IBM DATA SCIENCE CAPSTONE PROJECT

INTRODUCTION

The capstone project aims to give a taste of what data scientists do in real life when working with data. The project requires the knowledge of location data and different location data providers, such as Foursquare. One also needs the understanding of how to make RESTful API calls to the Foursquare API to retrieve data about venues in different neighborhoods around the world. It also encourages one to be creative in situations where data is not readily available by scraping web data and parsing HTML code. Python and its pandas library are utilized to manipulate data, which help to explore and analyze data. Folium library is also used to great maps of geospatial data and to communicate results and findings.

BUSINESS PROBLEM

An entrepreneur would like to open a café that specializes in tea, cocoa and cheesecakes in Dubai. Being a city with diverse population and a tourist hub, Dubai is considered great choice for café and restaurant owners to begin or expand their business. The entrepreneur would like for the café to be affordable and easily accessible to the public.

Taking into account the price level and easy access to public, the café needs to be located within a community in Dubai that has a good amount of footfall of the general public as well as the tourists.

Being a resident of Dubai for 20 years now, the intention behind is to derive optimal communities within Dubai for the location of the restaurant using unsupervised machine learning in addition to application of knowledge of the environment of the city.

Although this business problem is specific for a particular café owner, this model can also be extrapolated to the audience of any potential entrepreneur looking to open a new restaurant or café.

OBJECTIVE

The primary objective of this project was to use K-Means Clustering to identify the optimal list of communities in Dubai that would be a great fit for our entrepreneur to open their café.

DATA

To build this model, 3 different data sources will be used:

1) List of Communities in Dubai
   https://en.wikipedia.org/wiki/List_of_communities_in_Dubai

This data will be retrieved from the URL using Web Scraping. The *pandas* package on Python will be used to retrieve this data.

2) Geospatial data of the Communities in Dubai from the above list

The latitude and longitude of the communities in Dubai will be retrieved by using the *geocoder* package on Python.

This data will then be merged with the data obtained from Wikipedia to create the base data.

BLOCKER:

The *geocoder* package did not retrieve the right coordinates for the various communities in Dubai. This was identified when the communities were superimposed over Dubai's map using Folium.

Therefore, the coordinates for the communities were retrieved manually from Google Maps and was consolidated in a CSV file. This was then loaded using the *pandas* package read_csv command. The link to the CSV file can be found below:

https://github.com/varsha30051996/datascience-personal/blob/master/Dubai.csv

3) Top Venues per Community

The top venues per community will be retrieved by using Foursquare through an API by using the data collected in points 1&2 as base data.

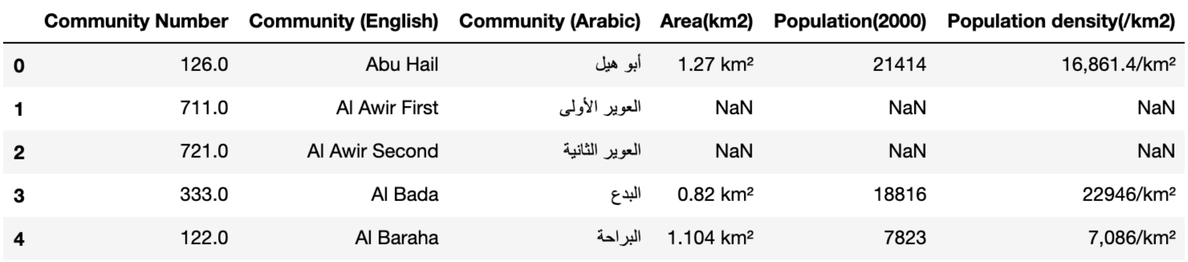
METHODOLOGY

1) DATA PREPARATION AND EXPLORATION

Step 1: Webscraping of Wikipedia page with the list of communities in Dubai

To get the first dataset containing the list of communities of Dubai, the Wikipedia was scraped using the **pandas** package *read_html* command.

