Final Project - The Battle of the Neighborhoods!

Introduction

Background

The Israeli socio demographic is a complex issue that's being discussed throughout the world's main news channels for the past century.

The main dispute is the everlasting city of Jerusalem. The unique texture of population, which is a combination of (mostly) religious Jews, non-religious Jews and Arabs - makes it a very special place.

Problem

In this challenge, I'm going to tackle the social texture of the city of Jerusalem in the context of business by neighborhoods analysis. I'll conduct a thorough analysis which will conclude with a clustering for the various venues throughout the different neighborhoods. as a city with a unique socio-demographic texture, this analysis should be super interesting. this problem should appeal to anyone who cares about the socio demographic texture of the city.

Data acquisition, cleaning and EDA

Data sources

Wikipedia pages which include the list of neighborhoods for the city of Jerusalem.

Geo-code location specifics (geocode + google).

Foursquare venue data.

Data cleaning

Scraping the data from non-tabular web page. Somewhat tedious. Ensuring naming is correct, no duplicates, no missing values or empty fields.

	Neighborhood
0	Abu Tor
1	American Colony, Jerusalem
2	Armenian Quarter
3	Armon (given name)
4	Arnona
..	...
146	Yemin Moshe
147	Zikhron Moshe
148	Zikhron Tuvya
149	Zikhron Yosef
150	Mount Zion

[151 rows x 1 columns]

Mapping each of the neighborhoods to the relevant set of coordinates and validating them

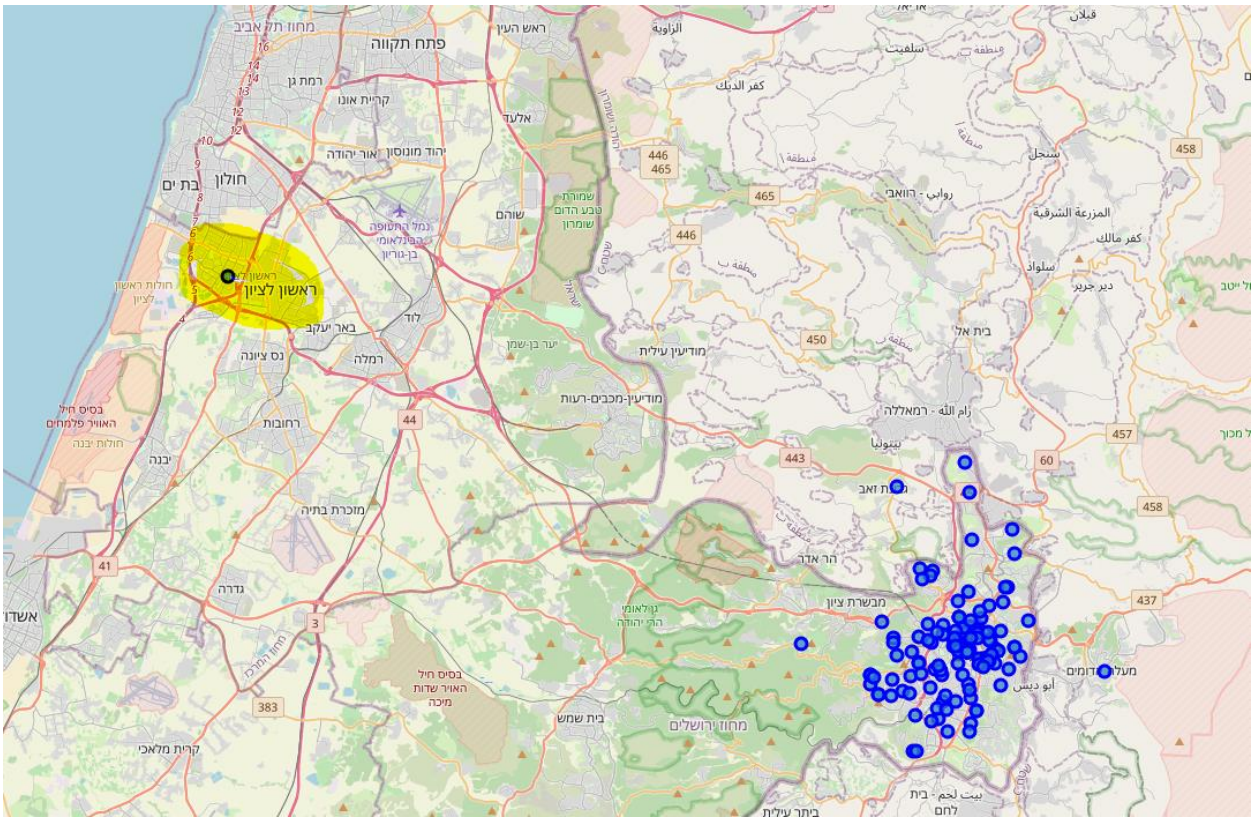
Validating geo location, step one – simple "eyeball" validation, relatively straightforward, a good example of a mismatch is the following highlighted observasion:

