FINDING THE OPTIMAL LOCATION FOR A BUSINESS

Contents:

1. Problem Description

In this project, the problem attempted to solve will be to find the best possible location or the most optimal, for a Mexican restaurant in the city of Madrid, Spain. To achieve this task, an analytical approach will be used, based on advanced machine learning techniques and data analysis, concretely clustering and perhaps some data visualization techniques.

During the process of analysis, several data transformations will be performed, in order the find the best possible data format for the machine learning model to ingest. Once the data is set up and prepared, a modeling process will be carried out, and this statistical analysis will provide the best possible places to locate the Mexican restaurant.

2. Data Presentation

The data that will be used to develop this project is based on two sites:

1. The Foursquare API: This data will be accessed via Python and used to obtain the most common venues per neighborhood in the city of Madrid. This way, it is possible to have a taste of how the city's venues are distributed, what are the most common places for leisure, and in general, it will provide an idea of what people's likes are.

2. The Madrid City Hall's Web Portal: This site provides several data sources of great utility to solve this problem. The files are provided in Excel format, and they are built over a statistical exploitation and use basis. The data contains updated information about the immigrant population per country and per nationality. This data will be analyzed in such a way that one could determine the best location of r anew venue/restaurant/other based on people's nationalities. For the sake of simplicity, it will be assumed for this exercise that people's likes vary according to their nationality, and that people from one specific country will be more attracted to place that matches the environment and culture of their own countries, rather than the ones from foreign countries.

You can access the data by clicking this link: https://www.madrid.es/UnidadesDescentralizadas/UDCEstadistica/Nuevaweb/Demograf%C3%ADa%20y%20poblaci%C3%B3n/Poblaci%C3%B3n%20extranjera/Nacionalidad/Poblaci%C3%B3n%20a%201%20de%20julio/C4210618.xls

3. Methodology

The methodology used to approach this problem includes some statistical exploration of the data and some visualizations. The main machine learning technique involved in the development of this project is clustering, in concrete the K-Means algorithm was used, implemented with Python.

At a first moment, the main problem was how to obtain the necessary data to build a constructive approach to the problem to be tackled. Usually, to solve these kinds of optimal business location problems, a lot of consumer's data are needed, but for this example and for the sake of simplicity, the focus was put mainly on the population's nationality. A study was carried out over the inhabitants of Madrid, and it was assumed for this example that the national population from a certain country would prefer restaurants based on their national country and food, rather than restaurants from other countries or that have nothing to do with the culture of their countries, specially when it comes to immigrant populations, that are not in their countries, and certainly would like to usually have a taste of their food and original culture. Because in the end, it is not only about the food, it is also about having a piece of the country in question. When a someone enters in an Italian restaurant, or American, or Peruvian restaurant, they are not only consuming the food and culinary specialties of the country in question, but also the culture, the people, the music, the decoration. All of this must make people feel like they were there on the country.

With all this being considered, it was decided that the main goal to efficiently solve this problem, was firstly to define what our target population is, and secondly, find the areas where this population is living, and finally, examine the venues and restaurants in this area to see if our product could work.

Here is an example of the data used:

Country of Pr	Total	Ciudad Centro	Arganzuela	Retiro	Salamanca	Chamartin	Tetuán
Rumanía	450360	8150	7540	4800	7530	6800	14680
China	372760	15080	13560	5640	7550	6520	19880
Ecuador	239530	6470	7410	2650	6190	3800	13950
Venezuela	233590	15630	9130	6380	15640	9330	13100
Colombia	226180	9980	7170	4830	8030	5510	8220
Marruecos	219090	11010	3900	1840	3220	2800	13930
Italia	203080	30300	12190	8400	18170	10600	11940
Perú	188290	5630	5210	2530	6120	4190	9650
Paraguay	186820	3640	4740	2370	5210	6570	33110
República Do	175110	3650	6540	2040	3440	3220	22720
Honduras	159810	1490	2280	2320	3320	3370	7550

This data contains information about the quantities of immigrant populations in Madrid inside each Neighborhood. The main features are the country of precedence, which

indicates where the people of that lives in those neighborhoods come from. It contains also the quantities of people by country living in each neighborhood. So, with this, it is already possible to have an idea of where is our target population located.

