FinalProject

April 21, 2020

1 Applied Data Science Capstone - IBM Professional Certificate

1.0.1 Marcelo Porto

1.1 Introduction

The skills learned during this course give us tools to solve some interesting problem. If you are deciding to open a new business, it might be interesting to explore a city and find a neighborhood where your business is needed.
Let's say you want to open a coffee shop. It wouldn't be interesting to open in an area where there are 3 Starbucks' already. We can use the Foursquare API to find neighborhoods where there might be a need for your new coffee shop.

We can use clustering to find similar neighborhoods in the city that might support your plan: neighborhood X has a couple of coffee shops and it is similar to neighborhood Y. So it might be good to take our business to neighborhood Y if there isn't many coffee shops there already. Are neighborhoods X and Y similar enough if we remove coffee shops from the equation?

1.1.1 Target Audience

Prospective business owners could use this to find the best location for their business.
City officials or the appropriate city departments could use this project to identify areas to invest in and attract new business, enhancing the value of possible up-and-coming neighborhoods.

1.1.2 Data Required

Some cities do not have postal codes. Abu Dhabi, in the United Arab Emirates, is one of the cities. So first I will need to search for a list of neighborhoods in Abu Dhabi. Then, I will need to find coordinates for each one of these neighborhoods with the geopy service. After this is done, I will be able to search the city for different venues with the Foursquare API, using this data to cluster and compare neighborhoods.

For Abu Dhabi, Wikipedia provides a list of neighborhoods, which I can use to search for coordinates.

1.1.3 Structure

The Methodology section will explain how the process was done and methods applied. In Results, the findings will be presented along with the codes used. This reports ends with a brief discussion about the results and limitations of this exercise, and improvements that can be made.

1.2 Methodology

The Foursquare API will be used to extract information from business venues in the city. Geopy will be used to turn neighborhood names into latitude and longitude coordinates. The folium package will allows us to visualize these findings in beautiful interactive maps. And talking about beautiful, I will use the BeautifulSoup package to scrape neighborhood names for Abu Dhabi from Wikipedia.

Last but not least, I will apply K-means to cluster the neighborhoods based on what type of businesses are most common between them. After specifying how many clusters are to be created, this unsupervised machine learning algorithm chooses random points as cluster centers, and every other point is assigned to the closest center via the calculation of its Euclidean distances. The mean point of each cluster, or centroids, is calculated, and it becomes the new center for the cluster. This centroid minimizes the total squared distance of each point to the cluster center (Source: my thesis. Just trust me on this). There are limitations to this method, but this is out of the scope of this exercise.

All the coding here is done in Python, in a Jupyter Notebook, using the IBM Skill Network Labs platform, which is free and I **highly** recommend, it will make your life easier. As you can see, a Github repository is used to store the notebook. Feel free to clone it and use for your own learning!

(By the way, even though I am not using it here, I also suggest you to open an account on IBM Cloud. They have loads of free and cool resources for Data Science!)

1.3 Results

Let's begin by loading and installing our tools!

[1]:

```
import numpy as np # library to handle data in a vectorized manner

import pandas as pd # library for data analsysis
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

import json # library to handle JSON files

!conda install -c conda-forge geopy --yes # uncomment this line if you haven't␣
 ↪completed the Foursquare API lab
from geopy.geocoders import Nominatim # convert an address into latitude and␣
 ↪longitude values

import requests # library to handle requests
from pandas.io.json import json_normalize # tranform JSON file into a pandas␣
 ↪dataframe

# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors
```

```python
# import k-means from clustering stage
from sklearn.cluster import KMeans

!conda install -c conda-forge folium=0.5.0 --yes # uncomment this line if you haven't completed the Foursquare API lab
import folium # map rendering library

print('Libraries imported.')
```

```
Collecting package metadata (current_repodata.json): done
Solving environment: done

## Package Plan ##

  environment location: /home/jupyterlab/conda/envs/python

  added / updated specs:
    - geopy


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    geographiclib-1.50         |             py_0          34 KB  conda-forge
    geopy-1.21.0               |             py_0          58 KB  conda-forge
    ------------------------------------------------------------
                                           Total:          92 KB

The following NEW packages will be INSTALLED:

  geographiclib      conda-forge/noarch::geographiclib-1.50-py_0
  geopy              conda-forge/noarch::geopy-1.21.0-py_0



Downloading and Extracting Packages
geopy-1.21.0         | 58 KB     | ##################################### | 100%
geographiclib-1.50   | 34 KB     | ##################################### | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Collecting package metadata (current_repodata.json): done
Solving environment: failed with initial frozen solve. Retrying with flexible
solve.
Collecting package metadata (repodata.json): done
Solving environment: done
```

```
## Package Plan ##

  environment location: /home/jupyterlab/conda/envs/python

  added / updated specs:
    - folium=0.5.0


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    altair-4.1.0               |             py_1         614 KB  conda-forge
    branca-0.4.0               |             py_0          26 KB  conda-forge
    brotlipy-0.7.0             |py36h8c4c3a4_1000         346 KB  conda-forge
    chardet-3.0.4              |py36h9f0ad1d_1006         188 KB  conda-forge
    cryptography-2.8           |   py36h45558ae_2         628 KB  conda-forge
    folium-0.5.0               |             py_0          45 KB  conda-forge
    pandas-1.0.3               |   py36h830a2c2_1        11.1 MB  conda-forge
    pysocks-1.7.1              |   py36h9f0ad1d_1          27 KB  conda-forge
    toolz-0.10.0               |             py_0          46 KB  conda-forge
    urllib3-1.25.9             |             py_0          92 KB  conda-forge
    vincent-0.4.4              |             py_1          28 KB  conda-forge
    ------------------------------------------------------------
                                           Total:        13.1 MB

The following NEW packages will be INSTALLED:

  altair             conda-forge/noarch::altair-4.1.0-py_1
  attrs              conda-forge/noarch::attrs-19.3.0-py_0
  branca             conda-forge/noarch::branca-0.4.0-py_0
  brotlipy           conda-forge/linux-64::brotlipy-0.7.0-py36h8c4c3a4_1000
  chardet            conda-forge/linux-64::chardet-3.0.4-py36h9f0ad1d_1006
  cryptography       conda-forge/linux-64::cryptography-2.8-py36h45558ae_2
  entrypoints        conda-forge/linux-64::entrypoints-0.3-py36h9f0ad1d_1001
  folium             conda-forge/noarch::folium-0.5.0-py_0
  idna               conda-forge/noarch::idna-2.9-py_1
  importlib-metadata conda-forge/linux-64::importlib-
metadata-1.6.0-py36h9f0ad1d_0
  importlib_metadata conda-forge/noarch::importlib_metadata-1.6.0-0
  jinja2             conda-forge/noarch::jinja2-2.11.2-pyh9f0ad1d_0
  jsonschema         conda-forge/linux-64::jsonschema-3.2.0-py36h9f0ad1d_1
  markupsafe         conda-forge/linux-64::markupsafe-1.1.1-py36h8c4c3a4_1
  pandas             conda-forge/linux-64::pandas-1.0.3-py36h830a2c2_1
  pyopenssl          conda-forge/noarch::pyopenssl-19.1.0-py_1
  pyrsistent         conda-forge/linux-64::pyrsistent-0.16.0-py36h8c4c3a4_0
  pysocks            conda-forge/linux-64::pysocks-1.7.1-py36h9f0ad1d_1
  pytz               conda-forge/noarch::pytz-2019.3-py_0
  requests           conda-forge/noarch::requests-2.23.0-pyh8c360ce_2
  toolz              conda-forge/noarch::toolz-0.10.0-py_0
  urllib3            conda-forge/noarch::urllib3-1.25.9-py_0
  vincent            conda-forge/noarch::vincent-0.4.4-py_1
  zipp               conda-forge/noarch::zipp-3.1.0-py_0



Downloading and Extracting Packages
pysocks-1.7.1        | 27 KB     | ##################################### | 100%
cryptography-2.8     | 628 KB    | ##################################### | 100%
toolz-0.10.0         | 46 KB     | ##################################### | 100%
chardet-3.0.4        | 188 KB    | ##################################### | 100%
folium-0.5.0         | 45 KB     | ##################################### | 100%
urllib3-1.25.9       | 92 KB     | ##################################### | 100%
brotlipy-0.7.0       | 346 KB    | ##################################### | 100%
pandas-1.0.3         | 11.1 MB   | ##################################### | 100%
altair-4.1.0         | 614 KB    | ##################################### | 100%
branca-0.4.0         | 26 KB     | ##################################### | 100%
vincent-0.4.4        | 28 KB     | ##################################### | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Libraries imported.
```

First, let's test with some location, to see if there are entries in the Foursquare database for Abu Dhabi.