113	Ramat Rachel	31.740010	35.220060
114	Ramat Sharett	31.758960	35.184680
115	Ramat Shlomo	31.810210	35.219360
116	Ramot Polin	31.818930	35.196741
117	Ramot, Jerusalem	31.816920	35.192080
118	Ras al-Amud	31.771319	35.243758
119	Ras Khamis	31.813055	35.242806
120	Rassco (neighborhood)	7.642330	122.936240
121	Rehavia	31.780030	35.218730
122	Ring Neighborhoods, Jerusalem	31.780030	35.218730
123	Romema	31.789150	35.204647
124	Russian Compound	31.780030	35.218730
125	Sanhedria	31.797620	35.213770
126	Sanhedria Murhevet	31.797620	35.213770

Harder to track relatively smaller mismatches, we can use the visualization tool and deep dive into the map to explore any further anomalies, for example, the following row might seem “normal” when just exploring the table:

62	King's Garden (Jerusalem)	31.784830	35.197690
63	Kirya Ne'emana	31.789403	35.224894
64	Kiryat HaLeom	31.969870	34.778440
65	Kiryat HaMemshala	31.780030	35.218730
66	Kiryat HaYovel	31.766150	35.174390
67	Kiryat Itri	31.780030	35.218730

However, once we visualize it on the map, we can clearly see that it’s an outlier:



Further data acquisition, EDA and parameters for extraction:

Radius

Grabbing the relevant venues for the different neighborhoods faces us with another challenge, what should we choose as the radius from the neighborhood's geo-code?

This is a unique challenge as Jerusalem's neighborhoods' size has high variance. While some neighborhoods are small (both in terms of residence and actual size), other are huge.

I've tried various set of ranges, and it turned out 500M seems representative for most neighborhoods – I work under the assumption that I might be losing a LOT for the larger neighborhoods, however, the need for no-overlap strikes me as more important.

Venues per Neighborhood

As I fetched the data, I set the venue per neighborhood parameter to 100, so for approx. 140 neighborhoods, I've expected a around 13k-14k results.

However, the number of fetched venues was about 3k. Initially, I figured it had to be a coding error / API issue. After further exploring the data and, code, API and responses per iteration, I decided to deep dive and see the breakdown by neighborhood.

Sorted by neighborhood, we see the below table:

```
with pd.option_context('display.max_rows', None, 'display.max_columns', None):
    display(venues_df)
```

591	Emek Refaim	31.763770	35.219710	McDonald's	31.762637	35.218386	Fast Food Restaurant
592	Emek Refaim	31.763770	35.219710	Cinnabon	31.764958	35.221201	Bakery
593	Emek Refaim	31.763770	35.219710	Kampai Street Wok	31.764106	35.220114	Asian Restaurant
594	Emek Refaim	31.763770	35.219710	Pizza Italia	31.763359	35.219269	Pizza Place
595	Emek Refaim	31.763770	35.219710	ניו-דלי New-Deli	31.762562	35.218279	Deli / Bodega
596	Emek Refaim	31.763770	35.219710	Super Hamoshava	31.762538	35.218300	Grocery Store
597	Emek Refaim	31.763770	35.219710	Nature Museum	31.766196	35.219980	History Museum
598	Emek Refaim	31.763770	35.219710	La Guta (לה גוטה)	31.762619	35.223167	French Restaurant
599	Ezrat Torah	31.797822	35.213887	KSP	31.800253	35.211351	Electronics Store
600	Ezrat Torah	31.797822	35.213887	Ricotta Kosher Halavi	31.800002	35.210776	Restaurant
601	Ezrat Torah	31.797822	35.213887	אנטריקוט	31.800197	35.210970	Asian Restaurant
602	Ezrat Torah	31.797822	35.213887	Wok Station	31.801736	35.213470	Noodle House
603	Ezrat Yisrael	31.784027	35.217713	Abraham Hostel (אברהם הוסטל)	31.784972	35.215675	Hostel
604	Ezrat Yisrael	31.784027	35.217713	ANNA Italian cafe (אנה מסעדה איטלקית)	31.783651	35.219294	Italian Restaurant
605	Ezrat Yisrael	31.784027	35.217713	Arthur Hotel	31.782148	35.218640	Hotel

If we'd like to group, it per neighborhood to see the aggregated results we'll get the below summary:

Neighborhood	Latitude	Longitude	VenueName	VenueLatitude	VenueLongitude	VenueCategory
Abu Tor	1	1	1	1	1	1
Al-Ram	46	46	46	46	46	46
Al-Walaja	3	3	3	3	3	3
American Colony, Jerusalem	26	26	26	26	26	26
Armenian Quarter	41	41	41	41	41	41
Armon (given name)	46	46	46	46	46	46
Arnona	2	2	2	2	2	2
Arzei HaBira	6	6	6	6	6	6
At-Tur (Mount of Olives)	5	5	5	5	5	5
Atarot	1	1	1	1	1	1
Bab Huta	23	23	23	23	23	23
Bab a-Zahara	15	15	15	15	15	15
Baka, Jerusalem	8	8	8	8	8	8
Batei Munkacs	46	46	46	46	46	46
Batei Saidoff	47	47	47	47	47	47
Batei Ungarin	46	46	46	46	46	46
Batei Warsaw	46	46	46	46	46	46
Bayit VeGan	4	4	4	4	4	4
Beit David	6	6	6	6	6	6
Beit HaKerem, Jerusalem	9	9	9	9	9	9
Beit Orot	5	5	5	5	5	5
Beit Safafa	1	1	1	1	1	1
Beit Ya'akov, Jerusalem	1	1	1	1	1	1
Beit Yisrael	11	11	11	11	11	11
Bezetha	46	46	46	46	46	46
Bukharim Quarter	4	4	4	4	4	4
Christian Quarter	52	52	52	52	52	52
City of David	14	14	14	14	14	14
Downtown Triangle (Jerusalem)	23	23	23	23	23	23

As we can see, the variance in the number of extracted venues per neighborhood is very high.

After exploring it further, it appears to be related to the NATURE of the population that resides in the neighborhood.

As discussed in the beginning, Jerusalem has three main types of population:

1. Religious Jews
2. Non-religious Jews
3. Arabs

There are some other minority groups, however, they're not crucial or relevant for this analysis.

the distribution between the 3 groups are 1/3 in each (approximately). In addition to have a very different religious views, they have very different social/technological approach. In general Religious Jews don't interact with social media / go online (some of them have "Kosher" phones- which isn't a smart phone). They don't use the web, etc. The Arab population, while they don't share the restrictions, they suffer from low income, and educational level, which correlates with social media / online interactions etc.

At this point I was facing a decision. There are two types of analysis I can perform,

1. Between analysis – try to estimate the difference between the various groups. Hopefully, there will be some interesting insights and the data will align with the above assumptions and priors, or perhaps, we'll discover a different "truth" which we'll need to explore further. All of that – of course when taking into account the fact of sufficient reliable and robust data to support the assumptions (discussed later)
2. Within analysis – pick and choose a population and explore it further. A good approach would be to sample the non-religious Jewish population (again, will be explained later).

There are two relevant issues to consider,

1. Data robustness per analysis. In the end of the day, we need good and reliable data (and "enough" of it) in order to conduct any type of analysis and check out hypothesis/ find trends etc. In our case, there's a big issue of lacking data for 2 out of the 3 sectors. Effectively we have sufficient amount of data to conduct a reliable analysis only for the non-religious Jewish sector.
2. Interest of study – while data robustness is important, this isn't a statistics class :D I think discussing between population difference is way more interesting.

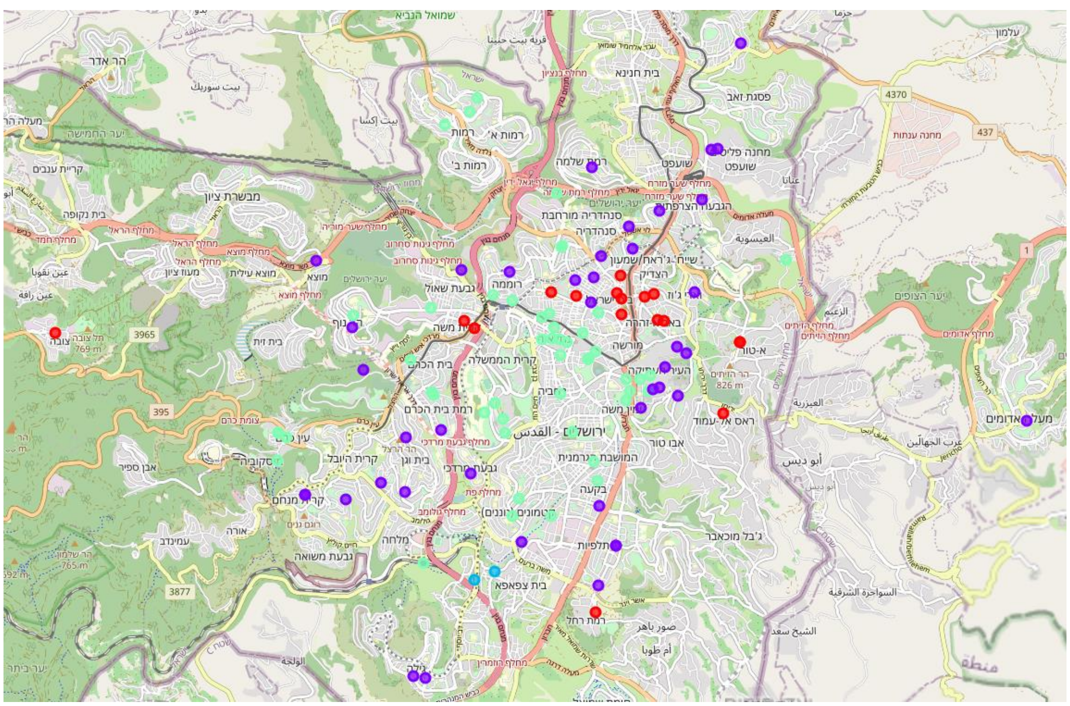
In the end of the day, I've decided to go with my heart and choose the between analysis, with the hope that someday, I'll get enough reliable data, and will be able to continue the study.