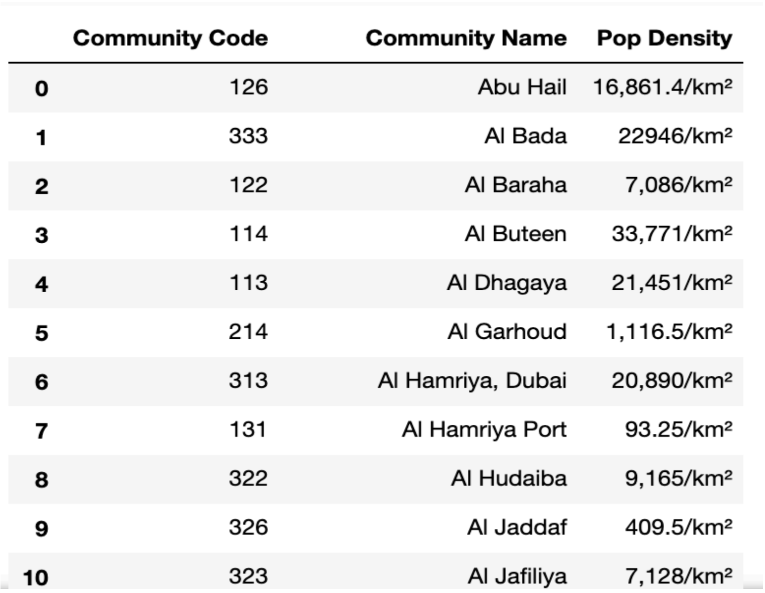
The below dataframe was created containing the list:



	Community Number	Community (English)	Community (Arabic)	Area(km2)	Population(2000)	Population density(/km2)
0	126.0	Abu Hail	أبو هيل	1.27 km^2	21414	16,861.4/km^2
1	711.0	Al Awir First	العوير الأولى	NaN	NaN	NaN
2	721.0	Al Awir Second	العوير الثانية	NaN	NaN	NaN
3	333.0	Al Bada	البدع	0.82 km^2	18816	22946/km^2
4	122.0	Al Baraha	البراحة	1.104 km^2	7823	7,086/km^2

In the above data, there are lot of unnecessary columns as well as NaN values in Population Density which is an important feature to consider while choosing the optimum list of communities. Therefore, data cleaning was done on this base dataset to remove any Community with NaN Population Density. Also, Downtown Dubai's community number which was missing was added manually since it is an important community in Dubai.

After all the necessary cleaning, the final base data was obtained as follows:



	Community Code	Community Name	Pop Density
0	126	Abu Hail	16,861.4/km²
1	333	Al Bada	22946/km²
2	122	Al Baraha	7,086/km²
3	114	Al Buteen	33,771/km²
4	113	Al Dhagaya	21,451/km²
5	214	Al Garhoud	1,116.5/km²
6	313	Al Hamriya, Dubai	20,890/km²
7	131	Al Hamriya Port	93.25/km²
8	322	Al Hudaiba	9,165/km²
9	326	Al Jaddaf	409.5/km²
10	323	Al Jafiliya	7,128/km²

Out of 130 communities in the initial file, 91 of them had all their population density populated. Therefore, we restrict our analysis to these 91 areas.

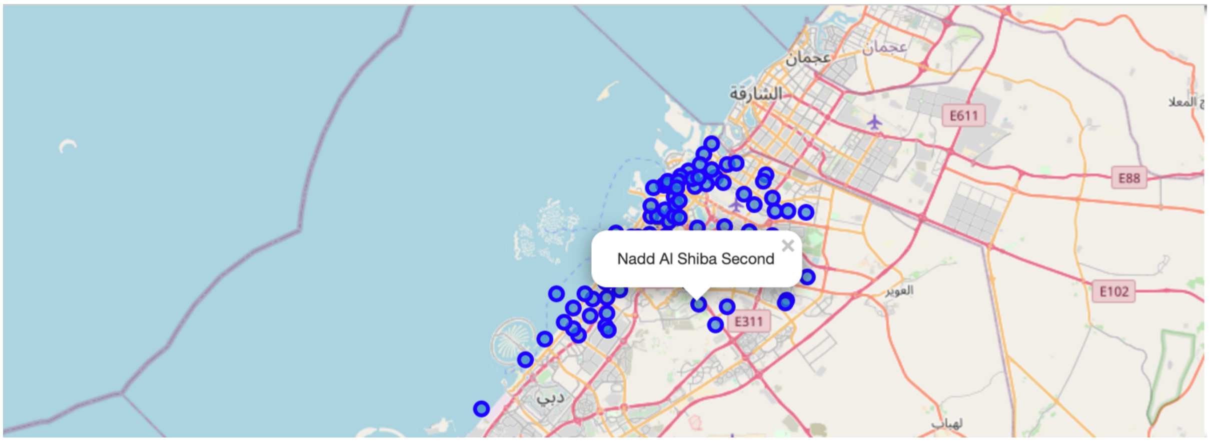
Assumption:
Of the 130 areas, only 91 of them had all their fields populated. Therefore, we discard the other 29 from consideration. Since most of these were industrial areas or outskirts, its safe to discard them.
With the base data ready, the next step was to identify the geographical coordinates for these communities.