[2]:
```python
#Test with Abu Dhabi
CLIENT_ID = 'yourid' # your Foursquare ID
CLIENT_SECRET = 'yoursecret' # your Foursquare Secret
VERSION = '20200401' # Foursquare API version
neighborhood_latitude =24.4539
neighborhood_longitude =54.3773
# type your answer here
LIMIT = 100 # limit of number of venues returned by Foursquare API
radius = 500 # define radius
url = 'https://api.foursquare.com/v2/venues/explore?
 ↪&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
    CLIENT_ID,
    CLIENT_SECRET,
    VERSION,
    neighborhood_latitude,
    neighborhood_longitude,
    radius,
    LIMIT)
url # display URL
```

```
results = requests.get(url).json()
results
```

```
[2]: {'meta': {'code': 200, 'requestId': '5e9e8d9c6001fe001c91e8d2'},
      'response': {'suggestedFilters': {'header': 'Tap to show:',
        'filters': [{'name': 'Open now', 'key': 'openNow'}]},
       'headerLocation': 'Abu Dhabi',
       'headerFullLocation': 'Abu Dhabi',
       'headerLocationGranularity': 'city',
       'totalResults': 5,
       'suggestedBounds': {'ne': {'lat': 24.458400004500007,
         'lng': 54.38223422930707},
        'sw': {'lat': 24.449399995499995, 'lng': 54.37236577069292}},
       'groups': [{'type': 'Recommended Places',
         'name': 'recommended',
         'items': [{'reasons': {'count': 0,
            'items': [{'summary': 'This spot is popular',
              'type': 'general',
              'reasonName': 'globalInteractionReason'}]},
           'venue': {'id': '52958c2d11d2ce1a0539c550',
            'name': 'Umm Al Emarat Park    )     (     ',
            'location': {'address': 'Al Karamah St',
             'crossStreet': 'Mohammed bin Khalifa St',
             'lat': 24.453299953559355,
             'lng': 54.3810916845015,
             'labeledLatLngs': [{'label': 'display',
               'lat': 24.453299953559355,
               'lng': 54.3810916845015}],
             'distance': 389,
             'cc': 'AE',
             'neighborhood': 'Al Mushrif',
             'city': '    ',
             'state': '    ',
             'country': '              ',
             'formattedAddress': ['Al Karamah St (Mohammed bin Khalifa St)',
              '    ',
              '              ']},
            'categories': [{'id': '4bf58dd8d48988d163941735',
              'name': 'Park',
              'pluralName': 'Parks',
              'shortName': 'Park',
              'icon': {'prefix':
'https://ss3.4sqi.net/img/categories_v2/parks_outdoors/park_',
               'suffix': '.png'},
              'primary': True}],
            'photos': {'count': 0, 'groups': []}},
      'referralId': 'e-0-52958c2d11d2ce1a0539c550-0'},
     {'reasons': {'count': 0,
       'items': [{'summary': 'This spot is popular',
         'type': 'general',
         'reasonName': 'globalInteractionReason'}]},
      'venue': {'id': '5921762b2a7ab62513eaef0d',
       'name': 'Home Bakery',
       'location': {'address': 'Umm Al-Emarat Park',
        'lat': 24.45333677996986,
        'lng': 54.38101845236142,
        'labeledLatLngs': [{'label': 'display',
          'lat': 24.45333677996986,
          'lng': 54.38101845236142}],
        'distance': 381,
        'cc': 'AE',
        'city': '   ',
        'state': '   ',
        'country': '              ',
        'formattedAddress': ['Umm Al-Emarat Park',
         '   ',
         '              ']},
       'categories': [{'id': '4bf58dd8d48988d16a941735',
         'name': 'Bakery',
         'pluralName': 'Bakeries',
         'shortName': 'Bakery',
         'icon': {'prefix':
'https://ss3.4sqi.net/img/categories_v2/food/bakery_',
          'suffix': '.png'},
         'primary': True}],
       'photos': {'count': 0, 'groups': []}},
      'referralId': 'e-0-5921762b2a7ab62513eaef0d-1'},
     {'reasons': {'count': 0,
       'items': [{'summary': 'This spot is popular',
         'type': 'general',
         'reasonName': 'globalInteractionReason'}]},
      'venue': {'id': '4d4d7a0a4aa3a093124c43ae',
       'name': 'Café Arabia',
       'location': {'address': '15th Street',
        'crossStreet': 'btwn 2nd/Airport Road and 24th/Karamah',
        'lat': 24.455759648289817,
        'lng': 54.37931840807956,
        'labeledLatLngs': [{'label': 'display',
          'lat': 24.455759648289817,
          'lng': 54.37931840807956}],
        'distance': 291,
        'cc': 'AE',
        'city': '   ',
        'state': '   ',
        'country': '              ',
        'formattedAddress': ['15th Street (btwn 2nd/Airport Road and
24th/Karamah)',
         '   ',
         '              ']},
       'categories': [{'id': '4bf58dd8d48988d16d941735',
         'name': 'Café',
         'pluralName': 'Cafés',
         'shortName': 'Café',
         'icon': {'prefix': 'https://ss3.4sqi.net/img/categories_v2/food/cafe_',
          'suffix': '.png'},
         'primary': True}],
       'photos': {'count': 0, 'groups': []}},
      'referralId': 'e-0-4d4d7a0a4aa3a093124c43ae-2'},
     {'reasons': {'count': 0,
       'items': [{'summary': 'This spot is popular',
         'type': 'general',
         'reasonName': 'globalInteractionReason'}]},
      'venue': {'id': '4d932666d176a1cd105332f0',
       'name': 'Mushrif palace park',
       'location': {'address': 'Mushrif palace',
        'lat': 24.45337508860367,
        'lng': 54.37472906857962,
        'labeledLatLngs': [{'label': 'display',
          'lat': 24.45337508860367,
          'lng': 54.37472906857962}],
        'distance': 266,
        'cc': 'AE',
        'city': '   ',
        'state': '   ',
        'country': '              ',
        'formattedAddress': ['Mushrif palace',
         '   ',
         '              ']},
       'categories': [{'id': '4bf58dd8d48988d163941735',
         'name': 'Park',
         'pluralName': 'Parks',
         'shortName': 'Park',
         'icon': {'prefix':
'https://ss3.4sqi.net/img/categories_v2/parks_outdoors/park_',
          'suffix': '.png'},
         'primary': True}],
       'photos': {'count': 0, 'groups': []}},
      'referralId': 'e-0-4d932666d176a1cd105332f0-3'},
     {'reasons': {'count': 0,
       'items': [{'summary': 'This spot is popular',
         'type': 'general',
         'reasonName': 'globalInteractionReason'}]},
      'venue': {'id': '4e3ddac72271d21e86fcb9cf',
       'name': 'Murjan Asfar Hotel Apartment',
       'location': {'lat': 24.453511255348968,
        'lng': 54.377871397437495,
        'labeledLatLngs': [{'label': 'display',
          'lat': 24.453511255348968,
          'lng': 54.377871397437495}],
        'distance': 72,
        'cc': 'AE',
        'city': '   ',
        'state': '   ',
        'country': '              ',
        'formattedAddress': ['   ', '              ']},
       'categories': [{'id': '4bf58dd8d48988d1fa931735',
         'name': 'Hotel',
         'pluralName': 'Hotels',
         'shortName': 'Hotel',
         'icon': {'prefix':
'https://ss3.4sqi.net/img/categories_v2/travel/hotel_',
          'suffix': '.png'},
         'primary': True}],
       'photos': {'count': 0, 'groups': []}},
      'referralId': 'e-0-4e3ddac72271d21e86fcb9cf-4'}]}]}}
```

