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1. Introduction - Business Problem

Dublin is the capital and largest city of Ireland. Situated on a bay on the east coast, at the mouth of the River Liffey, the city encompasses a land area of approximately 922 km² in east-central Ireland with a population of 1,345,402 and a population density of 4,811/km² (12,460/sq. mi). Dublin County has more than 27 postal districts of which we are targeting North Dublin and South Dublin with 22 (D01–D18, D6W, D20, D22, D24) postal districts.

I was in Dublin for 1 year on an assignment and for the first few weeks I was given accommodation in a hotel where I ended up staying for a month paying for the hotel accommodation as I was not able to find an apartment to stay. It was so hard for me to find a double bed room apartment for rent nearby Dublin City Center and with lower cost.

Since there are lots of apartments in Dublin South/North Districts we will try to detect locations that are closer to the Dublin City and apartments that are at lower cost.

When we consider all these problems, we can create a map and information chart where the apartment cost is placed on Dublin and each district is clustered according to the venue density.

Target Audience

Fingal's Housing Community Agency is a community driven agency that helps people in buying and renting Houses/Apartments. To recommend the optimal apartment, Fingal's Housing Community Agency has appointed me into their Data Science team. The objective is to locate and recommend to the Housing Management which neighborhood of Dublin city will be best to rent an apartment. The Management also expects to understand the rationale of the recommendations made so that the Fingal's Housing Community Agency could recommend those apartments to the people who are looking to rent.

This project will be useful for people who are looking to rent a low cost apartment near to Dublin City.

2. Data Description

To consider the problem we can list the dataset as below:

The Dataset will be created by Web scrapping of [Residential Tenancies Board \(RTB\)](#) statistics hosted by the [Central Statistics Office \(CSO\)](#)

1. Dataset of 2 Bed Apartment Data with Borough and Neighborhoods.

a. For the project we have filtered relevant categories of data from RTB

- Number of Bedrooms = Two Bed
- Property Type = Apartment
- Location = D01–D18, D6W, D20, D22, D24 postal districts
- Time Duration = Quarterly Data from 2015 to 2019 (Q1)

b. Generated [report](#) with below columns.

Property Type Number of Bedrooms Location 2015Q1 2015Q2 2015Q3 2015Q4 2016Q1 2016Q2 2016Q3 2016Q4 2017Q1 2017Q2 2017Q3 2017Q4 2018Q1 2018Q2 2018Q3 2018Q4 2019Q1

- c. Web Scrapping html tabular report which was generated from above filtered categories into pandas data frame.
- d. Cleaned up all missing values.
- e. Average apartment rent for all the years for each Neighborhood and Y-Y percentage rise for Years 2018 and 2019 for each Neighborhood.

2. Geo coordinates were automatically generated algorithmically for all Neighborhoods using **geopy.geocoders** and populated that data into Latitude and Longitude.

3. Distance from Dublin City Center to all the Neighborhoods were automatically generated using **geopy.distance**.

4. Foursquare API was used to get the most common venues for all the Neighborhoods of Dublin Districts with a limit of 100 and a radius of 500.

These columns were fetched from json response

Venue.id	=	Venue ID
Venue.name	=	Venue Name
Venue.Location[lat][lon]	=	Venue Latitude and Longitude
Venue.Categories.name	=	Venue Category Name
Venue.Location.address	=	Venue Address formatted
Venue.Location.distance	=	Venue Distance

Property Type	Number of Bedrooms	Borough	Neighbourhood	Latitude	Longitude	2015Q1	2015Q2	2015Q3	2015Q4	...	2018Q3	2018Q4	2019Q1	Distance_from_City_Center_miles	avgAptRent
Apartment	Two bed	Dublin	Dublin	53.349764	-6.260273	1203.10	1224.80	1271.08	1274.81	...	1557.85	1579.17	1605.37	1.0	1395
Apartment	Two bed	Balbriggan	Dublin	53.609832	-6.186196	806.56	824.96	840.79	861.38	...	1088.56	1118.25	1126.03	18.2	967
Apartment	Two bed	Blackrock	Dublin	53.301864	-6.178834	1403.09	1431.49	1462.82	1467.62	...	1726.35	1735.95	1779.98	4.7	1587
Apartment	Two bed	Boooterstown	Dublin	53.308629	-6.196652	1411.06	1452.15	1459.70	1484.88	...	1805.39	1830.86	1871.69	3.9	1607
Apartment	Two bed	Donabate	Dublin	53.481800	-6.154880	925.00	957.98	978.41	992.05	...	1239.22	1252.57	1253.95	10.1	1117

3. Methodology

In this project we will direct our efforts on identifying areas near to Dublin City that have lowest apartment rent, particularly those are near with lower rent. We will limit our analysis to area ~6.2mi around city center as we can drive easily.

- a. In first step we have collected the required **data: locations within 6.2mi from Dublin City Center**.
- b. In the second step in our analysis we have collected the **required data: apartments rent that's less than 1500 euros in all Borough's**.

We have also collected Foursquare data for each Borough that fall under criteria 1 (≤ 6.2) and criteria 2 (apartment cost ≤ 1500) with a limit as 100 venues and the radius 1000 meters

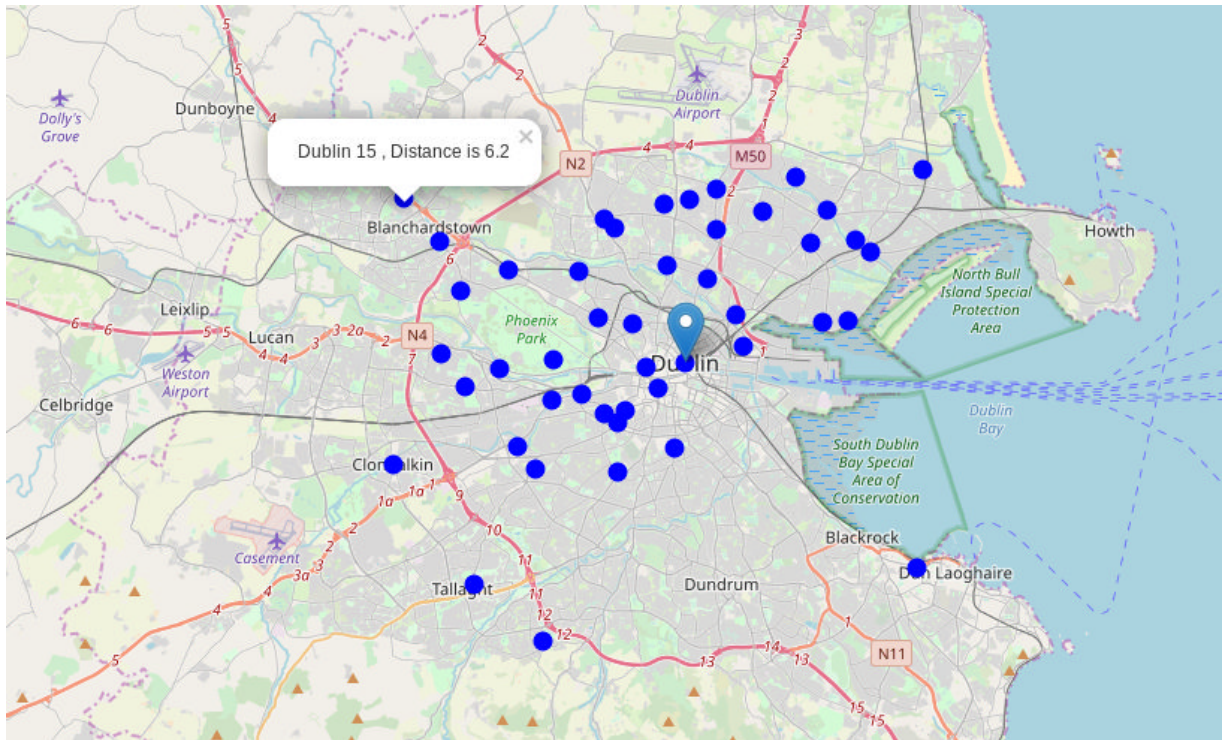
- c. In third step we have used unsupervised learning **K-means algorithm** to cluster the boroughs on avgAptrent.
- d. In final step we will focus on most promising areas. Using folium map we will take into consideration locations that are **closer to Dublin City Center and have lowest apartment rent**.

4. Exploratory Data Analysis

After filtering data - Locations within 6.2mi and Apartment rent of less than 1500 euros we got 46 matching Locations.

Locations within 6.2mi from Dublin City Center : 76
Apartments with rent less than 1500 euros: 66
Locations with both conditions met: 46

We will create a map using **Folium Library** to visualize geographical coordinates. Let's **Marker Dublin Center** and **CircleMaker** all Dublin boroughs from the refined locations data.



