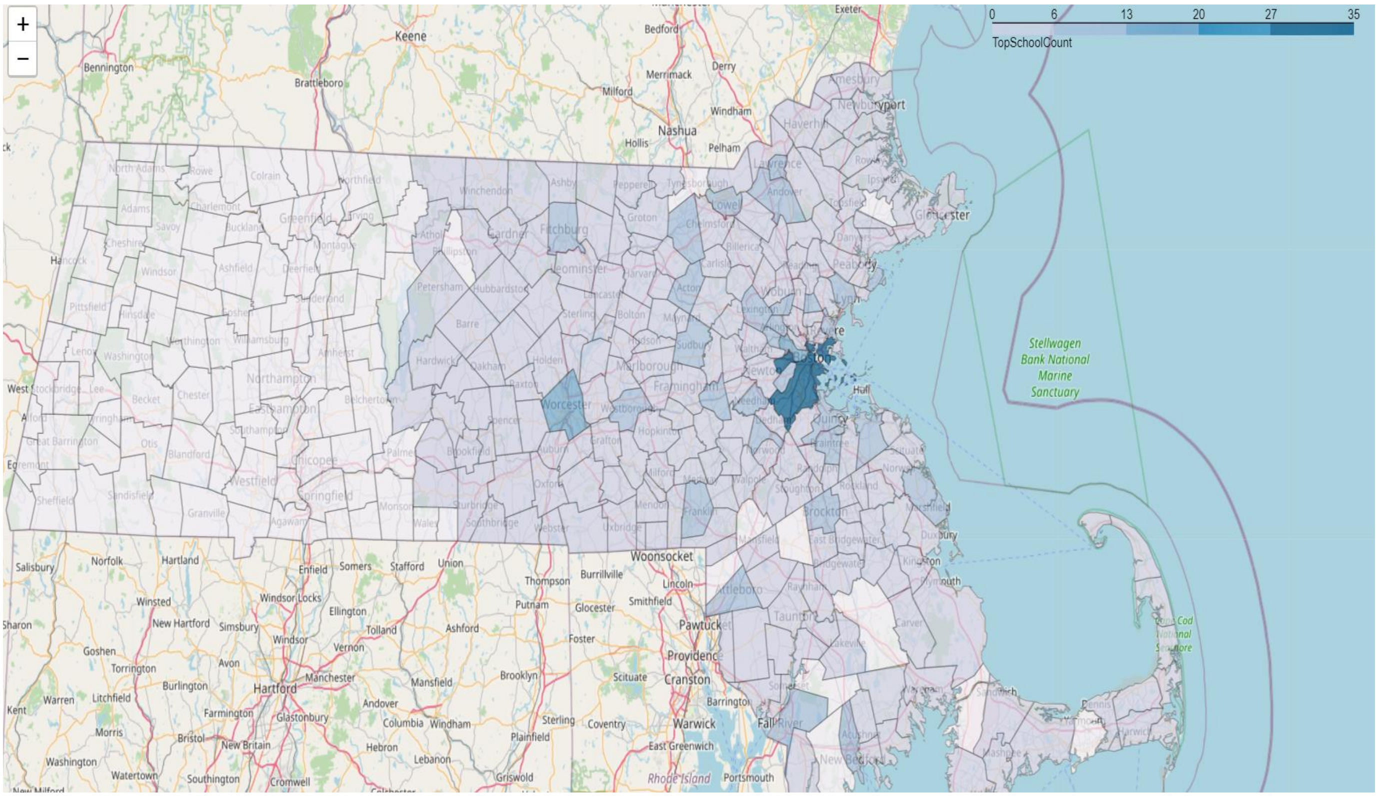
Legend: The **Darker** the shade the **Higher** the **Median Home Price** in the neighborhood.