[3]:

```python
# function that extracts the category of the venue
def get_category_type(row):
    try:
        categories_list = row['categories']
    except:
        categories_list = row['venue.categories']

    if len(categories_list) == 0:
        return None
    else:
        return categories_list[0]['name']
```

[4]:

```python
venues = results['response']['groups'][0]['items']

nearby_venues = json_normalize(venues) # flatten JSON

# filter columns
filtered_columns = ['venue.name', 'venue.categories', 'venue.location.lat',␣
 ↪'venue.location.lng']
nearby_venues =nearby_venues.loc[:, filtered_columns]
```

```
# filter the category for each row
nearby_venues['venue.categories'] = nearby_venues.apply(get_category_type,␣
 ↪axis=1)

# clean columns
nearby_venues.columns = [col.split(".")[-1] for col in nearby_venues.columns]

nearby_venues.head()
```

```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-
packages/ipykernel_launcher.py:3: FutureWarning: pandas.io.json.json_normalize
is deprecated, use pandas.json_normalize instead
  This is separate from the ipykernel package so we can avoid doing imports
until
```

[4]:

```
                                         name categories        lat        lng
0  Umm Al Emarat Park    )     (           Park  24.453300  54.381092
1                                 Home Bakery     Bakery  24.453337  54.381018
2                                 Café Arabia       Café  24.455760  54.379318
3                         Mushrif palace park       Park  24.453375  54.374729
4                Murjan Asfar Hotel Apartment      Hotel  24.453511  54.377871
```

[5]:

```
nearby_venues.shape
```

[5]:

```
(5, 4)
```

Ok, apparently there are some. Let's plot these venues in a map of Abu Dhabi.

[6]:

```
# create map of AD using latitude and longitude values
latitude = 24.4539
longitude = 54.3773
#neighborhood_latitude =24.4539
#neighborhood_longitude =54.3773
map_AD = folium.Map(location=[latitude, longitude], zoom_start=10)

# add markers to map
for lat, lng, borough, neighborhood in zip(nearby_venues['lat'],␣
 ↪nearby_venues['lng'], nearby_venues['name'], nearby_venues['categories']):
    label = '{}, {}'.format(neighborhood, borough)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_AD)

map_AD
```

```
[6]: <folium.folium.Map at 0x7fb4cd72bdd8>
```

Cool! Now, those are venues. There are no postal codes in Abu Dhabi.
We can find a list of neighborhoods on Wikipedia.
Let's see if I can find coordinates for one of these neighborhoods, Al Karama.

[7]:

```
address = 'Al Karama, Abu Dhabi, United Arab Emirates'

geolocator = Nominatim(user_agent="foursquare_agent")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print(latitude, longitude)
```

```
25.244402800000003 55.30475541735386
```

Alright, it works. There aren't that many, so I could copy the list to a spreadsheet and load here as a csv file.
But that's no fun. Let's scrape the Wikipedia page to get the Neighborhood names, using the BeautifulSoup package.

[8]:

```
import requests
website_url = requests.get('https://en.wikipedia.org/wiki/Abu_Dhabi').text
!pip install BeautifulSoup4
from bs4 import BeautifulSoup
soup = BeautifulSoup(website_url,'html.parser')
```

```
Collecting BeautifulSoup4
  Downloading https://files.pythonhosted.org/packages/e8/b5/7bb03a696f2c9b
7af792a8f51b82974e51c268f15e925fc834876a4efa0b/beautifulsoup4-4.9.0-py3-none-
any.whl (109kB)
     |                 | 112kB 6.1MB/s eta 0:00:01
Collecting soupsieve>1.2 (from BeautifulSoup4)
  Downloading https://files.pythonhosted.org/packages/05/cf/ea245e52f55823f19992
447b008bcbb7f78efc5960d77f6c34b5b45b36dd/soupsieve-2.0-py2.py3-none-any.whl
Installing collected packages: soupsieve, BeautifulSoup4
Successfully installed BeautifulSoup4-4.9.0 soupsieve-2.0
```

The output is pretty long, so I suggest collapsing it for a better read of the notebook. But printing the whole thing is necessary to find what we want. Or you can check the source code of the page.

[ ]:

```
print(soup)
```

Sorry about that, that was long. By inspecting our "soup", we see that the list is under the class “div-col columns column-width”.

```
[10]: #div-col columns column-width
      hoods = soup.find(class_="div-col columns column-width")
      print(hoods)
```

```
<div class="div-col columns column-width" style="-moz-column-width: 18em;
-webkit-column-width: 18em; column-width: 18em;">
<ul><li><a class="new"
href="/w/index.php?title=Al_Aman&amp;action=edit&amp;redlink=1" title="Al Aman
(page does not exist)">Al Aman</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Bateen&amp;action=edit&amp;redlink=1" title="Al
Bateen (page does not exist)">Al Bateen</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Dhafrah&amp;action=edit&amp;redlink=1" title="Al
Dhafrah (page does not exist)">Al Dhafrah</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Falah&amp;action=edit&amp;redlink=1" title="Al Falah
(page does not exist)">Al Falah</a></li>
<li><a href="/wiki/Al_Karama,_United_Arab_Emirates" title="Al Karama, United
Arab Emirates">Al Karama</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Khubeirah&amp;action=edit&amp;redlink=1" title="Al
Khubeirah (page does not exist)">Al Khubeirah</a></li>
<li><a href="/wiki/Al_Lulu_Island" title="Al Lulu Island">Al Lulu
Island</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Madina_(Abu_Dhabi)&amp;action=edit&amp;redlink=1"
title="Al Madina (Abu Dhabi) (page does not exist)">Al Madina</a></li>
<li><a href="/wiki/Al_Maryah_Island" title="Al Maryah Island">Al Maryah
Island</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Manaseer&amp;action=edit&amp;redlink=1" title="Al
Manaseer (page does not exist)">Al Manaseer</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Manhal&amp;action=edit&amp;redlink=1" title="Al
Manhal (page does not exist)">Al Manhal</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Maqtaa&amp;action=edit&amp;redlink=1" title="Al
Maqtaa (page does not exist)">Al Maqtaa</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Markaziyah&amp;action=edit&amp;redlink=1" title="Al
Markaziyah (page does not exist)">Al Markaziyah</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Meena&amp;action=edit&amp;redlink=1" title="Al Meena
(page does not exist)">Al Meena</a></li>
<li><a class="new"
```

```
href="/w/index.php?title=Al_Moroor&amp;action=edit&amp;redlink=1" title="Al
Moroor (page does not exist)">Al Moroor</a></li>
<li><a href="/wiki/Al_Mushrif" title="Al Mushrif">Al Mushrif</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Muzoon&amp;action=edit&amp;redlink=1" title="Al
Muzoon (page does not exist)">Al Muzoon</a></li>
<li><a href="/wiki/Al_Nahyan_neighbourhood" title="Al Nahyan neighbourhood">Al
Nahyan</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Qubesat&amp;action=edit&amp;redlink=1" title="Al
Qubesat (page does not exist)">Al Qubesat</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Ras_Al_Akhdar&amp;action=edit&amp;redlink=1"
title="Al Ras Al Akhdar (page does not exist)">Al Ras Al Akhdar</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Reef&amp;action=edit&amp;redlink=1" title="Al Reef
(page does not exist)">Al Reef</a></li>
<li><a href="/wiki/Al_Reem_Island" title="Al Reem Island">Al Reem
Island</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Rehhan&amp;action=edit&amp;redlink=1" title="Al
Rehhan (page does not exist)">Al Rehhan</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Rowdah&amp;action=edit&amp;redlink=1" title="Al
Rowdah (page does not exist)">Al Rowdah</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Shamkha&amp;action=edit&amp;redlink=1" title="Al
Shamkha (page does not exist)">Al Shamkha</a></li>
<li><a href="/wiki/Bani_Yas" title="Bani Yas">Bani Yas</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Zaab&amp;action=edit&amp;redlink=1" title="Al Zaab
(page does not exist)">Al Zaab</a></li>
<li><a href="/wiki/Al_Zahiyah" title="Al Zahiyah">Al Zahiyah</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Zahraa&amp;action=edit&amp;redlink=1" title="Al
Zahraa (page does not exist)">Al Zahraa</a></li>
<li><a class="new"
href="/w/index.php?title=Al_Khalidyah&amp;action=edit&amp;redlink=1" title="Al
Khalidyah (page does not exist)">Al Khalidyah</a></li>
<li><a class="new"
href="/w/index.php?title=Bain_Al_Jisrain&amp;action=edit&amp;redlink=1"
title="Bain Al Jisrain (page does not exist)">Bain Al Jisrain</a></li>
<li><a class="new"
href="/w/index.php?title=Hideriyyat&amp;action=edit&amp;redlink=1"
title="Hideriyyat (page does not exist)">Hideriyyat</a></li>
<li><a href="/wiki/Khalifa_City" title="Khalifa City">Khalifa City</a></li>
<li><a class="new" href="/w/index.php?title=Marina_Village_(Abu_Dhabi)&amp;actio
n=edit&amp;redlink=1" title="Marina Village (Abu Dhabi) (page does not
exist)">Marina Village</a></li>
<li><a href="/wiki/Masdar_City" title="Masdar City">Masdar City</a></li>
<li><a class="mw-redirect" href="/wiki/Mohammed_Bin_Zayed_City" title="Mohammed
Bin Zayed City">Mohammed Bin Zayed City</a></li>
<li><a href="/wiki/Saadiyat_Island" title="Saadiyat Island">Saadiyat
Island</a></li>
<li><a class="new"
href="/w/index.php?title=Shakhbout_City&amp;action=edit&amp;redlink=1"
title="Shakhbout City (page does not exist)">Shakhbout City</a></li>
<li><a class="new"
href="/w/index.php?title=Officers_City&amp;action=edit&amp;redlink=1"
title="Officers City (page does not exist)">Officers City</a></li>
<li><a class="new"
href="/w/index.php?title=Qasr_El_Bahr&amp;action=edit&amp;redlink=1" title="Qasr
El Bahr (page does not exist)">Qasr El Bahr</a></li>
<li><a class="new"
href="/w/index.php?title=Qasr_El_Shatie&amp;action=edit&amp;redlink=1"
title="Qasr El Shatie (page does not exist)">Qasr El Shatie</a></li>
<li><a href="/wiki/Yas_Island" title="Yas Island">Yas Island</a></li>
<li><a href="/wiki/Al_Samha" title="Al Samha">Al Samha</a></li></ul>
</div>
```