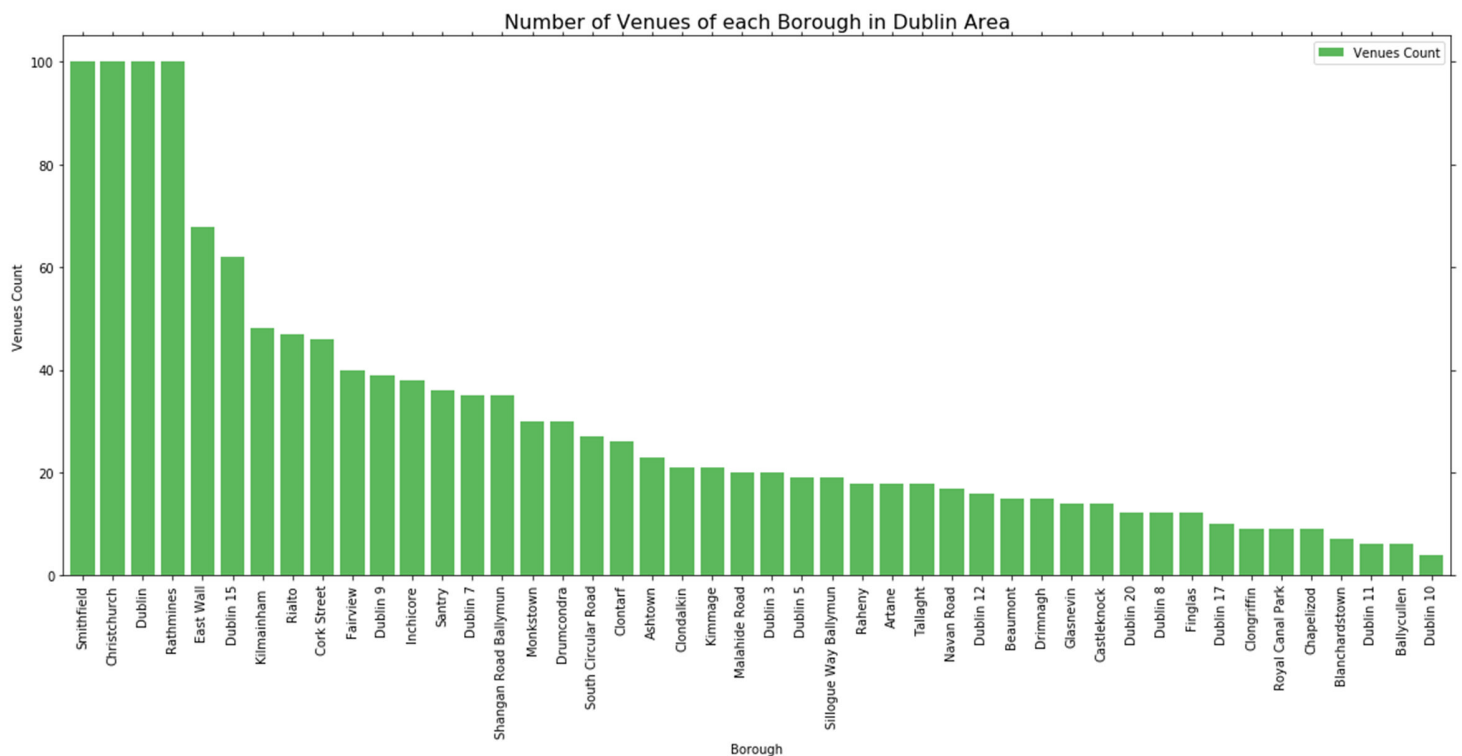
Foursquare API was used to fetch Venue information for each borough. We have used limit as 100 and radius as 1000 meter for each borough given latitude and longitude information. Venue information returned for each Borough from Foursquare API was mapped into a dataframe.

	Borough	Neighborhood Latitude	Neighborhood Longitude	Venue ID	Venue Name	Venue Latitude	Venue Longitude	Venue Category	Venue Address	Venue Distance
0	Dublin	53.349764	-6.260273	4bb9e25e1261d13ae1efe998	Pull&Bear	53.349533	-6.262053	Clothing Store	22-23 Henry St, Dublin, Dublin City, Ireland	121
1	Dublin	53.349764	-6.260273	51093750e4b0e991dc341337	Vice Coffee Inc.	53.347915	-6.262327	Coffee Shop	54 Middle Abbey St, Dublin, Dublin City, Ireland	247
2	Dublin	53.349764	-6.260273	5092a33be4b0eedd3968e593	Dealz	53.350623	-6.263183	Discount Store	44-45 The Ilac Centre, Moore Street Moore St, ...	215
3	Dublin	53.349764	-6.260273	5187b38b498e68948f3a969d	Gino's Gelato	53.349573	-6.261846	Ice Cream Shop	41 Henry St, Dublin, Dublin City, Ireland	106
4	Dublin	53.349764	-6.260273	4ade0f17f964a520177121e3	Abbey Theatre	53.348542	-6.257492	Theater	26 Lwr Abbey St, Dublin, Dublin City, Ireland	229

We can see that few Boroughs reached 100 venues list whereas few are below 10. Below is the venues count for each Borough.

	Borough	Venues Count
0	Artane	18
1	Ashtown	23
2	Ballycullen	6
3	Beaumont	15
4	Blanchardstown	7
5	Castleknock	14
6	Chapelizod	9
7	Christchurch	100
8	Clondalkin	21
9	Clongriffin	9

The result shows that Foursquare API request was executed for all borough's Latitude and Longitude information. Let's plot the venues count in bar plot for each borough.



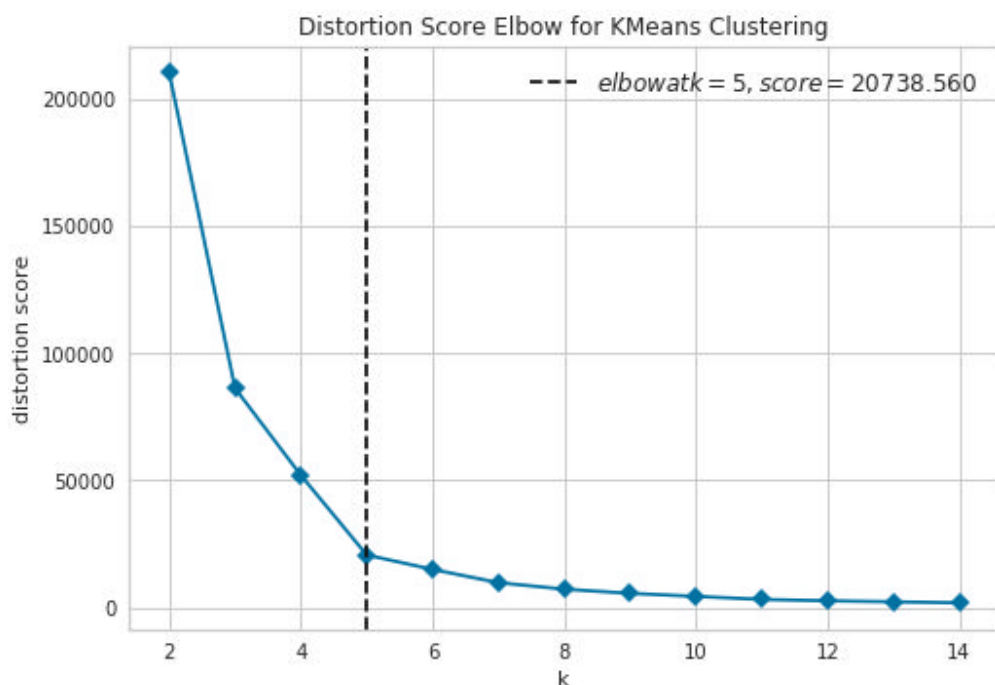
The results show that 189 unique categories are returned for all borough's latitude and longitude information using Foursquare API. Out of the returned venues for each borough we will show data of top 10 most common venues for each borough.

	Borough	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Artane	Grocery Store	Supermarket	Ice Cream Shop	Pharmacy	Sports Club	Fast Food Restaurant	Bus Stop	Shopping Mall	Chinese Restaurant	Pub
1	Ashtown	Train Station	Sports Club	Park	Café	Canal Lock	Sporting Goods Shop	Bar	Coffee Shop	Restaurant	Gym
2	Ballycullen	Convenience Store	Supermarket	Mountain	Pharmacy	Chinese Restaurant	Indian Restaurant	Arts & Crafts Store	Furniture / Home Store	French Restaurant	Food Truck
3	Beaumont	Supermarket	Café	Fast Food Restaurant	Sandwich Place	Other Great Outdoors	Electronics Store	Coffee Shop	Athletics & Sports	Bus Stop	Convenience Store
4	Blanchardstown	Supermarket	Hotel	Bar	Steakhouse	Pub	Thai Restaurant	Food & Drink Shop	Fish & Chips Shop	Film Studio	Fast Food Restaurant
5	Castleknock	Chinese Restaurant	Café	Park	Bakery	Pub	Italian Restaurant	Asian Restaurant	Gastropub	Farm	Supermarket
6	Chapelizod	Convenience Store	Chinese Restaurant	Café	Gastropub	Park	Golf Course	Grocery Store	Pub	Hotel	Dessert Shop
7	Christchurch	Pub	Café	Coffee Shop	Restaurant	Cocktail Bar	Historic Site	Pizza Place	Bar	Bakery	Burrito Place
8	Clondalkin	Restaurant	Bar	Fast Food Restaurant	Convenience Store	Coffee Shop	Chinese Restaurant	Supermarket	Italian Restaurant	Garden Center	Park
9	Clongriffin	Park	Food & Drink Shop	Fish & Chips Shop	Italian Restaurant	Auto Garage	Badminton Court	Chinese Restaurant	Grocery Store	Train Station	Zoo Exhibit

In order to find optimal location and show useful data we have grouped all common venues and joined top 3 grouped venues for each borough.