<u>Step 2</u>: To get the coordinates of the 91 communities

To get the coordinates, at first the ***geocoder*** package on Python was used. However, when these coordinates were retrieved from the geocoder package were superimposed over Dubai's coordinates to create a map using Folium, it was seen that there was a complete mismatch and the package did not retrieve the right coordinates as seen below:

Therefore, the coordinates were filled in manually by obtaining the latitude and longitude via Google Maps search and a CSV file containing the coordinates was created.

Once these new coordinates were superimposed over Dubai's map using Folium, the following was obtained:



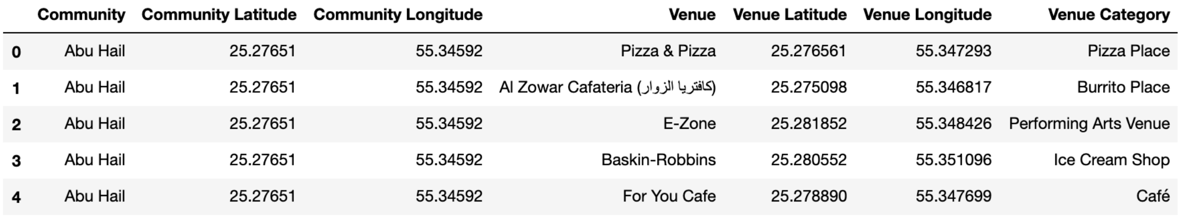
Therefore, the coordinates obtained were correct.

These coordinates were then merged to the base file to create the final input file required.

With this, the data preparation and exploration was completed.

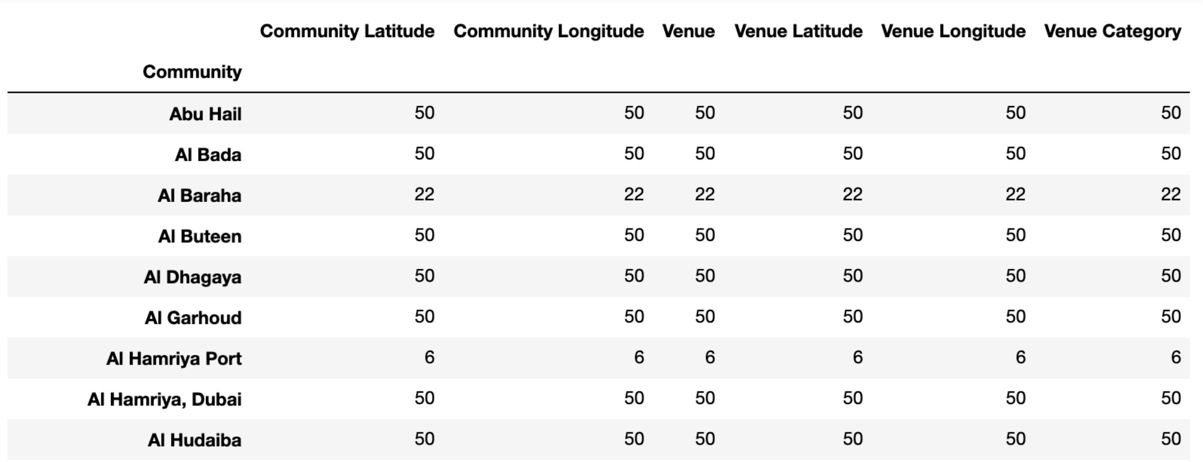
2) <u>SEGMENTATION USING FOURSQUARE API</u>