To get just the name of the neighborhood, we use this code:

[11]:
```python
hoods.a.text
```

[11]:
```
'Al Aman'
```

I'll create a dataframe for the neighborhoods and iterate over our "soup" to get all the names.

[12]:
```python
header=["Neighborhood","Lat","Lon"]

df = pd.DataFrame(columns=header)
hoods_rows = hoods.find_all('a')
for tr in hoods_rows:
    row = tr.text

    df = df.append({'Neighborhood': row}, ignore_index=True)
```

[13]:
```python
df
```

[13]:
```
               Neighborhood  Lat  Lon
0                   Al Aman  NaN  NaN
1                 Al Bateen  NaN  NaN
2                Al Dhafrah  NaN  NaN
3                  Al Falah  NaN  NaN
4                 Al Karama  NaN  NaN
5               Al Khubeirah  NaN  NaN
```

```
6             Al Lulu Island  NaN  NaN
7                  Al Madina  NaN  NaN
8          Al Maryah Island  NaN  NaN
9                Al Manaseer  NaN  NaN
10                 Al Manhal  NaN  NaN
11                 Al Maqtaa  NaN  NaN
12            Al Markaziyah  NaN  NaN
13                  Al Meena  NaN  NaN
14                 Al Moroor  NaN  NaN
15                Al Mushrif  NaN  NaN
16                 Al Muzoon  NaN  NaN
17                 Al Nahyan  NaN  NaN
18                Al Qubesat  NaN  NaN
19          Al Ras Al Akhdar  NaN  NaN
20                   Al Reef  NaN  NaN
21            Al Reem Island  NaN  NaN
22                 Al Rehhan  NaN  NaN
23                 Al Rowdah  NaN  NaN
24                Al Shamkha  NaN  NaN
25                  Bani Yas  NaN  NaN
26                   Al Zaab  NaN  NaN
27                Al Zahiyah  NaN  NaN
28                 Al Zahraa  NaN  NaN
29              Al Khalidyah  NaN  NaN
30           Bain Al Jisrain  NaN  NaN
31                Hideriyyat  NaN  NaN
32              Khalifa City  NaN  NaN
33            Marina Village  NaN  NaN
34               Masdar City  NaN  NaN
35  Mohammed Bin Zayed City  NaN  NaN
36           Saadiyat Island  NaN  NaN
37            Shakhbout City  NaN  NaN
38             Officers City  NaN  NaN
39              Qasr El Bahr  NaN  NaN
40            Qasr El Shatie  NaN  NaN
41                Yas Island  NaN  NaN
42                  Al Samha  NaN  NaN
```

Great! Now we can put that into the geocoder to get our coordinates.

[14]:

```python
address = '{}, Abu Dhabi, United Arab Emirates'
geolocator = Nominatim(user_agent="foursquare_agent")

for i in range(0, df.shape[0]):
    hood = df.iloc[i,0]
    location = geolocator.geocode(address.format(hood))
    if location is not None:
        df.iloc[i,1] = location.latitude
        df.iloc[i,2] = location.longitude
```

[15]:
```
df
```

[15]:
```
               Neighborhood      Lat      Lon
0                   Al Aman   24.432  54.4266
1                 Al Bateen  24.2151  55.6263
2                Al Dhafrah  24.4761  54.3694
3                  Al Falah  24.4447  54.7282
4                 Al Karama  25.2444  55.3048
5              Al Khubeirah  24.4652  54.3368
6            Al Lulu Island  24.4996  54.3457
7                 Al Madina  24.3409  54.4907
8          Al Maryah Island  24.5021  54.3902
9               Al Manaseer      NaN      NaN
10                Al Manhal  24.4666   54.366
11                Al Maqtaa  24.4346  54.4544
12            Al Markaziyah  24.4933  54.3667
13                 Al Meena      NaN      NaN
14                Al Moroor      NaN      NaN
15               Al Mushrif  24.4369   54.391
16                Al Muzoon      NaN      NaN
17                Al Nahyan  24.4684  54.3852
18               Al Qubesat      NaN      NaN
19         Al Ras Al Akhdar      NaN      NaN
20                  Al Reef  24.4577  54.6737
21           Al Reem Island  24.4867  54.4105
22                Al Rehhan      NaN      NaN
23                Al Rowdah  24.4564  54.3596
24               Al Shamkha  24.3885  54.7184
25                 Bani Yas      NaN      NaN
26                  Al Zaab      NaN      NaN
27               Al Zahiyah  24.4933  54.3799
28                Al Zahraa  24.4392  54.4352
29             Al Khalidyah      NaN      NaN
30          Bain Al Jisrain  24.4092  54.4954
31               Hideriyyat      NaN      NaN
32             Khalifa City  24.4214  54.5774
33           Marina Village      NaN      NaN
34              Masdar City  24.4259  54.6193
35  Mohammed Bin Zayed City  24.3279  54.5624
36          Saadiyat Island  24.5303  54.4409
37           Shakhbout City  24.3622   54.631
38            Officers City  24.3824   54.535
39             Qasr El Bahr  24.4746  54.3966
40           Qasr El Shatie      NaN      NaN
```

```
41                Yas Island  24.4864  54.6091
42                  Al Samha      NaN      NaN
```

We couldn't find all the neighborhoods, but that's ok, we still got plenty for this exercise. Let's remove the ones without coordinates.