	Borough	Top3Venues
0	Artane	3 Grocery Store, 2 Ice Cream Shop, 2 Supermarket
1	Ashtown	4 Train Station, 2 Sports Club, 2 Park
2	Ballycullen	1 Supermarket, 1 Pharmacy, 1 Mountain
3	Beaumont	2 Café, 2 Fast Food Restaurant, 2 Supermarket
4	Blanchardstown	2 Supermarket, 1 Thai Restaurant, 1 Steakhouse
5	Castleknock	2 Café, 2 Park, 2 Chinese Restaurant
6	Chapelizod	1 Convenience Store, 1 Pub, 1 Park
7	Christchurch	9 Café, 8 Coffee Shop, 3 Bar
8	Clondalkin	2 Bar, 2 Chinese Restaurant, 2 Convenience Store
9	Clongriffin	1 Italian Restaurant, 1 Train Station, 1 Park

As our goal is to find low cost apartment which is near to Dublin city center in all boroughs, we will cluster the average Apartment Rent using **k-means algorithm (elbow method)**. K-Means algorithm is one of the most common cluster methods of unsupervised learning. We will visualize the data of k-means algorithm elbow method using **KElbowVisualizer**.



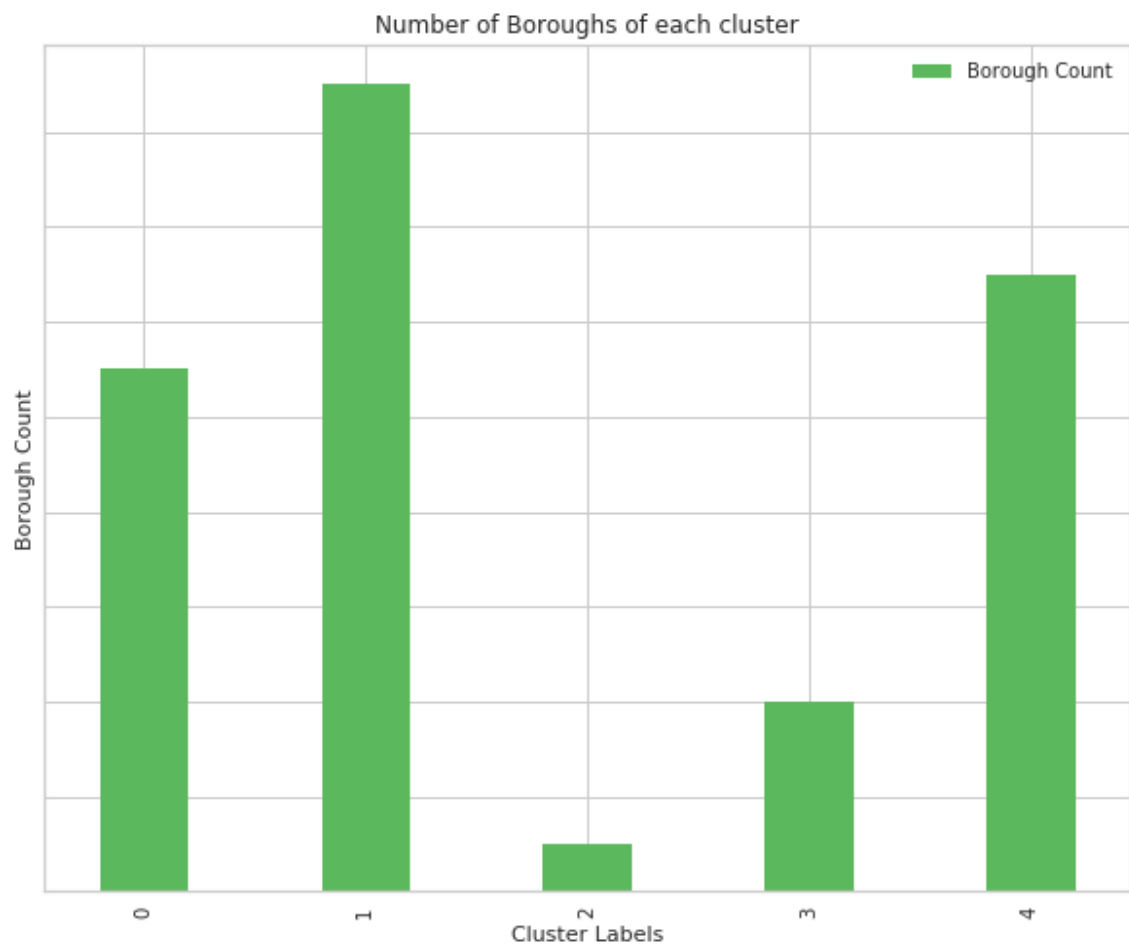
k-means elbow method shows that the optimum value for **k** is **5**.

Now we will cluster the boroughs data into **5 clusters** using K-Means.

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent
0	Dublin	53.349764	-6.260273	1.0	4	1395
8	Monkstown	53.293645	-6.153902	5.9	4	1438
21	Dublin 3	53.361223	-6.185467	3.2	4	1437
22	Clontarf	53.360814	-6.196854	2.7	4	1458
23	East Wall	53.354069	-6.233519	1.1	4	1428

Results of boroughs count for each cluster.

	Cluster Labels	Borough Count
0	0	11
1	1	17
2	2	1
3	3	4
4	4	13



We will label each cluster for better understanding of average apartment rent.

Cluster 0	:	Low Range
Cluster 1	:	Mid-Range Level-1
Cluster 2	:	Mid-Range Level-2
Cluster 3	:	High Range Level-1
Cluster 4	:	High Range Level-2

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name
0	Dublin	53.349764	-6.260273	1.0	4	1395	High-Range Level-2
1	Monkstown	53.293645	-6.153902	5.9	4	1438	High-Range Level-2
2	Dublin 3	53.361223	-6.185467	3.2	4	1437	High-Range Level-2
3	Clontarf	53.360814	-6.196854	2.7	4	1458	High-Range Level-2
4	East Wall	53.354069	-6.233519	1.1	4	1428	High-Range Level-2
5	Fairview	53.362846	-6.236656	1.3	0	1332	High-Range Level-1
6	Dublin 5	53.383454	-6.181923	4.0	0	1333	High-Range Level-1
7	Artane	53.382500	-6.202500	3.3	1	1256	Mid-Range Level-2
8	Raheny	53.380198	-6.175146	4.1	4	1415	High-Range Level-2
9	Rathmines	53.326520	-6.264857	1.6	4	1447	High-Range Level-2

For better understanding we will group the data on 'Distance to City Centre in Miles' in the following manner. We have 46 boroughs and this miles count returned same number. We will use this miles count in our further study in this project.

Less than 1 Mile	=	1 Mile Radius
Between 1 and 3 Mile Radius	=	3 Mile Radius
Between 3 and 5 Mile Radius	=	5 Mile Radius
Between 5 and 7 Mile Radius	=	7 Mile Radius
More than 7 Mile Radius	=	10 Mile Radius

Distance_from_City_Center_miles	Count	
0	2.6	3
1	5.9	3
2	4.1	2
3	3.5	2
4	1.9	2
5	0.7	2
6	3.1	2
7	5.8	2
8	3.3	2
9	1.6	2