12. Create Choropleths to Show Best School Counts per City

school_map.html

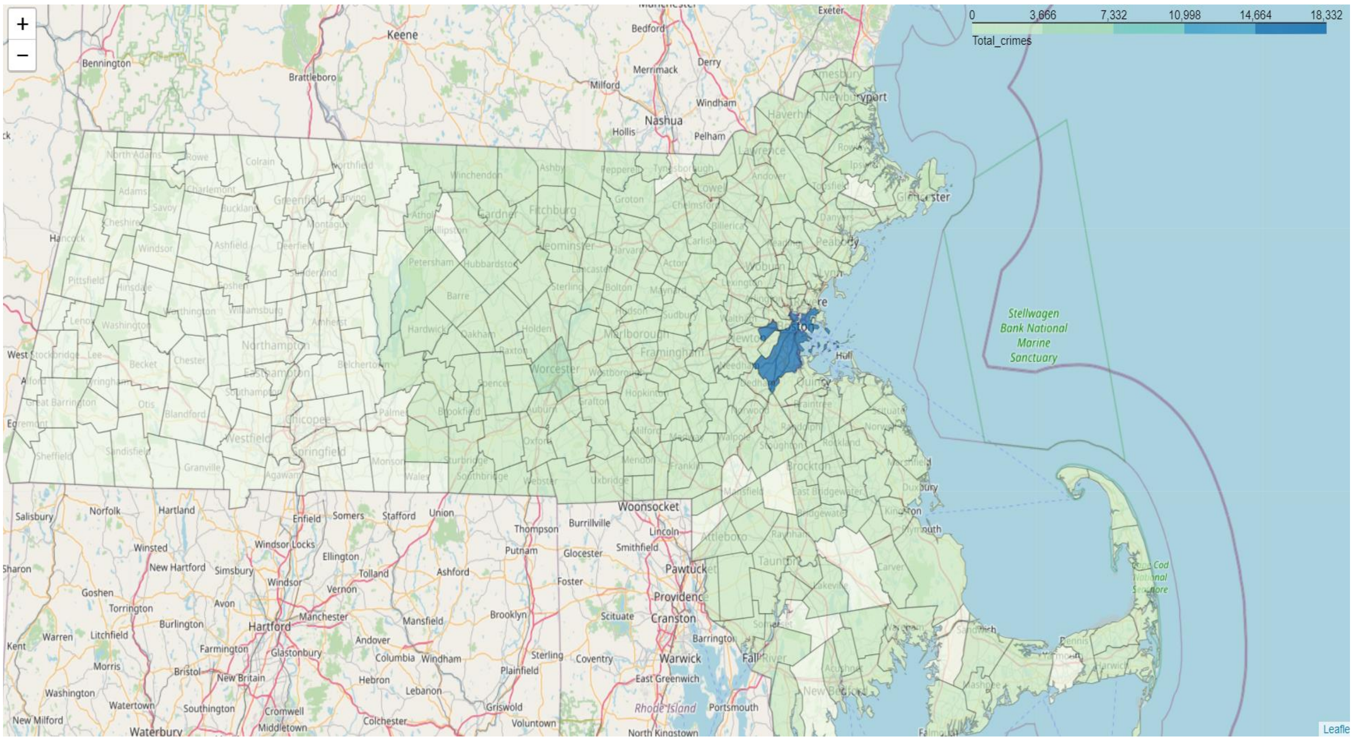
Legend: The **Darker** the shade the **Higher** the **Number of Top Rated Schools** in the neighborhood.



13. Create Choropleths to Show Crime per City

crm_map.html

Legend: The **Darker** the shade the **Higher** the **Number of Crimes** in the neighborhood.