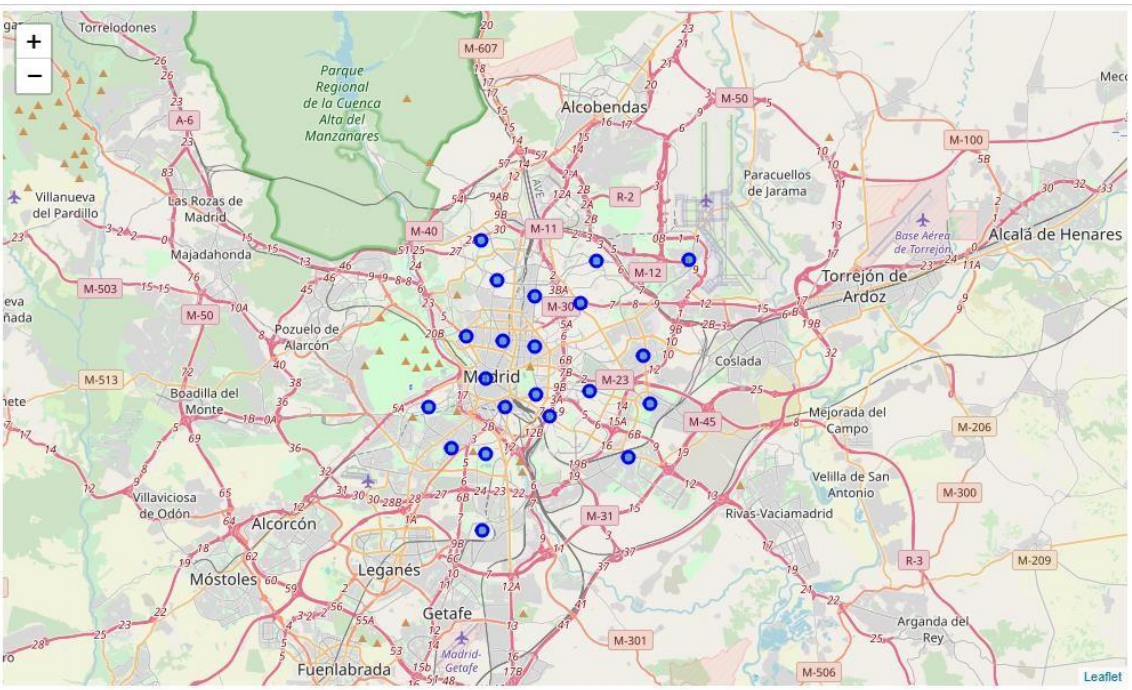
In this project, the idea is to open a Mexican restaurant in the city. With further analysis, this question will be answered. Nevertheless, this task could not be achieved only working with this raw data. It was also needed to obtain information about the most common venues in these neighborhoods, besides of the population kind that was inhabiting on the different neighborhoods. It was also needed to determine somehow in what measure these neighborhoods were different or similar between them.

To continue this line, The Foursquare API was used to obtain the needed data about the venues in each neighborhood, but to use the Foursquare API, it was first necessary to transform the raw data to something the Foursquare API was capable to handle. Basically, the coordinates of each neighborhood were needed.

This is an example of the transformed data:

Neighborhoo	Latitude	Longitude
Centro	40415347	-3707371
Arganzuela	40402733	-3695403
Retiro	40408072	-3676729
Salamanca	4043	-3677778
Chamartin	40453333	-36775
Tetuán	40460556	-37
Chamberí	40432792	-3697186
Fuencarral-El	40478611	-3709722
Moncloa-Arav	40435151	-3718765
Latina	40402461	-3741294
Carabanchel	40383669	-3727989
Usera	40381336	-3706856
Puente de Val	40398204	-3669059
Moratalaz	40409869	-3644436
Ciudad Lineal	4045	-365

Once the data was transformed into a format ingestible by the Foursquare API, the information about the venues could be obtained. The neighborhoods were then plotted into a map of Madrid, so it was possible to have an idea of their geographical situation:



The next step was to obtain the nearby venues by neighborhood, together with their respective coordinates:

Neighborhoo	Neighborhoo	Neighborhoo	Venue	Venue Latitud	Venue Longit	Venue Catego
Centro	40415347	-3707371	Plaza Mayor	4,0415E+16	-3,7076E+16	Plaza
Centro	40415347	-3707371	Mercado de S	4,0415E+15	-3,709E+16	Market
Centro	40415347	-3707371	La Taberna de	4,0415E+16	-3,7081E+15	Other Nightlif
Centro	40415347	-3707371	The Hat Madr	4,0414E+16	-3,7071E+14	Hotel
Centro	40415347	-3707371	Amorino	4,0416E+15	-3,7084E+16	Ice Cream Sho
Centro	40415347	-3707371	BotÃ•n	4,0414E+15	-3,7081E+15	Spanish Resta
Centro	40415347	-3707371	Bar El Cogollo	4,0414E+15	-3,7067E+15	Spanish Resta
Centro	40415347	-3707371	ChocolaterÃ•a	4,0417E+16	-3,7068E+16	Chocolate Sho
Centro	40415347	-3707371	Pinkleton & W	4,0415E+15	-3,7091E+16	Wine Bar

Looking at this sample, it is possible to see the names of the venues, their coordinates, and the category of each venue. The results are ordered by neighborhood. This is a vital step in the segmentation process, since all the important data about the venues is obtained from here.

Once the venues per neighborhood were obtained, it was then needed to look at the mean occurrence of each venue by neighborhood:

```
----Arganzuela----
              venue  freq
0        Restaurant  0.10
1  Spanish Restaurant  0.09
```

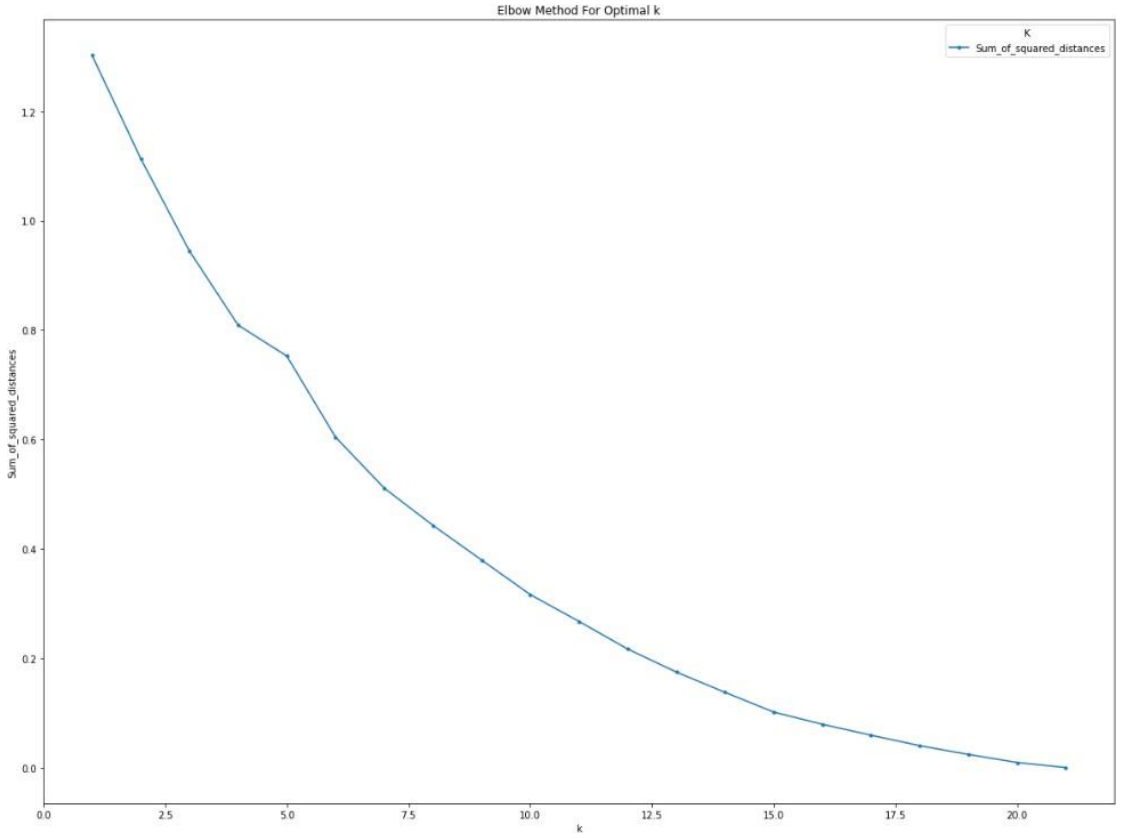
```
2    Tapas Restaurant  0.05
3              Bakery  0.05
4       Grocery Store  0.05


      ------Barajas------
         venue  freq
0                 Hotel  0.22
1            Restaurant  0.09
2    Spanish Restaurant  0.09
3           Coffee Shop  0.06
4  Fast Food Restaurant  0.06
```