Miles	Count	
0	3	19
1	7	7
2	5	17
5	1	3

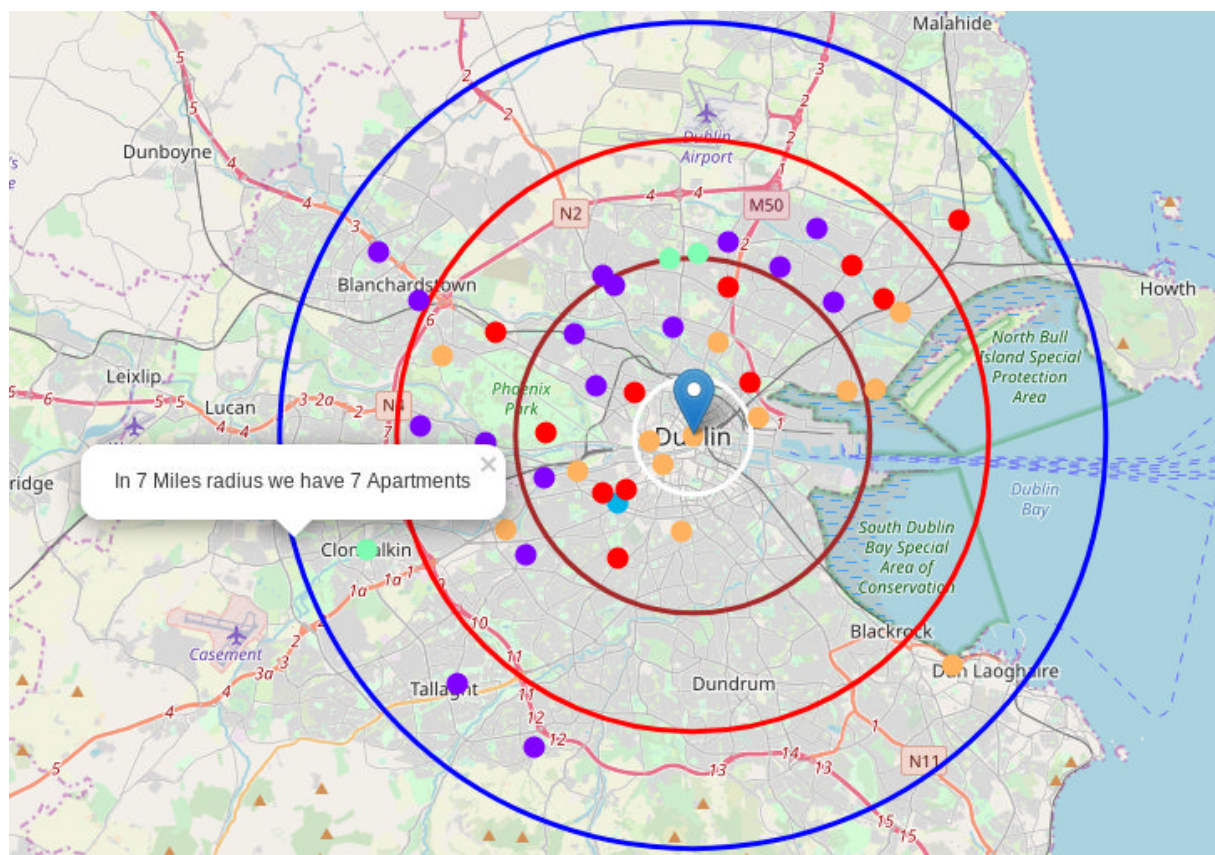
5. Results

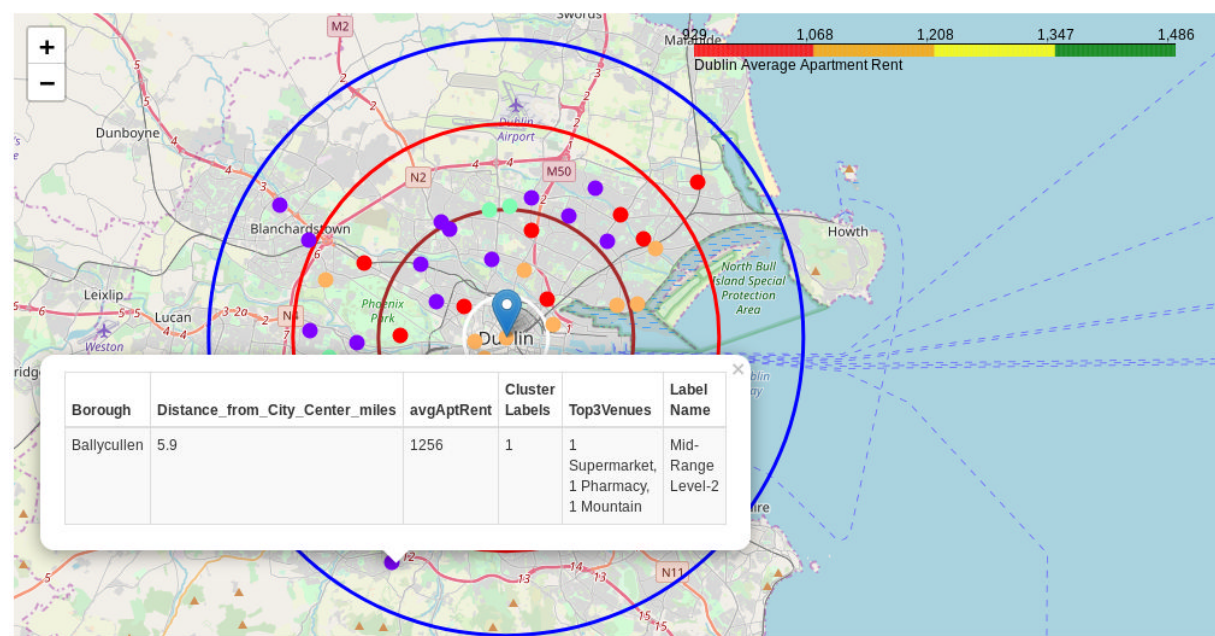
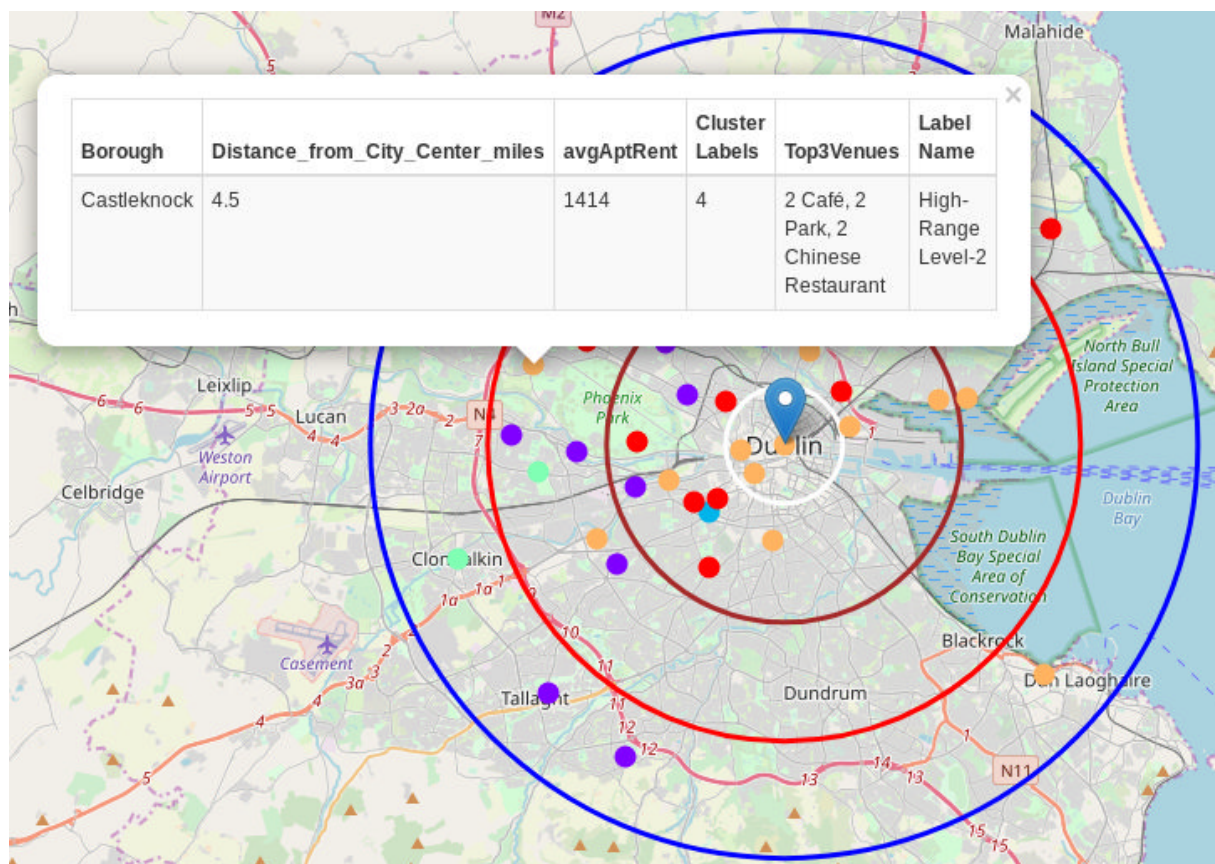
Results have been presented by merging all new variables and present the final dataframe.

Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
Dublin	53.349764	-6.260273		1.0	4	1395	High-Range Level-2 9 Café, 4 Coffee Shop, 2 Clothing Store	Pub	Café	Restaurant	Coffee Shop	Hotel	Italian Restaurant	Cocktail Bar	Gastropub	Clothing Store	Korean Restaurant
Monkstown	53.293645	-6.153902		5.9	4	1438	High-Range Level-2 3 Café, 3 Pub, 2 Train Station	Café	Pub	Train Station	Bar	Coffee Shop	Supermarket	Food & Drink Shop	Breakfast Spot	Steakhouse	Chinese Restaurant
Dublin 3	53.361223	-6.185467		3.2	4	1437	High-Range Level-2 2 Fish & Chips Shop, 2 Grocery Store, 2 Italia...	Beach	Italian Restaurant	Modern European Restaurant	Grocery Store	Fish & Chips Shop	Pub	Thai Restaurant	Harbor / Marina	Indian Restaurant	Supermarket
Clontarf	53.360814	-6.196854		2.7	4	1458	High-Range Level-2 3 Hotel, 2 Sports Club, 2 Restaurant	Hotel	Restaurant	Sports Club	Fish & Chips Shop	Italian Restaurant	Pub	Thai Restaurant	Scenic Lookout	Park	Café
East Wall	53.354069	-6.233519		1.1	4	1428	High-Range Level-2 7 Coffee Shop, 4 Bar, 3 Café	Coffee Shop	Bar	Tram Station	Café	Pizza Place	Pub	Deli / Bodega	Convenience Store	River	Italian Restaurant

We will plot this data into map using folium library. In the map we will use **Circle** for the distance to city center miles grouped data, **colormap** for the min and max average apartment rent, **CircleMarker** for each clustered boroughs with different colors for each cluster. We will present the below information for borough as html popup.

- Borough
- Distance to City Centre
- Average Apartment Rent
- Cluster Labels
- Top 3 Venues
- Label Name

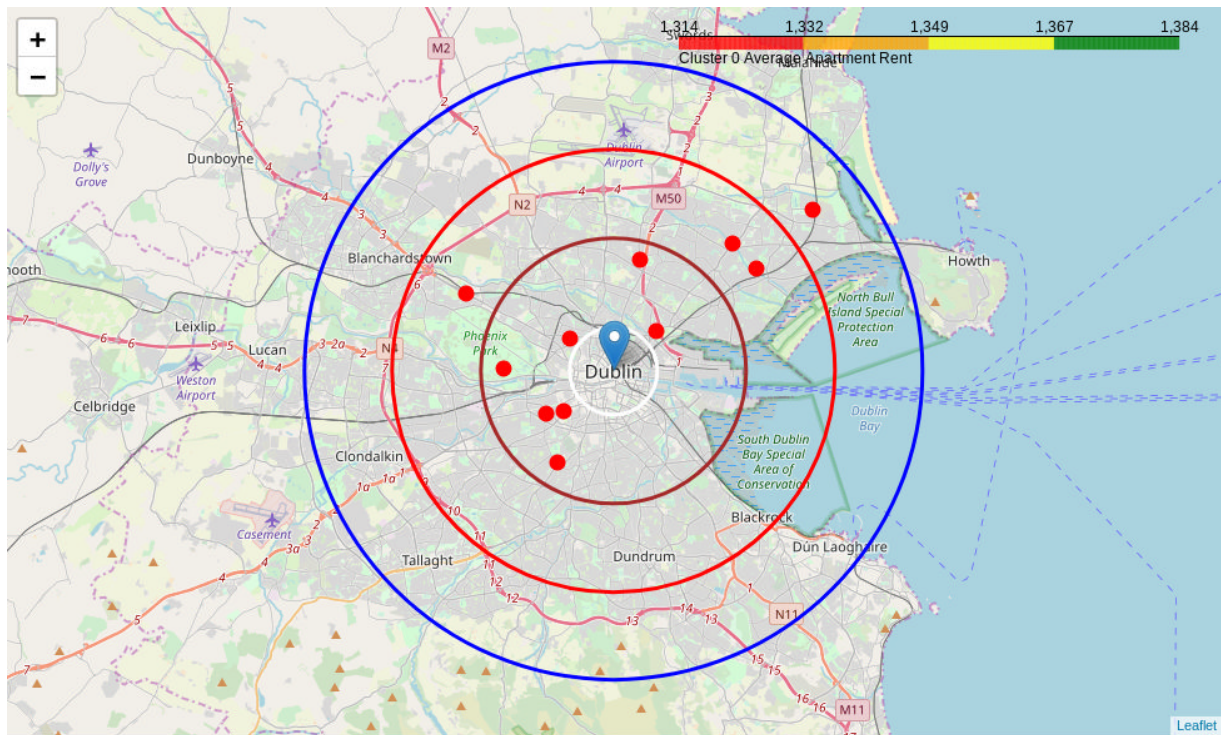




View data for each cluster

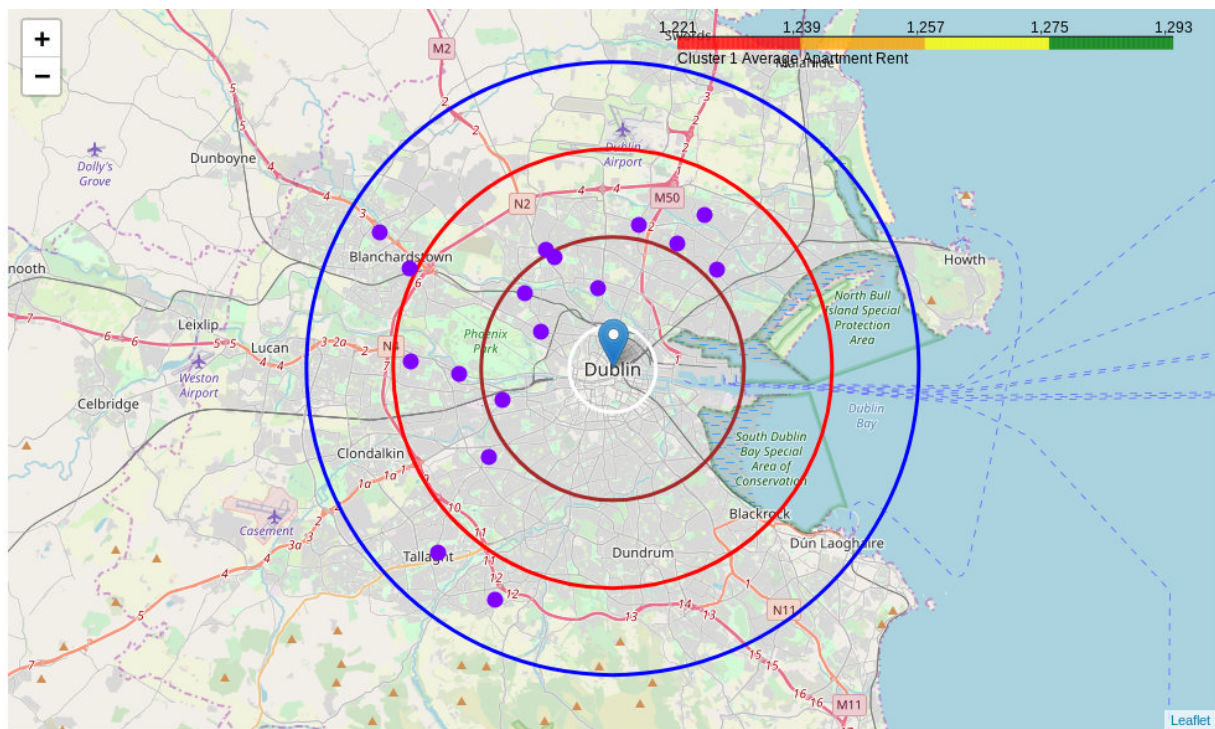
Cluster 0:

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues
0	Dublin 9	53.386050	-6.245577	2.6	0	1314	High-Range Level-1	4 Pub, 3 Supermarket, 3 Fast Food Restaurant
1	Clongriffin	53.402640	-6.151014	5.8	0	1330	High-Range Level-1	1 Auto Garage, 1 Badminton Court, 1 Fish & Chi...
2	Ashtown	53.375260	-6.341134	3.8	0	1331	High-Range Level-1	4 Train Station, 2 Park, 2 Sports Club
3	Fairview	53.362846	-6.236656	1.3	0	1332	High-Range Level-1	5 Café, 4 Grocery Store, 3 Pub
4	Dublin 5	53.383454	-6.181923	4.0	0	1333	High-Range Level-1	2 Train Station, 2 Gym, 2 Convenience Store
5	Malahide Road	53.391554	-6.194688	4.0	0	1335	High-Range Level-1	3 Grocery Store, 2 Supermarket, 2 Fast Food Re...
6	Rialto	53.335774	-6.296931	1.8	0	1346	High-Range Level-1	4 Bar, 3 Restaurant, 3 Pub
7	Dublin 7	53.360551	-6.284466	1.2	0	1346	High-Range Level-1	4 Supermarket, 3 Café, 2 Bar
8	Cork Street	53.336614	-6.287788	1.5	0	1362	High-Range Level-1	5 Pub, 5 Café, 4 Brewery
9	Dublin 8	53.350556	-6.320577	2.5	0	1371	High-Range Level-1	2 Park, 1 Sculpture Garden, 1 Rafting
10	Kimmage	53.319764	-6.290898	2.4	0	1384	High-Range Level-1	5 Café, 3 Pub, 2 Supermarket