In this step, the communities were explored further. Venues were collected for each community using the FourSquare API. Venues within a radius of 1000 m from the community coordinates were considered. The venue's coordinates along with their category was collected and arranged into the following dataframe:



	Community	Community Latitude	Community Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Abu Hail	25.27651	55.34592	Pizza & Pizza	25.276561	55.347293	Pizza Place
1	Abu Hail	25.27651	55.34592	Al Zowar Cafateria (كافتريا الزوار)	25.275098	55.346817	Burrito Place
2	Abu Hail	25.27651	55.34592	E-Zone	25.281852	55.348426	Performing Arts Venue
3	Abu Hail	25.27651	55.34592	Baskin-Robbins	25.280552	55.351096	Ice Cream Shop
4	Abu Hail	25.27651	55.34592	For You Cafe	25.278890	55.347699	Café

These venues were then grouped per community to understand the number of venues present in each community:



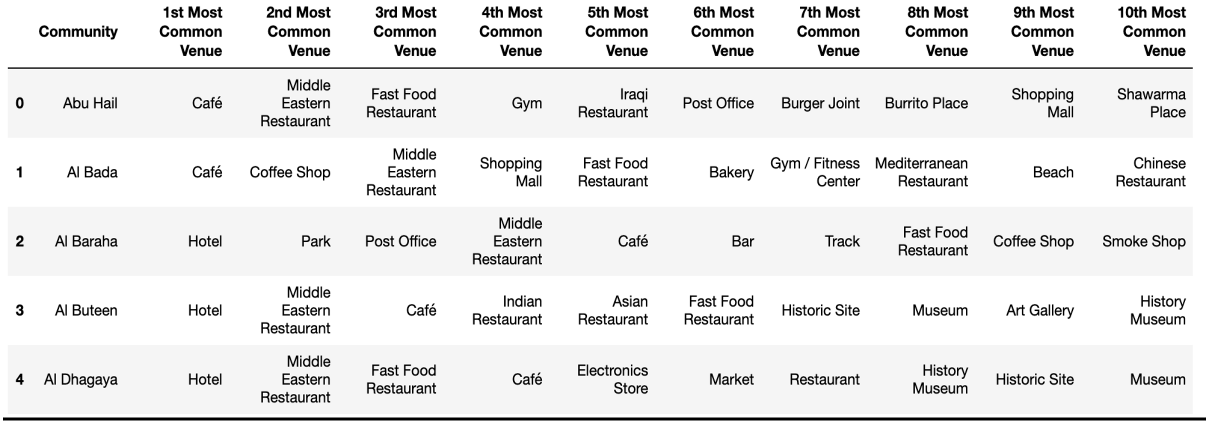
	Community Latitude	Community Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Community						
Abu Hail	50	50	50	50	50	50
Al Bada	50	50	50	50	50	50
Al Baraha	22	22	22	22	22	22
Al Buteen	50	50	50	50	50	50
Al Dhagaya	50	50	50	50	50	50
Al Garhoud	50	50	50	50	50	50
Al Hamriya Port	6	6	6	6	6	6
Al Hamriya, Dubai	50	50	50	50	50	50
Al Hudaiba	50	50	50	50	50	50

There were totally **258** unique venue categories found across the communities in Dubai.

For analyzing the communities, the focus is on venue categories to understand which venue category is the most commonly visited in each community so as to optimally place the café.

Therefore, one-hot encoding was performed to generate dummy variables for venue categories to be used for machine learning.