Clustering method

Next, I've prepared the data for clustering, everything's in the code, but essentially, I've utilized foursquare data and extracted the unique category of venues per neighborhood. But a OHE matrix, then the frequency matrix for the entire set of neighborhoods, and ran the kmeans algo on it.

	Neighborhoods	American Restaurant	Arcade	Art Gallery	Art Museum	Arts & Crafts Store	Asian Restaurant	Auto Garage	BBQ Joint	Bagel Shop	Bakery	Bar	Basketball Stadium	Bed & Breakfast	Beer
0	Abu Tor	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
1	Al-Ram	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021739	0.000000	0.000000	0.065217	0.00	0.021739	0.000
2	Al-Walaja	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
3	American Colony, Jerusalem	0.000000	0.00	0.000000	0.038462	0.000000	0.038462	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
4	Armenian Quarter	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.024390	0.000000	0.00	0.000000	0.000
5	Armon (given name)	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021739	0.000000	0.000000	0.065217	0.00	0.021739	0.000
6	Arnona	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
7	Arzei HaBira	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
8	At-Tur (Mount of Olives)	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
9	Atarot	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
10	Bab Huta	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
11	Bab a-Zahara	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.000000	0.000000	0.00	0.000000	0.000
12	Baka, Jerusalem	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.125000	0.000000	0.00	0.000000	0.000
13	Batei Munkacs	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021739	0.000000	0.000000	0.065217	0.00	0.021739	0.000
14	Batei Saidoff	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021277	0.000000	0.042553	0.085106	0.00	0.000000	0.042
15	Batei Ungarin	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021739	0.000000	0.000000	0.065217	0.00	0.021739	0.000
16	Batei Warsaw	0.000000	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.021739	0.000000	0.000000	0.065217	0.00	0.021739	0.000

I've then ran several specifications of the kmeans algorithm and received the following allocation to clusters: Of course we should visualize it in order to evaluate and explore:



Results and Summary

I've started with grabbing the data from the Jerusalem neighborhoods wiki page. I've then grabbed the relevant longitudes and latitudes per neighborhood. validated the data, cleaned for outliers. displayed over the map of the Jerusalem Area (including suburbs). The distribution makes sense and fits the real state of the world.

I've then created the relevant datasets utilizing the google geocode and foursquare APIs to grab relevant venues for each one of the neighborhoods (around 135 neighborhoods in total). an initial observation was that we've received a (relatively) low number of venues. As i was curious about the reason for that, i had a breakdown by the neighborhood. where it shows a drastic variance of venues for neighborhoods.

An important aspect of Israel, and Jerusalem in particular is the social texture. the city is somewhat split - 1/3 are religious Jews, 1/3 are non-religious Jews and 1/3 are Arabs (roughly). It appears that we have less information as a whole for the 2/3 of the Arab and the religious Jewish neighborhoods - which aligns with our expectations (these fractions of the population are somewhat less vanguard when it comes to technology). I've decided to move forward and analyze the entire set of neighborhoods as I figured a breakdown between populations is more interesting than a within population analysis (however, perhaps for future tasks...)

the clustering results make some sense as it appears to capture the difference between relatively mid-income non-religious Jewish neighborhoods (light green), and low income neighborhoods (purple), the Arab neighborhoods either fall in the purple (low income) neighborhoods or in red (east Jerusalem). when conducting this analysis, we need to consider the low number of observations for some of the neighborhoods which affect the results drastically.