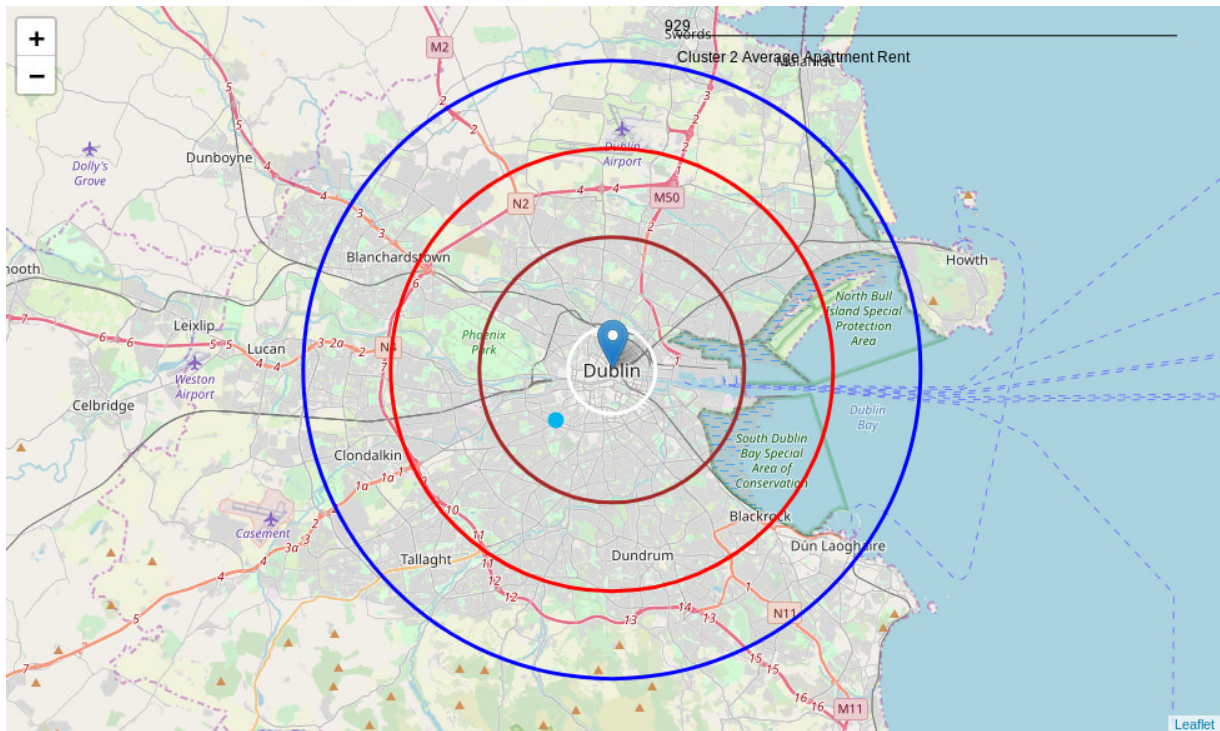
Cluster 1:

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues
0	Dublin 17	53.400361	-6.209491	4.1	1	1221	Mid-Range Level-2	2 Café, 2 Supermarket, 1 Sandwich Place
1	Dublin 11	53.386614	-6.292627	2.9	1	1227	Mid-Range Level-2	1 Supermarket, 1 Department Store, 1 Pet Store
2	Beaumont	53.391251	-6.224267	3.2	1	1237	Mid-Range Level-2	3 Supermarket, 2 Fast Food Restaurant, 2 Café
3	Blanchardstown	53.383081	-6.372418	5.2	1	1240	Mid-Range Level-2	2 Supermarket, 1 Hotel, 1 Bar
4	Chapelizod	53.347915	-6.345197	3.5	1	1245	Mid-Range Level-2	1 Hotel, 1 Café, 1 Chinese Restaurant
5	Finglas	53.389167	-6.296944	3.1	1	1246	Mid-Range Level-2	2 Fast Food Restaurant, 2 Supermarket, 2 Groce...



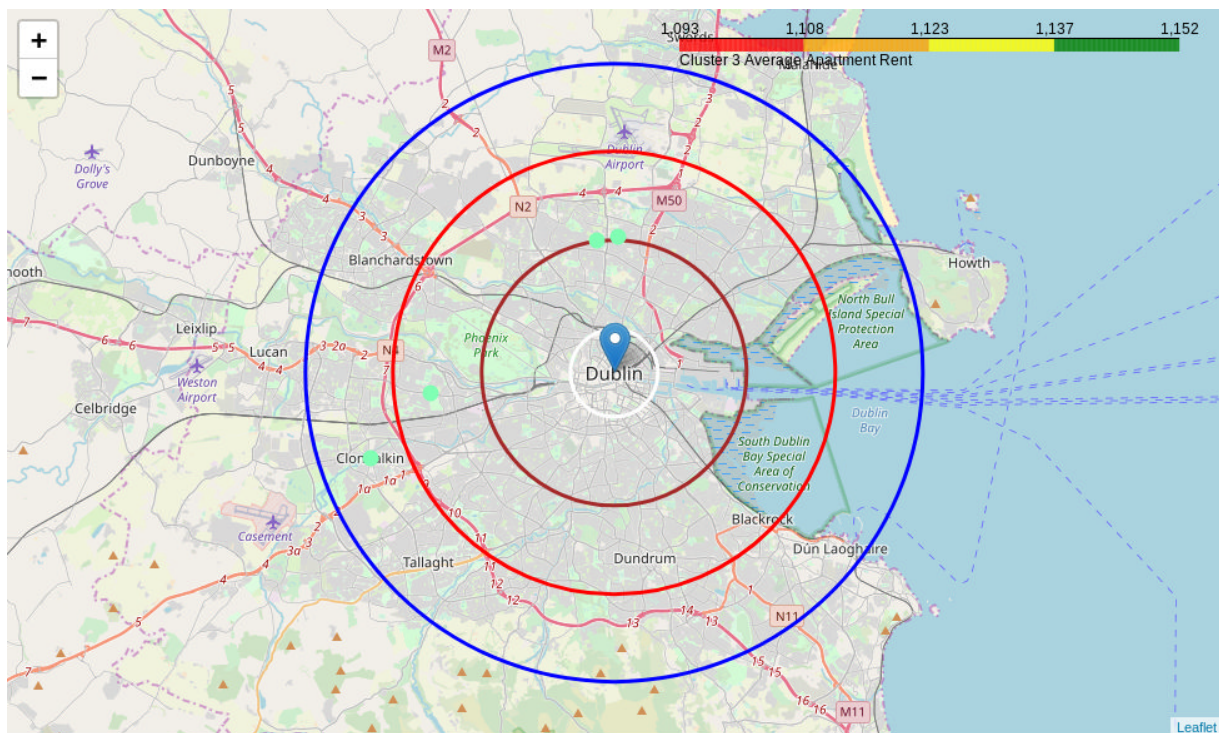
Cluster2:

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues
0	South Circular Road	53.333362	-6.291173	1.7	2	929	Low-Range	3 Brewery, 2 Bar, 2 Café



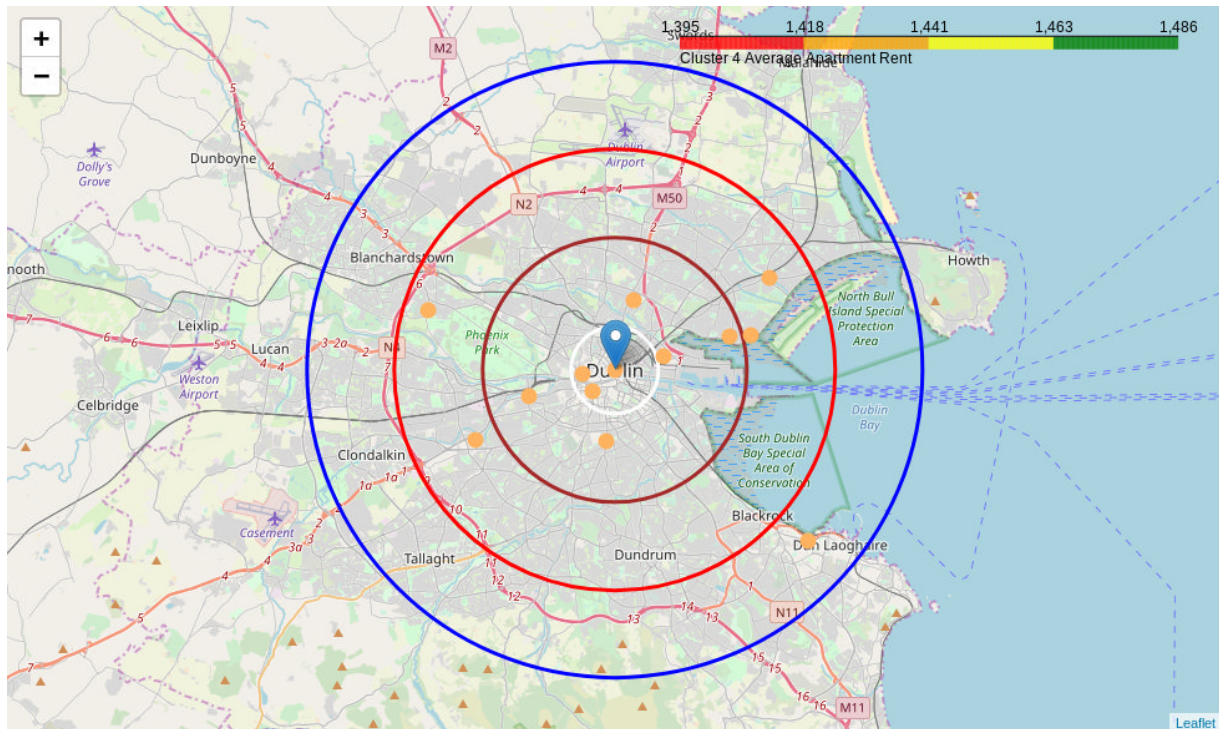
Cluster 3:

	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues
0	Silloogue Way Ballymun	53.393092	-6.269997	3.0	3	1093	Mid-Range Level-1	2 Pizza Place, 2 Pub, 2 Supermarket
1	Dublin 10	53.343217	-6.360964	4.2	3	1120	Mid-Range Level-1	1 Supermarket, 1 Bar, 1 Chinese Restaurant
2	Shangan Road Ballymun	53.394419	-6.258052	3.1	3	1142	Mid-Range Level-1	5 Supermarket, 3 Coffee Shop, 2 Theater
3	Clondalkin	53.321962	-6.394269	5.9	3	1152	Mid-Range Level-1	3 Supermarket, 2 Restaurant, 2 Fast Food Resta...