[16]:
```
df=df.dropna()
```

[17]:
```
df.reset_index(inplace=True,drop=True)
df
```

[17]:
```
               Neighborhood      Lat      Lon
0                   Al Aman   24.432  54.4266
1                 Al Bateen  24.2151  55.6263
2                Al Dhafrah  24.4761  54.3694
3                  Al Falah  24.4447  54.7282
4                 Al Karama  25.2444  55.3048
5              Al Khubeirah  24.4652  54.3368
6            Al Lulu Island  24.4996  54.3457
7                 Al Madina  24.3409  54.4907
8          Al Maryah Island  24.5021  54.3902
9                 Al Manhal  24.4666   54.366
10                Al Maqtaa  24.4346  54.4544
11            Al Markaziyah  24.4933  54.3667
12               Al Mushrif  24.4369   54.391
13                Al Nahyan  24.4684  54.3852
14                  Al Reef  24.4577  54.6737
15           Al Reem Island  24.4867  54.4105
16                Al Rowdah  24.4564  54.3596
17               Al Shamkha  24.3885  54.7184
18               Al Zahiyah  24.4933  54.3799
19                Al Zahraa  24.4392  54.4352
20          Bain Al Jisrain  24.4092  54.4954
21             Khalifa City  24.4214  54.5774
22              Masdar City  24.4259  54.6193
23  Mohammed Bin Zayed City  24.3279  54.5624
24          Saadiyat Island  24.5303  54.4409
25           Shakhbout City  24.3622   54.631
26            Officers City  24.3824   54.535
27             Qasr El Bahr  24.4746  54.3966
28               Yas Island  24.4864  54.6091
```

Now we can plot these in a map:

[18]:
```
# create map of Abu Dhabi using latitude and longitude values
latitude = 24.4539
longitude = 54.3773
map_AD = folium.Map(location=[latitude, longitude], zoom_start=10)
```

```
# add markers to map
for lat, lng, neighborhood in zip(df['Lat'], df['Lon'], df['Neighborhood']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_AD)

map_AD
```

```
[18]: <folium.folium.Map at 0x7fb4cce6aa58>
```

We use the Foursquare API to find venues in these neighborhoods.
Let's use that trusty function that was provided in the course.

```
[19]: def getNearbyVenues(names, latitudes, longitudes, radius=500):

    venues_list=[]
    for name, lat, lng in zip(names, latitudes, longitudes):
        print(name)

        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?
 ↪&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            radius,
            LIMIT)

        # make the GET request
        results = requests.get(url).json()["response"]['groups'][0]['items']

        # return only relevant information for each nearby venue
        venues_list.append([(
            name,
            lat,
            lng,
            v['venue']['name'],
            v['venue']['location']['lat'],
            v['venue']['location']['lng'],
            v['venue']['categories'][0]['name']) for v in results])

    nearby_venues = pd.DataFrame([item for venue_list in venues_list for item␣
↪in venue_list])
    nearby_venues.columns = ['Neighborhood',
                  'Neighborhood Latitude',
                  'Neighborhood Longitude',
                  'Venue',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Venue Category']

    return(nearby_venues)
```

Running the function…

[20]:
```
AD_venues = getNearbyVenues(names=df['Neighborhood'],
                                   latitudes=df['Lat'],
                                   longitudes=df['Lon']
                                  )
```

```
Al Aman
Al Bateen
Al Dhafrah
Al Falah
Al Karama
Al Khubeirah
Al Lulu Island
Al Madina
Al Maryah Island
Al Manhal
Al Maqtaa
Al Markaziyah
Al Mushrif
Al Nahyan
Al Reef
Al Reem Island
Al Rowdah
Al Shamkha
Al Zahiyah
Al Zahraa
Bain Al Jisrain
Khalifa City
Masdar City
Mohammed Bin Zayed City
```

```
Saadiyat Island
Shakhbout City
Officers City
Qasr El Bahr
Yas Island
```

Now we have a list of venues with coordinates for each neighborhood.
Let's just look at the first 10 entries.

[36]:

```
AD_venues.head(10)
```

[36]:

```
  Neighborhood  Neighborhood Latitude  Neighborhood Longitude  \
0      Al Aman              24.431990                54.42655
1      Al Aman              24.431990                54.42655
2      Al Aman              24.431990                54.42655
3      Al Aman              24.431990                54.42655
4      Al Aman              24.431990                54.42655
5      Al Aman              24.431990                54.42655
6   Al Dhafrah              24.476147                54.36936
7   Al Dhafrah              24.476147                54.36936
8   Al Dhafrah              24.476147                54.36936
9   Al Dhafrah              24.476147                54.36936

                          Venue  Venue Latitude  Venue Longitude  \
0                        Subway       24.435156        54.425187
1  Novotel Abu Dhabi Al Bustan       24.429431        54.429166
2                    McDonald's       24.434646        54.424393
3           Cafe Bonjour Bonsoir       24.429314        54.428250
4              Adagio Aparthotel       24.429396        54.428604
5                  Coffee Planet       24.434725        54.423094
6           Jumeirah Etihad Tower       24.476051        54.367716
7               Starbucks (     )    24.477430        54.371626
8              Gudee Pizza & Café       24.477860        54.371012
9  Al Shater Hassan Restaurant       24.478750        54.369562

          Venue Category
0        Sandwich Place
1                 Hotel
2  Fast Food Restaurant
3                  Café
4                 Hotel
5           Coffee Shop
6                 Hotel
7           Coffee Shop
8           Pizza Place
9    Falafel Restaurant
```

How many unique type of businesses do we have in Abu Dhabi?

```
[37]: print('There are {} unique businesses.'.format(len(AD_venues['Venue Category'].
       ↪unique())))
```

```
There are 125 unique businesses.
```

```
[58]: AD_venues.groupby('Neighborhood').count()
```

```
[58]:                          Neighborhood Latitude  Neighborhood Longitude  Venue  \
      Neighborhood
      Al Aman                                      6                       6      6
      Al Dhafrah                                  32                      32     32
      Al Karama                                   38                      38     38
      Al Khubeirah                                17                      17     17
      Al Lulu Island                               1                       1      1
      Al Madina                                    3                       3      3
      Al Manhal                                    7                       7      7
      Al Maqtaa                                   27                      27     27
      Al Markaziyah                               39                      39     39
      Al Maryah Island                            56                      56     56
      Al Mushrif                                   4                       4      4
      Al Nahyan                                   29                      29     29
      Al Reef                                     12                      12     12
      Al Reem Island                               1                       1      1
      Al Rowdah                                    8                       8      8
      Al Shamkha                                   2                       2      2
      Al Zahiyah                                  68                      68     68
      Al Zahraa                                    4                       4      4
      Bain Al Jisrain                             27                      27     27
      Khalifa City                                 4                       4      4
      Masdar City                                  6                       6      6
      Mohammed Bin Zayed City                      1                       1      1
      Officers City                                1                       1      1
      Saadiyat Island                              1                       1      1
      Shakhbout City                               1                       1      1
      Yas Island                                 100                     100    100

                               Venue Latitude  Venue Longitude  Venue Category
      Neighborhood
      Al Aman                               6                6               6
      Al Dhafrah                           32               32              32
      Al Karama                            38               38              38
      Al Khubeirah                         17               17              17
      Al Lulu Island                        1                1               1
      Al Madina                             3                3               3
      Al Manhal                             7                7               7
      Al Maqtaa                            27               27              27
      Al Markaziyah                        39               39              39
      Al Maryah Island                     56         56         56
      Al Mushrif                            4          4          4
      Al Nahyan                            29         29         29
      Al Reef                              12         12         12
      Al Reem Island                        1          1          1
      Al Rowdah                             8          8          8
      Al Shamkha                            2          2          2
      Al Zahiyah                           68         68         68
      Al Zahraa                             4          4          4
      Bain Al Jisrain                      27         27         27
      Khalifa City                          4          4          4
      Masdar City                           6          6          6
      Mohammed Bin Zayed City               1          1          1
      Officers City                         1          1          1
      Saadiyat Island                       1          1          1
      Shakhbout City                        1          1          1
      Yas Island                          100        100        100
```

We see we have a problem with our data here. There are a few neighborhoods with very few entries.
We could attempt to increase the radius of search. Or find another data source.
For this exercise we will limit our analysis to those areas with at least 5 businesses.

```
[70]: temp = AD_venues.groupby('Neighborhood').count()
      id = temp.index[temp.iloc[:,0] >= 5]
```

```
[74]: #rpt[rpt['STK_ID'].isin(stk_list)]
      AD_venues = AD_venues[AD_venues['Neighborhood'].isin(id)]
```