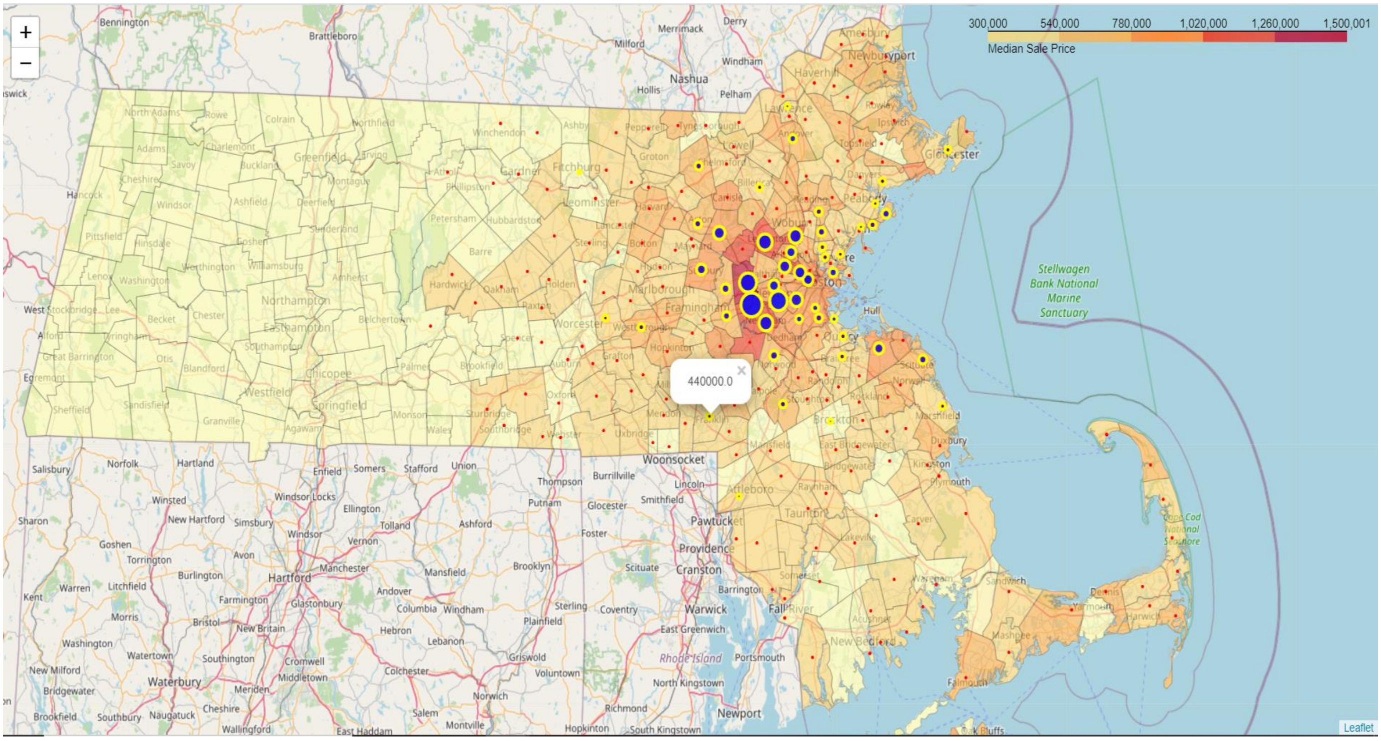
14. Determine the Best 50 Neighborhoods. Super Impose maps to show the Best 50 Neighborhoods in MA for Young Family with Kids to buy a home.

conclusion.html

Legend:

● : Indicates Best Neighborhoods in Massachusetts. The **Bigger** the circle the **Greater** is the Median Price of homes in that Neighborhood.

●: Indicates the Crime Rate (Number of Crimes Per Person) in the Neighborhood.



Discussion & Conclusion:

The answers to our business problems discussed above:

1. Which Neighborhood has the most Parks & Recreation avenues for a young family with toddlers/kids?

   The Top 10 Neighborhoods with most recreation avenues:

   Nahant
   Brewster
   Lynn
   Orleans
   Prides Crossing
   Swampscott
   North Eastham
   West Dennis
   North Chatham
   Marblehead

2. Which Neighborhood has the most Best Public Schools?

   The Top 10 Neighborhoods with best public schools:

   Braintree
   Boston
   Franklin
   Natick
   Winchester
   Attleboro
   Andover
   Westford
   Westwood
   Revere

3. Which Neighborhood has the best transit score for easy commute?

   The Top 10 Neighborhoods with best transit scores:

   Cambridge
   Boston
   Brookline
   Somerville
   Chelsea
   Revere
   Malden
   Medford
   Everett
   Quincy

4. Which Neighborhood is safest with the least Crime Rate?

The Top 10 Neighborhoods with least crime rates:

Wayland
New Braintree
Princeton
Chilmark
Dover
Nahant
Oakham
Boylston
Wenham
Paxton

5. Suggest Top 50 Best Neighborhoods in Massachusetts for a "Young Family with Kids" to own a home.

The Top 50 Neighborhoods in MA for "Young Family with Kids" to own a Home are:

Braintree, Boston, Natick, Franklin, Winchester, Attleboro, Westwood, Andover, Westford, Revere, Newton Center, Belmont, Melrose, Fitchburg, Marblehead, Hingham, Marshfield, Lexington, Wellesley Hills, Acton, Sudbury, Westborough, Everett, Lynn, Lawrence, Brockton, Salem, Gloucester, Wakefield, Quincy, Newtonville, Cambridge, Concord, Weston, Scituate, Sharon, Billerica, Shrewsbury, Cambridge, Boston, Malden, Quincy, Arlington, Needham, Swampscott, Brookline, Boston, Beverly, Roslindale & Wayland.