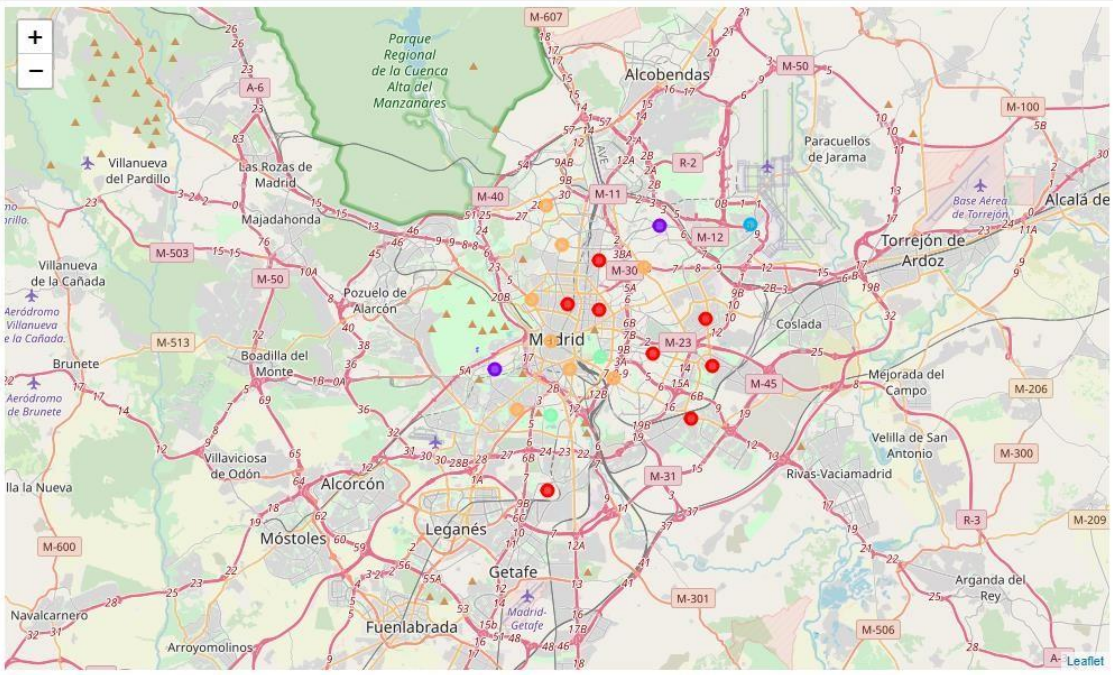
This what the frequencies of occurrence looks like. With this data it is possible to know which the most common venues are:

Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
Arganzuela	Restaurant	Spanish Restaurant	Bakery
Barajas	Hotel	Spanish Restaurant	Restaurant
Carabanchel	Burger Joint	Fast Food Restaurant	Pizza Place
Centro	Spanish Restaurant	Tapas Restaurant	Plaza
Chamartin	Spanish Restaurant	Restaurant	Pizza Place

This process is progressive, once a piece of information is obtained, it is possible to go for the next one. With this data in hands, now the segmentation can be made, and the clusters created. But first it is necessary to determine somehow, what the appropriate number of clusters is. To perform this task, the elbow method was used. This method consists in plotting a hypothetical and usually large number of clusters in our data, and draw a curve representing the squared distances between each cluster. At some point, the distances will descend to a point where there is no need to keep increasing them. This means that creating more divisions in the data (clusters) is pointless as the difference between groups starts being highly difficult to appreciate:



This is our curve. The distances start reducing importantly from cluster 5 on. So, it was determined that the optimal number of clusters for this problem was 5. With this being done, it is possibly to build the clusters now and have a look at them:



This are the 5 clusters on the map of Madrid, it is possible to see how many neighborhoods belong to each cluster, which is also important information.