What type of venue is more frequent in each neighborhood?
How are we going to cluster these together? To start to answer these questions, we turn the venues into dummy variables.
We can get the dummies with one hot encoding.

```
[75]: # one hot encoding
      AD_onehot = pd.get_dummies(AD_venues[['Venue Category']], prefix="",␣
       ↪prefix_sep="")

      # add neighborhood column back to dataframe
      AD_onehot['Neighborhood'] = AD_venues['Neighborhood']

      # move neighborhood column to the first column
      fixed_columns = [AD_onehot.columns[-1]] + list(AD_onehot.columns[:-1])
      AD_onehot = AD_onehot[fixed_columns]

      AD_onehot.head()
```

[75]:

```
   Women's Store  Afghan Restaurant  African Restaurant  Airport Terminal  \
0              0                  0                   0                 0
1              0                  0                   0                 0
2              0                  0                   0                 0
3              0                  0                   0                 0
4              0                  0                   0                 0

   American Restaurant  Arcade  Asian Restaurant  BBQ Joint  Bakery  Beach  \
0                    0       0                 0          0       0      0
1                    0       0                 0          0       0      0
2                    0       0                 0          0       0      0
3                    0       0                 0          0       0      0
4                    0       0                 0          0       0      0

   Bed & Breakfast  Bistro  Bookstore  Boutique  Bowling Alley  \
0                0       0          0         0              0
1                0       0          0         0              0
2                0       0          0         0              0
3                0       0          0         0              0
4                0       0          0         0              0

   Breakfast Spot  Buffet  Burger Joint  Cafeteria  Café  Candy Store  \
0               0       0             0          0     0            0
1               0       0             0          0     0            0
2               0       0             0          0     0            0
3               0       0             0          0     1            0
4               0       0             0          0     0            0

   Chinese Restaurant  Clothing Store  Cocktail Bar  Coffee Shop  \
0                   0               0             0            0
1                   0               0             0            0
2                   0               0             0            0
3                   0               0             0            0
4                   0               0             0            0

   Convenience Store  Cosmetics Shop  Cupcake Shop  Department Store  \
0                  0               0             0                 0
1                  0               0             0                 0
2                  0               0             0                 0
3                  0               0             0                 0
4                  0               0             0                 0

   Dessert Shop  Donut Shop  Electronics Store  Ethiopian Restaurant  \
0             0           0                  0                     0
1             0           0                  0                     0
2             0           0                  0                     0
3             0           0                  0                     0
```

```
4             0          0                  0                     0

   Falafel Restaurant  Fast Food Restaurant  Filipino Restaurant  \
0                   0                     0                    0
1                   0                     0                    0
2                   0                     1                    0
3                   0                     0                    0
4                   0                     0                    0

   Fish & Chips Shop  Flower Shop  Food & Drink Shop  Food Court  \
0                  0            0                  0           0
1                  0            0                  0           0
2                  0            0                  0           0
3                  0            0                  0           0
4                  0            0                  0           0

   French Restaurant  Fried Chicken Joint  Furniture / Home Store  Gift Shop  \
0                  0                    0                       0          0
1                  0                    0                       0          0
2                  0                    0                       0          0
3                  0                    0                       0          0
4                  0                    0                       0          0

   Go Kart Track  Greek Restaurant  Grocery Store  Gym  Gym / Fitness Center  \
0              0                 0              0    0                     0
1              0                 0              0    0                     0
2              0                 0              0    0                     0
3              0                 0              0    0                     0
4              0                 0              0    0                     0

   Gym Pool  Gymnastics Gym  Harbor / Marina  Health & Beauty Service  \
0         0               0                0                        0
1         0               0                0                        0
2         0               0                0                        0
3         0               0                0                        0
4         0               0                0                        0

   Hookah Bar  Hostel  Hot Spring  Hotel  Hotel Bar  IT Services  \
0           0       0           0      0          0            0
1           0       0           0      1          0            0
2           0       0           0      0          0            0
3           0       0           0      0          0            0
4           0       0           0      1          0            0

   Ice Cream Shop  Indian Restaurant  Italian Restaurant  Japanese Restaurant  \
0               0                  0                   0                    0
1               0                  0                   0                    0
```

```
2               0                  0                   0                    0
3               0                  0                   0                    0
4               0                  0                   0                    0

   Jewelry Store  Juice Bar  Korean Restaurant  Lebanese Restaurant  \
0              0          0                  0                    0
1              0          0                  0                    0
2              0          0                  0                    0
3              0          0                  0                    0
4              0          0                  0                    0

   Lingerie Store  Lounge  Medical Center  Mediterranean Restaurant  \
0               0       0               0                         0
1               0       0               0                         0
2               0       0               0                         0
3               0       0               0                         0
4               0       0               0                         0

   Mexican Restaurant  Middle Eastern Restaurant  Miscellaneous Shop  \
0                   0                          0                   0
1                   0                          0                   0
2                   0                          0                   0
3                   0                          0                   0
4                   0                          0                   0

   Moroccan Restaurant  Movie Theater  Multiplex  Nail Salon Neighborhood  \
0                    0              0          0           0      Al Aman
1                    0              0          0           0      Al Aman
2                    0              0          0           0      Al Aman
3                    0              0          0           0      Al Aman
4                    0              0          0           0      Al Aman

   Nightclub  Optical Shop  Pakistani Restaurant  Park  Peruvian Restaurant  \
0          0             0                     0     0                    0
1          0             0                     0     0                    0
2          0             0                     0     0                    0
3          0             0                     0     0                    0
4          0             0                     0     0                    0

   Pet Store  Pharmacy  Pizza Place  Playground  Plaza  Pool  Pub  Racetrack  \
0          0         0            0           0      0     0    0          0
1          0         0            0           0      0     0    0          0
2          0         0            0           0      0     0    0          0
3          0         0            0           0      0     0    0          0
4          0         0            0           0      0     0    0          0

   Residential Building (Apartment / Condo)  Resort  Restaurant  \
0                                         0       0           0
1                                         0       0           0
2                                         0       0           0
3                                         0       0           0
4                                         0       0           0

   Sandwich Place  Seafood Restaurant  Shawarma Place  Shoe Store  \
0               1                   0               0           0
1               0                   0               0           0
2               0                   0               0           0
3               0                   0               0           0
4               0                   0               0           0

   Shopping Mall  Snack Place  South Indian Restaurant  Spa  \
0              0            0                        0    0
1              0            0                        0    0
2              0            0                        0    0
3              0            0                        0    0
4              0            0                        0    0

   Sporting Goods Shop  Sports Bar  Steakhouse  Supermarket  Sushi Restaurant  \
0                    0           0           0            0                 0
1                    0           0           0            0                 0
2                    0           0           0            0                 0
3                    0           0           0            0                 0
4                    0           0           0            0                 0