Cluster 4:

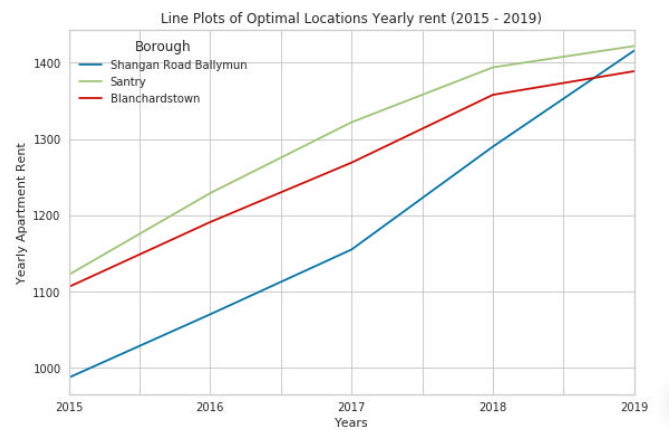
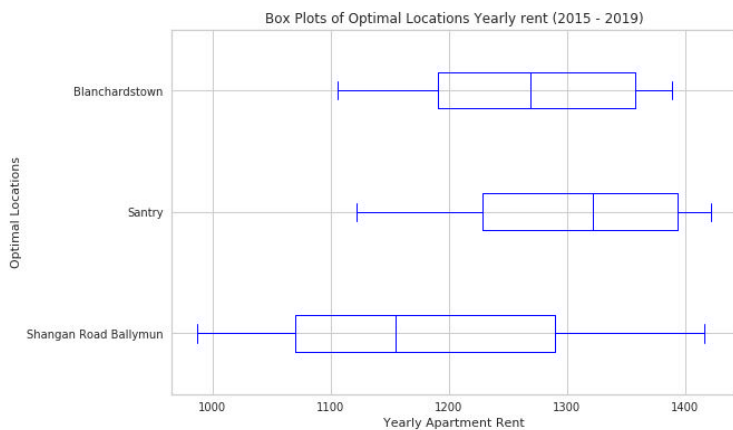
	Borough	Latitude	Longitude	Distance_from_City_Center_miles	Cluster Labels	avgAptRent	Label Name	Top3Venues
0	Dublin	53.349764	-6.260273	1.0	4	1395	High-Range Level-2	9 Café, 4 Coffee Shop, 2 Clothing Store
1	Kilmainham	53.341046	-6.307278	2.0	4	1409	High-Range Level-2	3 Café, 2 Pub, 2 Platform
2	Drumcondra	53.372525	-6.249515	1.6	4	1412	High-Range Level-2	6 Pub, 3 Café, 2 Grocery Store
3	Castleknock	53.369209	-6.362871	4.5	4	1414	High-Range Level-2	2 Café, 2 Chinese Restaurant, 2 Park
4	Drimnagh	53.326579	-6.336933	3.6	4	1414	High-Range Level-2	2 Convenience Store, 2 Grocery Store, 2 Superm...
5	Raheny	53.380198	-6.175146	4.1	4	1415	High-Range Level-2	2 Pub, 2 Music Venue, 2 Gym



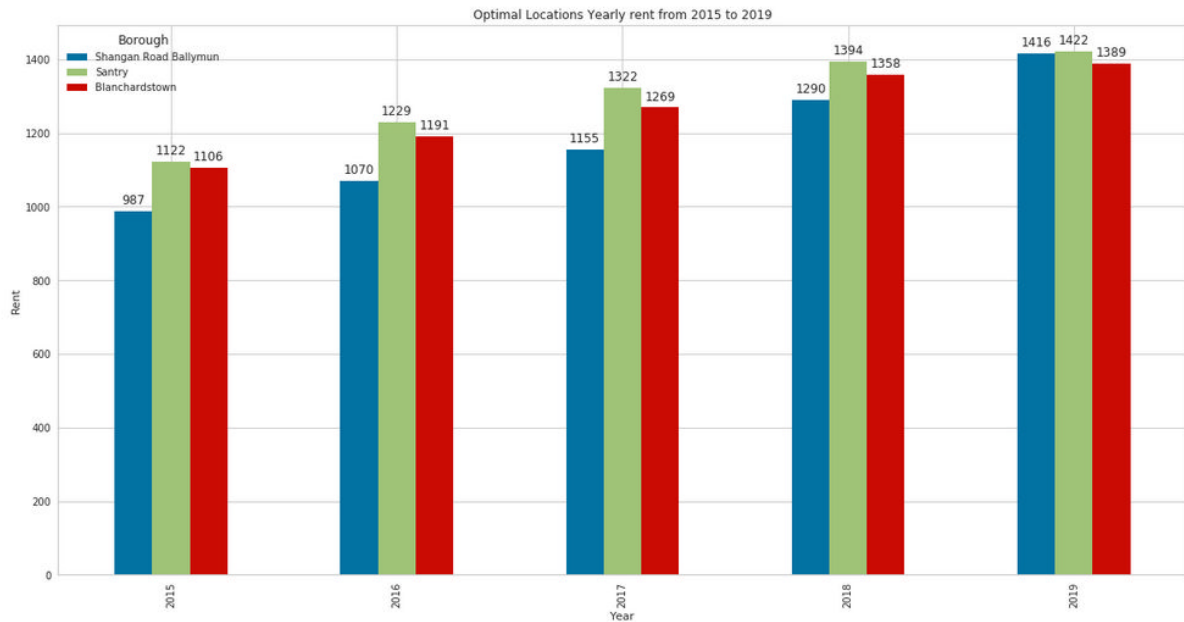
We are going to present new dataframe's of yearly apartment rent for all optimal locations and yearly apartment percentage rise for all optimal locations for the years 2015 to 2019. This data would be useful to identify the best location out of all optimal locations.

Borough	Shangan Road Ballymun	Santry	Blanchardstown
2015	987	1122	1106
2016	1070	1229	1191
2017	1155	1322	1269
2018	1290	1394	1358
2019	1416	1422	1389

Plot out the Yearly apartment rent in box and line graphs which will help us to visualize the data better.



Barplot presented the data



After adding Y-Y% and total percentage rise of (2015-2019)

	Borough	2015	2016	2017	2018	2019	2015-2016%	2016-2017%	2017-2018%	2018-2019%	2015-2019%
0	Shangan Road Ballymun	987	1070	1155	1290	1416	8.4	7.9	11.7	9.8	43.5
1	Santry	1122	1229	1322	1394	1422	9.5	7.6	5.4	2.0	26.7
2	Blanchardstown	1106	1191	1269	1358	1389	7.7	6.5	7.0	2.3	25.6

Final master table for presentation

	Borough	Latitude	Longitude	Cluster Labels	Distance_from_City_Center_miles	avgAptRent	Top3Venues	Label Name	Venues Count
0	South Circular Road	53.333362	-6.291173	2	1.7	929	3 Brewery, 2 Bar, 2 Café	Low-Range	26
1	Sillogue Way Ballymun	53.393092	-6.269997	3	3.0	1093	2 Pizza Place, 2 Pub, 2 Supermarket	Mid-Range Level-1	19
2	Dublin 10	53.343217	-6.360964	3	4.2	1120	1 Supermarket, 1 Bar, 1 Chinese Restaurant	Mid-Range Level-1	6
3	Shangan Road Ballymun	53.394419	-6.258052	3	3.1	1142	5 Supermarket, 3 Coffee Shop, 2 Theater	Mid-Range Level-1	32
4	Clondalkin	53.321962	-6.394269	3	5.9	1152	3 Supermarket, 2 Restaurant, 2 Fast Food Resta...	Mid-Range Level-1	21
5	Dublin 17	53.400361	-6.209491	1	4.1	1221	2 Café, 2 Supermarket, 1 Sandwich Place	Mid-Range Level-2	12
6	Dublin 11	53.386614	-6.292627	1	2.9	1227	1 Supermarket, 1 Department Store, 1 Pet Store	Mid-Range Level-2	4
7	Beaumont	53.391251	-6.224267	1	3.2	1237	3 Supermarket, 2 Fast Food Restaurant, 2 Café	Mid-Range Level-2	17
8	Blanchardstown	53.383081	-6.372418	1	5.2	1240	2 Supermarket, 1 Hotel, 1 Bar	Mid-Range Level-2	7
9	Chapelizod	53.347915	-6.345197	1	3.5	1245	1 Hotel, 1 Café, 1 Chinese Restaurant	Mid-Range Level-2	9

6. Discussion:

When we compare the apartment rents in different clusters, we see that the lowest and highest rents were observed in Cluster 2 (929 Euros) and Cluster 4 (1395 to 1486 Euros). The apartment rent in Cluster 3 ranged from 1093 to 1152 Euros whereas in Cluster 1 it was between 1221 and 1293 Euros. The range of rent in Cluster 0 was 1314 to 1384 Euros.