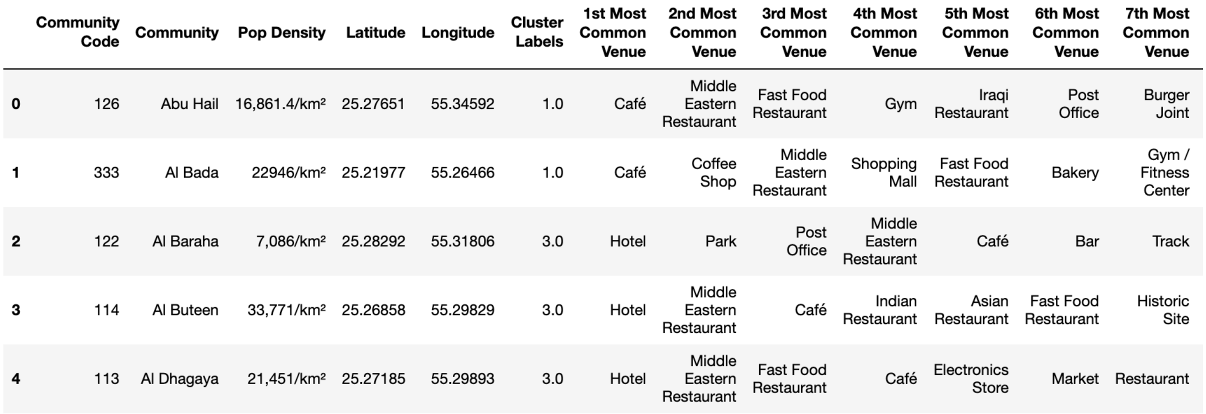
Communities were grouped to get the frequency of occurrence of various venue categories and the top 10 venue categories for each community was obtained as per the frequency of occurrence as below:



	Community	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	Abu Hail	Café	Middle Eastern Restaurant	Fast Food Restaurant	Gym	Iraqi Restaurant	Post Office	Burger Joint	Burrito Place	Shopping Mall	Shawarma Place
1	Al Bada	Café	Coffee Shop	Middle Eastern Restaurant	Shopping Mall	Fast Food Restaurant	Bakery	Gym / Fitness Center	Mediterranean Restaurant	Beach	Chinese Restaurant
2	Al Baraha	Hotel	Park	Post Office	Middle Eastern Restaurant	Café	Bar	Track	Fast Food Restaurant	Coffee Shop	Smoke Shop
3	Al Buteen	Hotel	Middle Eastern Restaurant	Café	Indian Restaurant	Asian Restaurant	Fast Food Restaurant	Historic Site	Museum	Art Gallery	History Museum
4	Al Dhagaya	Hotel	Middle Eastern Restaurant	Fast Food Restaurant	Café	Electronics Store	Market	Restaurant	History Museum	Historic Site	Museum

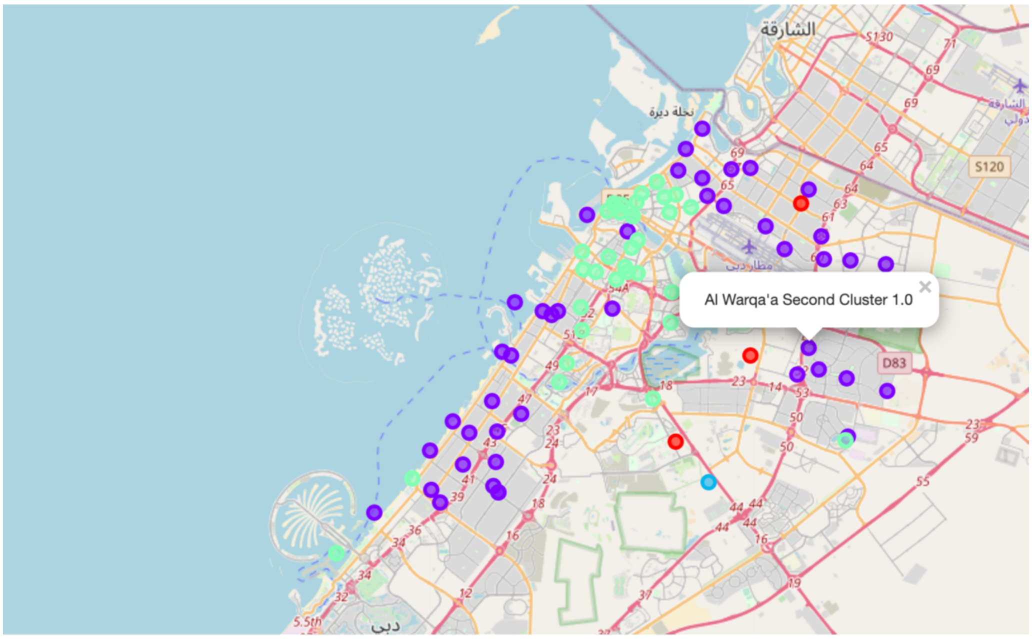
3) CLUSTERING

K-Means Clustering is performed to cluster the various communities. By the method of trial and error, the communities were clustered into 5 different clusters.