   Tennis Court  Theater  Theme Park  Theme Park Ride / Attraction  \
0             0        0           0                             0
1             0        0           0                             0
2             0        0           0                             0
3             0        0           0                             0
4             0        0           0                             0

   Theme Restaurant  Toy / Game Store  Turkish Restaurant  \
0                 0                 0                   0
1                 0                 0                   0
2                 0                 0                   0
3                 0                 0                   0
4                 0                 0                   0

   Vegetarian / Vegan Restaurant  Wine Bar
0                              0         0
1                              0         0
2                              0         0
3                              0         0
4                              0         0
```

```
[76]: AD_grouped = AD_onehot.groupby('Neighborhood').mean().reset_index()
      AD_grouped
```

```
[76]:         Neighborhood  Women's Store  Afghan Restaurant  African Restaurant  \
0             Al Aman       0.000000           0.000000            0.000000
1          Al Dhafrah       0.000000           0.000000            0.000000
2           Al Karama       0.000000           0.000000            0.000000
3        Al Khubeirah       0.000000           0.000000            0.000000
4           Al Manhal       0.000000           0.000000            0.000000
5           Al Maqtaa       0.000000           0.000000            0.000000
6       Al Markaziyah       0.000000           0.000000            0.000000
7    Al Maryah Island       0.017857           0.017857            0.000000
8           Al Nahyan       0.000000           0.000000            0.000000
9             Al Reef       0.000000           0.000000            0.000000
10          Al Rowdah       0.000000           0.000000            0.000000
11         Al Zahiyah       0.000000           0.000000            0.014706
12    Bain Al Jisrain       0.000000           0.000000            0.000000
13        Masdar City       0.000000           0.000000            0.000000
14         Yas Island       0.000000           0.000000            0.010000

    Airport Terminal  American Restaurant  Arcade  Asian Restaurant  \
0           0.000000             0.000000    0.00          0.000000
1           0.000000             0.000000    0.00          0.000000
2           0.000000             0.000000    0.00          0.105263
3           0.000000             0.000000    0.00          0.000000
4           0.000000             0.000000    0.00          0.000000
5           0.037037             0.000000    0.00          0.000000
6           0.000000             0.025641    0.00          0.051282
7           0.000000             0.035714    0.00          0.000000
8           0.000000             0.034483    0.00          0.034483
9           0.000000             0.000000    0.00          0.000000
10          0.000000             0.000000    0.00          0.000000
11          0.000000             0.000000    0.00          0.029412
12          0.000000             0.000000    0.00          0.000000
13          0.000000             0.000000    0.00          0.000000
14          0.000000             0.010000    0.01          0.000000

    BBQ Joint    Bakery    Beach  Bed & Breakfast    Bistro  Bookstore  \
0    0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
1    0.000000  0.031250  0.03125         0.000000  0.000000   0.000000
2    0.000000  0.078947  0.00000         0.000000  0.000000   0.000000
3    0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
4    0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
5    0.000000  0.037037  0.00000         0.000000  0.000000   0.000000
6    0.000000  0.025641  0.00000         0.025641  0.000000   0.000000
7    0.000000  0.035714  0.00000         0.000000  0.017857   0.000000
8    0.000000  0.068966  0.00000         0.000000  0.000000   0.000000
```

```
9    0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
10   0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
11   0.014706  0.000000  0.00000         0.029412  0.000000   0.014706
12   0.000000  0.000000  0.00000         0.000000  0.000000   0.037037
13   0.000000  0.000000  0.00000         0.000000  0.000000   0.000000
14   0.000000  0.010000  0.00000         0.000000  0.000000   0.010000

    Boutique  Bowling Alley  Breakfast Spot    Buffet  Burger Joint  \
0   0.000000       0.000000        0.000000  0.000000      0.000000
1   0.000000       0.000000        0.000000  0.000000      0.000000
2   0.000000       0.000000        0.000000  0.000000      0.000000
3   0.000000       0.000000        0.000000  0.000000      0.000000
4   0.000000       0.000000        0.000000  0.000000      0.000000
5   0.000000       0.000000        0.000000  0.000000      0.037037
6   0.000000       0.025641        0.025641  0.000000      0.000000
7   0.017857       0.000000        0.000000  0.017857      0.017857
8   0.000000       0.000000        0.000000  0.000000      0.034483
9   0.000000       0.000000        0.000000  0.000000      0.000000
10  0.000000       0.000000        0.000000  0.000000      0.000000
11  0.029412       0.000000        0.014706  0.000000      0.029412
12  0.000000       0.000000        0.000000  0.000000      0.037037
13  0.000000       0.000000        0.000000  0.000000      0.000000
14  0.000000       0.000000        0.000000  0.000000      0.030000

    Cafeteria      Café  Candy Store  Chinese Restaurant  Clothing Store  \
0    0.000000  0.166667         0.00            0.000000        0.000000
1    0.000000  0.093750         0.00            0.000000        0.031250
2    0.026316  0.026316         0.00            0.000000        0.000000
3    0.000000  0.235294         0.00            0.000000        0.000000
4    0.000000  0.428571         0.00            0.000000        0.000000
5    0.000000  0.185185         0.00            0.000000        0.000000
6    0.000000  0.076923         0.00            0.025641        0.000000
7    0.000000  0.089286         0.00            0.035714        0.000000
8    0.000000  0.172414         0.00            0.000000        0.000000
9    0.000000  0.000000         0.00            0.000000        0.000000
10   0.000000  0.625000         0.00            0.000000        0.000000
11   0.000000  0.044118         0.00            0.029412        0.029412
12   0.000000  0.037037         0.00            0.000000        0.000000
13   0.000000  0.166667         0.00            0.000000        0.000000
14   0.000000  0.110000         0.01            0.010000        0.040000

    Cocktail Bar  Coffee Shop  Convenience Store  Cosmetics Shop  \
0       0.000000     0.166667           0.000000        0.000000
1       0.000000     0.031250           0.000000        0.000000
2       0.000000     0.000000           0.026316        0.000000
3       0.000000     0.235294           0.000000        0.000000
4       0.000000     0.142857           0.000000        0.000000
```

```
5       0.000000     0.074074           0.037037        0.000000
6       0.000000     0.000000           0.000000        0.000000
7       0.017857     0.071429           0.000000        0.017857
8       0.000000     0.103448           0.034483        0.000000
9       0.000000     0.083333           0.083333        0.000000
10      0.000000     0.250000           0.000000        0.125000
11      0.000000     0.044118           0.000000        0.014706
12      0.037037     0.111111           0.000000        0.000000
13      0.000000     0.000000           0.000000        0.000000
14      0.000000     0.070000           0.000000        0.020000

    Cupcake Shop  Department Store  Dessert Shop  Donut Shop  \
0       0.000000          0.000000      0.000000    0.000000
1       0.000000          0.031250      0.000000    0.000000
2       0.000000          0.000000      0.000000    0.000000
3       0.000000          0.000000      0.000000    0.058824
4       0.000000          0.000000      0.000000    0.000000
5       0.000000          0.000000      0.037037    0.000000
6       0.000000          0.025641      0.000000    0.025641
7       0.000000          0.000000      0.017857    0.000000
8       0.034483          0.000000      0.068966    0.000000
9       0.000000          0.000000      0.000000    0.000000
10      0.000000          0.000000      0.000000    0.000000
11      0.000000          0.014706      0.044118    0.000000
12      0.000000          0.000000      0.000000    0.000000
13      0.000000          0.000000      0.000000    0.000000
14      0.000000          0.030000      0.010000    0.000000

    Electronics Store  Ethiopian Restaurant  Falafel Restaurant  \
0            0.000000              0.000000            0.000000
1            0.000000              0.000000            0.031250
2            0.000000              0.000000            0.000000
3            0.000000              0.000000            0.000000
4            0.000000              0.000000            0.000000
5            0.000000              0.000000            0.000000
6            0.000000              0.000000            0.000000
7            0.000000              0.000000            0.000000
8            0.000000              0.000000            0.034483
9            0.000000              0.000000            0.000000
10           0.000000              0.000000            0.000000
11           0.029412              0.014706            0.000000
12           0.000000              0.000000            0.000000
13           0.000000              0.000000            0.000000
14           0.010000              0.000000            0.000000

    Fast Food Restaurant  Filipino Restaurant  Fish & Chips Shop  Flower Shop  \
0               0.166667             0.000000               0.00     0.000000
```

```
1               0.062500             0.031250               0.00     0.000000
2               0.000000             0.000000               0.00     0.000000
3               0.117647             0.000000               0.00     0.000000
4               0.000000             0.000000               0.00     0.000000
5               0.037037             0.000000               0.00     0.000000
6               0.128205             0.025641               0.00     0.000000
7               0.000000             0.000000               0.00     0.017857
8               0.000000             0.000000               0.00     0.068966
9               0.000000             0.000000               0.00     0.000000
10              0.000000             0.000000               0.00     0.000000
11              0.044118             0.000000               0.00     0.000000