Cluster 0 has good number of boroughs located close to Dublin City Center, approximately within 3 miles. These boroughs also have higher number of venue counts. However, the apartment rent is a bit high (1314 to 1384 Euros) in this cluster. Hence, we can ignore this cluster.

Cluster 4 being close to Dublin City Center has more number of boroughs with venue count reaching 100 but the apartment rents are the highest here compared to other clusters.

Cluster 2 with the lowest apartment rent has only one borough [South Circular Road](#), though it higher number of venue counts. Much information about this borough was not available in Wikipedia.

Cluster 3 has four boroughs that with mid-range apartment rent. Out of the 4 boroughs we consider two Boroughs as they are in 3 mile radius to City Center.

1. Sillogue Way Ballymun: It has an average apartment rent of 1093 Euros and is located 3 miles from Dublin City Center with a venue Count of 18
2. Shangan Road Ballymun; It has an average apartment rent of 1142 Euros and is located 3.1 miles from Dublin City Center with a venue Count of 35.

These two boroughs are located within 100m radius and therefore they might be sharing common venues though Shangan Road Ballymun has more number of venues compared to the Sillogue Way Ballymun. Shangan Road Ballymun, with a population 21,626 persons has Bus Station, Schools and Dublin Central University (DCU) and is also in close proximity to Dublin Airport

Hence, we can recommend Shangan Road Ballymun location as optimal one from Cluster 3

Cluster 1 has apartments with mid-range rent. It has few good locations such as Dublin 15, Santry, Blanchardstown, Artane, Inchicore which has good number of venues when compare to other locations of Cluster 1. Some of them are close and few are pretty far from Dublin City Center.

	Borough	2015	2016	2017	2018	2019	2015-2016%	2016-2017%	2017-2018%	2018-2019%	2015-2019%
0	Artane	1114	1183	1283	1387	1487	6.2	8.5	8.1	7.2	33.5
1	Inchicore	1166	1234	1344	1381	1422	5.8	8.9	2.8	3.0	22.0
2	Santry	1122	1229	1322	1394	1422	9.5	7.6	5.4	2.0	26.7
3	Dublin 15	1140	1226	1317	1415	1461	7.5	7.4	7.4	3.3	28.2
4	Blanchardstown	1106	1191	1269	1358	1389	7.7	6.5	7.0	2.3	25.6

Note: Blanchardstown is part of Dublin 15 Region. Hence the venue count of Dublin 15 can also be attributed to Blanchardstown. Dublin 15 is a district which consists of Blanchardstown and couple of other Neighborhoods.

Santry:

This borough has Boys and Girls National schools, Secondary schools, Colleges, Stadiums, Industrial Estates, Business Park (IT Companies) and Shopping Centers, Dublin Bus routes to major locations in Dublin, Dublin Metro Close to Airport.

Blanchardstown:

It is the one of the largest urban areas in Dublin. One of Ireland's largest shopping and leisure centres, the Blanchardstown Centre, is located in the area. It has bus routes to all places in Dublin operated by Dublin Bus, Go-Ahead Ireland.

Connolly Hospital, one of Dublin's main hospitals, and a public university teaching hospital, is located in the area, as is the Institute of Technology, Blanchardstown. Local retail outlets include Blanchardstown Centre (a large retail shopping centre with over 180 stores), and WestEnd Shopping Park (a retail park located beside the Blanchardstown Centre). The Carlton Hotel, a 4 Star Hotel north-west of the village, is located by the Blanchardstown Centre complex.

Blanchardstown has a large public library, and is also home to the Draíocht Arts Centre. It has Primary Level, Second Level and Third Level Education schools. The National Sports Campus is located in Blanchardstown, and includes the National Aquatic Centre (NAC), a major indoor aquatics facility with a 50m swimming pool, diving pool, leisure pool and aquapark, and fitness centre. The centre hosted the Special Olympics World Summer Games in 2003, and a number of international swimming events since then.

Artane:

It has a population of 36,564 persons, Shopping Centers, Dublin Bus serving more locations and it has two Train Stations.

	Borough	2015	2016	2017	2018	2019	2015-2016%	2016-2017%	2017-2018%	2018-2019%	2015-2019%
0	Artane	1114	1183	1283	1387	1487	6.2	8.5	8.1	7.2	33.5
1	Santry	1122	1229	1322	1394	1422	9.5	7.6	5.4	2.0	26.7
2	Blanchardstown	1106	1191	1269	1358	1389	7.7	6.5	7.0	2.3	25.6

Artane apartment rent as well as it's percentage of apartment rise from 2015-2019 is 33.5 which is higher than Santry and Blanchardstown. And Artane's Venue count is lower than all. So we are excluding Artane.

Inchicore:

Meaning "Island of Sheep" is a suburb of Dublin, Ireland.

Inchicore is accessed by multiple roads and served by a range of Dublin Bus services. Modern Inchicore grew from a small village near a marsh on the River Camac, at Inse Chaoire (Irish Gaelic for "Sheep Island") where sheep were herded and watered outside Dublin city prior to market. The building of houses increased as the business complex of the railway station grew. Employment in Inchicore at this time revolved around the railway station.

Inchicore's centre, at the junction of Emmet Road and Tyrconnell Road, retains a village atmosphere. The area includes a variety of local stores including a butcher/deli, hardware, ethnic stores, and two mid-size supermarkets. The village is served by several pubs, including the ancient Black Lion Inn, and several restaurants and take-aways including an Italian Restaurant called O'Liva. A brewery has also opened in the area.

It has few schools and colleges.

As it retains a village atmosphere we can exclude as we are looking for urban locations.

From Cluster 1 we choose Santry and Blanchardstown as the optimal locations

Compare the optimal locations of Cluster1 and Cluster 3:

Borough	Latitude	Longitude	Cluster Labels	Distance_from_City_Center_miles	avgAptRent	Top3Venues	Label Name	Venues Count
Shangan Road Ballymun	53.394419	-6.258052	3	3.1	1142	5 Supermarket, 3 Coffee Shop, 2 Theater	Mid-Range Level-1	32
Blanchardstown	53.383081	-6.372418	1	5.2	1240	2 Supermarket, 1 Hotel, 1 Bar	Mid-Range Level-2	7
Santry	53.397158	-6.245472	1	3.3	1276	4 Supermarket, 3 Park, 2 Asian Restaurant	Mid-Range Level-2	35

Taking price as the only criterion:

Out of the determined optimal locations of Shangan Road Ballymun (Cluster3), Santry (Cluster1) and Blanchardstown (Cluster1), the study found Blanchardstown (Cluster1) is the ideal locations to rent a low cost apartment near to Dublin City Centre.

Though Shangan Road Ballymun average apartment rent is low but the percentage rise of apartment rent from 2015 to 2019 is 43.5% which is double the growth of Blanchardstown percentage rise.

Though Blanchardstown is 5.2 miles away from the Dublin City Centre, it has direct buses to many locations and has Irish Rail Train station, Hospital, Shopping Center, Leisure centers, National Sports Campus, Large Public Library.

When we think about price and distance

Shangan Road Ballymun(Cluster3) & Santry (Cluster1) - Santry is the ideal location

	Borough	2015	2016	2017	2018	2019	2015-2016%	2016-2017%	2017-2018%	2018-2019%	2015-2019%
0	Shangan Road Ballymun	987	1070	1155	1290	1416	8.4	7.9	11.7	9.8	43.5
1	Santry	1122	1229	1322	1394	1422	9.5	7.6	5.4	2.0	26.7
2	Blanchardstown	1106	1191	1269	1358	1389	7.7	6.5	7.0	2.3	25.6

7. Conclusion:

With the data we have we were able to accurately cluster the locations and identify the best possible location for the client's current requirements (To rent a low cost apartment which is close to Dublin City Center).

The analysis can be further improved by considering various other factors such as:
Population, Average per-capita income, Crime of all locations.

As a result, people are opting for urban locations which has more number of venues which are close to City center to rent an apartment.