	Community Code	Community	Pop Density	Latitude	Longitude	Cluster Labels	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
0	126	Abu Hail	16,861.4/km²	25.27651	55.34592	1.0	Café	Middle Eastern Restaurant	Fast Food Restaurant	Gym	Iraqi Restaurant	Post Office	Burger Joint
1	333	Al Bada	22946/km²	25.21977	55.26466	1.0	Café	Coffee Shop	Middle Eastern Restaurant	Shopping Mall	Fast Food Restaurant	Bakery	Gym / Fitness Center
2	122	Al Baraha	7,086/km²	25.28292	55.31806	3.0	Hotel	Park	Post Office	Middle Eastern Restaurant	Café	Bar	Track
3	114	Al Buteen	33,771/km²	25.26858	55.29829	3.0	Hotel	Middle Eastern Restaurant	Café	Indian Restaurant	Asian Restaurant	Fast Food Restaurant	Historic Site
4	113	Al Dhagaya	21,451/km²	25.27185	55.29893	3.0	Hotel	Middle Eastern Restaurant	Fast Food Restaurant	Café	Electronics Store	Market	Restaurant

These clusters were then visualized on a map of Dubai using Folium library.



LIMITATIONS FOR CLUSTERING:

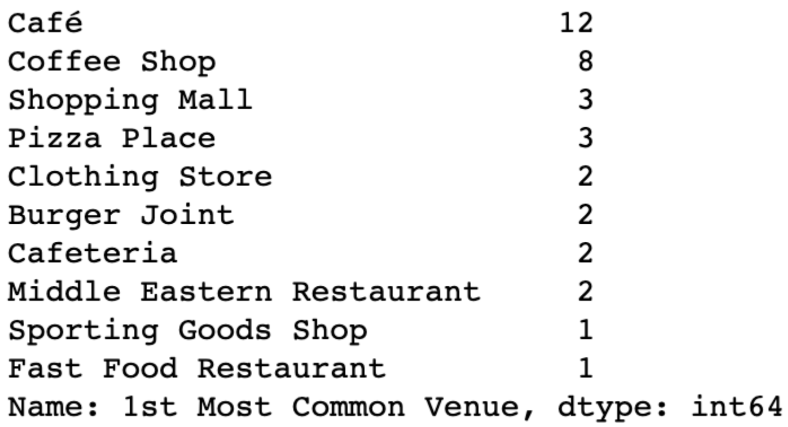
1) *The analysis was only performed on 91 out of the 130 communities in Dubai due to missing data.*
2) *The analysis was performed on a community level in Dubai.*
3) *While collecting the venues visited from FourSquare, a 1000 meter radius restriction from the community coordinates was applied and the number of collected venues was restricted to 50 per community.*

RESULTS

From the K-Means Clustering performed, it was seen that the Clusters 3 and 1 were the most popular.

These clusters were then further analyzed to understand the 1st common venue for the various communities present within the cluster.

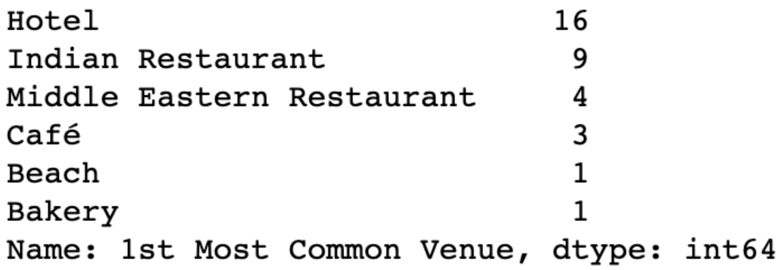
Cluster 1:



```
Café                          12
Coffee Shop                    8
Shopping Mall                  3
Pizza Place                    3
Clothing Store                 2
Burger Joint                   2
Cafeteria                      2
Middle Eastern Restaurant      2
Sporting Goods Shop            1
Fast Food Restaurant           1
Name: 1st Most Common Venue, dtype: int64
```

For Cluster 1, it was seen that 11 communities had coffee shop as their most common venue and 9 of them as Café.