Now it is possible to examine the data of each cluster:

Barajas	Neighborhoo	Cluster Labels	1st Most Common Venue	2nd Most Common Venue
3140	Centro	0	Spanish Restaurant	Tapas Restaurant
740	Villa de Vallec	0	Food	Spanish Restaurant
1910	Retiro	0	Spanish Restaurant	Supermarket
3370	Ciudad Lineal	0	Spanish Restaurant	Burger Joint
570	VicÃ¡lvaro	0	Spanish Restaurant	Breakfast Spot
2580	Chamartin	0	Spanish Restaurant	Restaurant
920	Usera	0	Seafood Restaurant	Bubble Tea Shop
910	TetuÃ¡n	0	Spanish Restaurant	Brazilian Restaurant

So, this kind of approach, allow us to perform an analysis of an entire city by looking at its venues and population. With this information, observations and conclusions can be made now.

4. Results

The results obtained were five clusters of very different population and venues distribution. The following is a description of the clusters:

- Cluster One:

  Mostly inhabited by south Americans, Europeans, and north Americans. The most common venues are tapas restaurants, Argentinian restaurants, pizza places, supermarkets and Spanish restaurants, among many others.

- Cluster Two:

  This cluster is composed only by 2 different population kinds: Ukrainian people and Dominican Republic people. The most common venues are gyms, Asian restaurants, eastern European restaurants, grocery stores and bakeries among others.

- Cluster Three:

  This cluster is only composed by Bangladeshi people. The most common places are falafel restaurants, fish markets, fast food restaurants and electronic stores.

- Cluster Four:

  Again, only people from two countries seems to live in this clusters. Ecuador and Bolivia. The most common venues are nightclubs, soccer fields, falafel restaurants and fast food restaurants.

- Cluster Five:

  This is a very variate cluster. Some of the main countries here are Rumania, France, Honduras, Philippines, Paraguay and Morocco among others. The most common venues do also variate. Some of them are Mexican restaurants, Chinese restaurants, breweries, sandwich places, seafood restaurants, coffee shops, Mediterranean restaurants, etc.…

5. Discussion

It is interesting how the venues and people from different countries varies to one cluster to another. The main differentiation is located on these two variables. Each cluster has its own characteristics, but also common spots with other clusters. If we examine with more detail these results, some conclusions can be made.

As a recommendation, it must be said in a study of this size, to make good predictions about where to open a certain business or shop, more data is needed. For example, socio-demographic data about the population, like their income level, if they have children or not, the education level, what kind of job do they make a living from, etc.… Also, one of the most important data to examine carefully are the data related to the people's likes and tastes about how they prefer to spend their leisure time, what kinds of food do they like, or what are their hobbies. With all these data gathered, a more in-depth analysis could be performed, and the segmentations would be more accurate. For this project, these data weren't available, and was also out of the project's scope.

6. Conclusions

As far as we can see with this data, there are no Mexican populations registered in Madrid. However, in Cluster 1, it is possible to notice that there's a Mexican restaurant located in the "Centro" neighborhood, which is the town center.

If a deeper exam is performed into this cluster, it is noticeable that its living population are mostly Latinos, mixed with some other Europeans, but mainly, the people living in this cluster come from south American countries. Apart of this fact, other kinds of Latin restaurants can be found, like Argentinian restaurants, tapas restaurants, and Italian restaurants. So, it is possible to tell that the inhabitants of this area like these kinds of food.

By following this logic, if we would like to open a new Mexican restaurant in the city or any kind of restaurant in fact, it would only be necessary to find a where are the restaurants similar the one we want to open, study the population in that area, and find similar clusters of population in the city that don't have yet or have very few restaurants like the one we would like to open.

In this example, clusters 4 and 5 could make a good match for our target population. Looking at the venues in these clusters, it is possible to find one Mexican restaurant, and a good bunch of fast food, Argentinian, and south American restaurants. So, in these clusters, it is possible to state that the existing restaurants matches the population's nationalities and tastes.

In conclusion and taking into consideration the explanations given above as well as the data, it is highly possible that clusters 4 and five could be a good place to open our Mexican restaurants. As explained above, the same logic could apply to open other kind of restaurant or business in any other area of the city. It is only necessary to examine the existing businesses in our target area, and study the population, then compare these two factors with the same ones in areas where there are existing businesses like the one we want to open, and then verify if the matching is correct.