Cluster 3:



```
Hotel                         16
Indian Restaurant              9
Middle Eastern Restaurant      4
Café                           3
Beach                          1
Bakery                         1
Name: 1st Most Common Venue, dtype: int64
```

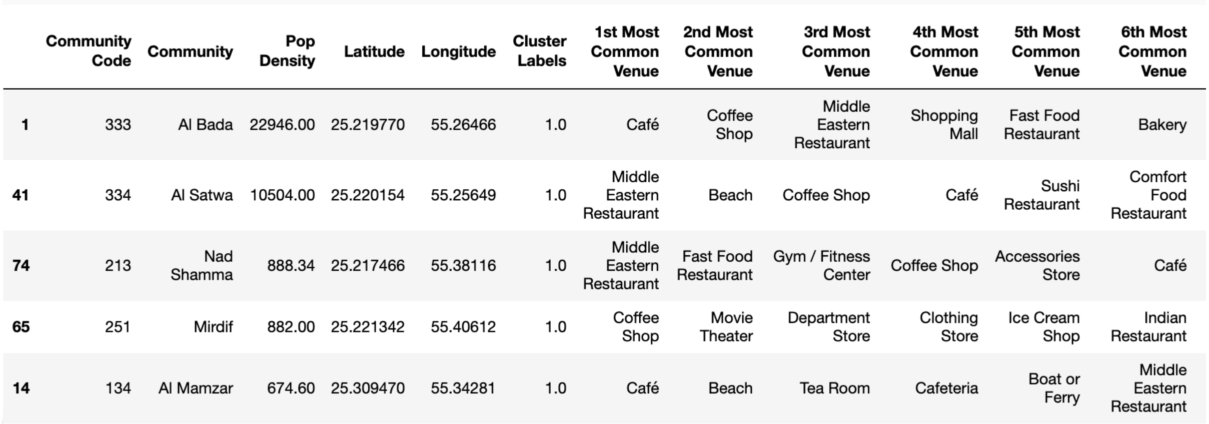
Cluster 3 seemed to have a lot of visits to hotels and Indian Restaurants and did not seem like a good fit for a café.

DISCUSSION

From the results, it is clear that Cluster 1 hosts the optimal list of communities wherein the Café can be opened.

Any area within Cluster 1 could be chosen as a potential area to open the café.

However, further analysis was done by arranging the communities within the Cluster by population density.



	Community Code	Community	Pop Density	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue
1	333	Al Bada	22946.00	25.219770	55.26466	1.0	Café	Coffee Shop	Middle Eastern Restaurant	Shopping Mall	Fast Food Restaurant	Bakery
41	334	Al Satwa	10504.00	25.220154	55.25649	1.0	Middle Eastern Restaurant	Beach	Coffee Shop	Café	Sushi Restaurant	Comfort Food Restaurant
74	213	Nad Shamma	888.34	25.217466	55.38116	1.0	Middle Eastern Restaurant	Fast Food Restaurant	Gym / Fitness Center	Coffee Shop	Accessories Store	Café
65	251	Mirdif	882.00	25.221342	55.40612	1.0	Coffee Shop	Movie Theater	Department Store	Clothing Store	Ice Cream Shop	Indian Restaurant
14	134	Al Mamzar	674.60	25.309470	55.34281	1.0	Café	Beach	Tea Room	Cafeteria	Boat or Ferry	Middle Eastern Restaurant

When looking at the top 5 communities within Cluster 1 by population density, it seen that Al Bada and Mamzar have their top common venue as a café.

So, these 2 could be the optimal communities to open a café.

CONCLUSION

In this project, 12 communities were identified within Dubai which have most common visits to a café. Of these 12 communities, 2 of them had a high population density where we can expect high footfall – Al Bada and Mamzar. These 2 communities were chosen as optimal communities to open the café.

Although this analysis was restricted to finding the optimal location for a café. This can be utilized by any entrepreneur to understand where to open their business such as a restaurant, bakery, gym, etc.

APPENDIX

The Python file on which the project was done can be found on the below link:

https://github.com/varsha30051996/datascience-personal/blob/master/Final%20Capstone%20Project.ipynb