12              0.000000             0.000000               0.00     0.000000
13              0.166667             0.000000               0.00     0.000000
14              0.010000             0.000000               0.01     0.000000

    Food & Drink Shop  Food Court  French Restaurant  Fried Chicken Joint  \
0            0.000000        0.00           0.000000               0.0000
1            0.000000        0.00           0.000000               0.0625
2            0.000000        0.00           0.000000               0.0000
3            0.000000        0.00           0.000000               0.0000
4            0.000000        0.00           0.000000               0.0000
5            0.000000        0.00           0.037037               0.0000
6            0.000000        0.00           0.000000               0.0000
7            0.000000        0.00           0.017857               0.0000
8            0.000000        0.00           0.034483               0.0000
9            0.000000        0.00           0.000000               0.0000
10           0.000000        0.00           0.000000               0.0000
11           0.000000        0.00           0.014706               0.0000
12           0.037037        0.00           0.037037               0.0000
13           0.000000        0.00           0.000000               0.0000
14           0.000000        0.01           0.010000               0.0000

    Furniture / Home Store  Gift Shop  Go Kart Track  Greek Restaurant  \
0                   0.0000   0.000000           0.00          0.000000
1                   0.0625   0.000000           0.00          0.000000
2                   0.0000   0.000000           0.00          0.000000
3                   0.0000   0.000000           0.00          0.000000
4                   0.0000   0.000000           0.00          0.000000
5                   0.0000   0.000000           0.00          0.000000
6                   0.0000   0.000000           0.00          0.000000
7                   0.0000   0.000000           0.00          0.017857
8                   0.0000   0.000000           0.00          0.000000
9                   0.0000   0.000000           0.00          0.000000
10                  0.0000   0.000000           0.00          0.000000
11                  0.0000   0.014706           0.00          0.000000
12                  0.0000   0.037037           0.00          0.000000
13                  0.0000   0.000000           0.00          0.000000
```

```
14                  0.0300   0.010000           0.01          0.010000

    Grocery Store       Gym  Gym / Fitness Center  Gym Pool  Gymnastics Gym  \
0        0.000000  0.000000              0.000000  0.000000        0.000000
1        0.031250  0.000000              0.000000  0.000000        0.000000
2        0.000000  0.000000              0.000000  0.000000        0.000000
3        0.000000  0.000000              0.058824  0.000000        0.000000
4        0.000000  0.000000              0.000000  0.000000        0.000000
5        0.037037  0.037037              0.000000  0.037037        0.000000
6        0.000000  0.025641              0.000000  0.000000        0.000000
7        0.000000  0.000000              0.000000  0.000000        0.000000
8        0.000000  0.000000              0.034483  0.000000        0.000000
9        0.000000  0.166667              0.000000  0.000000        0.083333
10       0.000000  0.000000              0.000000  0.000000        0.000000
11       0.000000  0.014706              0.014706  0.000000        0.000000
12       0.000000  0.037037              0.000000  0.000000        0.000000
13       0.000000  0.000000              0.000000  0.000000        0.000000
14       0.000000  0.000000              0.000000  0.000000        0.000000

    Harbor / Marina  Health & Beauty Service  Hookah Bar    Hostel  \
0          0.000000                 0.000000    0.000000  0.000000
1          0.000000                 0.000000    0.000000  0.000000
2          0.000000                 0.000000    0.000000  0.000000
3          0.000000                 0.000000    0.000000  0.000000
4          0.000000                 0.000000    0.000000  0.000000
5          0.000000                 0.000000    0.000000  0.000000
6          0.000000                 0.025641    0.000000  0.000000
7          0.000000                 0.000000    0.000000  0.000000
8          0.000000                 0.000000    0.000000  0.000000
9          0.000000                 0.000000    0.000000  0.000000
10         0.000000                 0.000000    0.000000  0.000000
11         0.000000                 0.000000    0.014706  0.014706
12         0.037037                 0.000000    0.000000  0.000000
13         0.000000                 0.000000    0.000000  0.000000
14         0.000000                 0.000000    0.020000  0.000000

    Hot Spring     Hotel  Hotel Bar  IT Services  Ice Cream Shop  \
0     0.000000  0.333333   0.000000         0.00        0.000000
1     0.000000  0.031250   0.000000         0.00        0.031250
2     0.000000  0.000000   0.000000         0.00        0.026316
3     0.000000  0.000000   0.000000         0.00        0.058824
4     0.142857  0.142857   0.000000         0.00        0.000000
5     0.000000  0.037037   0.000000         0.00        0.000000
6     0.000000  0.128205   0.025641         0.00        0.025641
7     0.000000  0.017857   0.000000         0.00        0.000000
8     0.000000  0.000000   0.000000         0.00        0.000000
9     0.000000  0.000000   0.000000         0.00        0.000000
```

```
10    0.000000  0.000000   0.000000         0.00        0.000000
11    0.000000  0.058824   0.000000         0.00        0.029412
12    0.000000  0.074074   0.000000         0.00        0.000000
13    0.000000  0.000000   0.000000         0.00        0.000000
14    0.000000  0.000000   0.000000         0.01        0.010000

    Indian Restaurant  Italian Restaurant  Japanese Restaurant  Jewelry Store  \
0            0.000000            0.000000             0.000000       0.000000
1            0.062500            0.000000             0.000000       0.000000
2            0.447368            0.000000             0.026316       0.000000
3            0.000000            0.000000             0.000000       0.000000
4            0.000000            0.000000             0.000000       0.000000
5            0.037037            0.037037             0.000000       0.000000
6            0.025641            0.051282             0.000000       0.000000
7            0.017857            0.035714             0.017857       0.035714
8            0.000000            0.034483             0.000000       0.000000
9            0.000000            0.000000             0.000000       0.000000
10           0.000000            0.000000             0.000000       0.000000
11           0.073529            0.000000             0.000000       0.000000
12           0.037037            0.074074             0.037037       0.000000
13           0.000000            0.166667             0.000000       0.000000
14           0.010000            0.040000             0.010000       0.000000

    Juice Bar  Korean Restaurant  Lebanese Restaurant  Lingerie Store  \
0    0.000000           0.000000             0.000000            0.00
1    0.000000           0.000000             0.000000            0.00
2    0.000000           0.026316             0.000000            0.00
3    0.058824           0.000000             0.000000            0.00
4    0.000000           0.000000             0.000000            0.00
5    0.000000           0.000000             0.000000            0.00
6    0.000000           0.000000             0.000000            0.00
7    0.000000           0.000000             0.000000            0.00
8    0.000000           0.034483             0.000000            0.00
9    0.000000           0.000000             0.000000            0.00
10   0.000000           0.000000             0.000000            0.00
11   0.014706           0.000000             0.000000            0.00
12   0.000000           0.000000             0.037037            0.00
13   0.000000           0.000000             0.000000            0.00
14   0.010000           0.000000             0.000000            0.01

      Lounge  Medical Center  Mediterranean Restaurant  Mexican Restaurant  \
0   0.000000        0.000000                  0.000000            0.000000
1   0.000000        0.000000                  0.000000            0.000000
2   0.000000        0.000000                  0.000000            0.000000
3   0.000000        0.000000                  0.000000            0.000000
4   0.000000        0.142857                  0.000000            0.000000
5   0.000000        0.000000                  0.000000            0.000000
```

```
6   0.025641        0.000000                  0.000000            0.000000
7   0.035714        0.000000                  0.017857            0.035714
8   0.000000        0.000000                  0.000000            0.000000
9   0.000000        0.000000                  0.000000            0.000000
10  0.000000        0.000000                  0.000000            0.000000
11  0.000000        0.000000                  0.000000            0.000000
12  0.000000        0.000000                  0.000000            0.000000
13  0.000000        0.000000                  0.000000            0.000000
14  0.000000        0.000000                  0.000000            0.000000

    Middle Eastern Restaurant  Miscellaneous Shop  Moroccan Restaurant  \
0                    0.000000            0.000000             0.000000
1                    0.156250            0.000000             0.000000
2                    0.026316            0.000000             0.000000
3                    0.058824            0.000000             0.000000
4                    0.000000            0.000000             0.000000
5                    0.074074            0.000000             0.000000
6                    0.000000            0.000000             0.025641
7                    0.035714            0.000000             0.000000
8                    0.034483            0.000000             0.000000
9                    0.000000            0.000000             0.000000
10                   0.000000            0.000000             0.000000
11                   0.088235            0.014706             0.000000
12                   0.037037            0.000000             0.000000
13                   0.000000            0.000000             0.000000
14                   0.020000            0.000000             0.000000

    Movie Theater  Multiplex  Nail Salon  Nightclub  Optical Shop  \
0        0.000000   0.000000    0.000000   0.000000          0.00
1        0.062500   0.000000    0.000000   0.000000          0.00
2        0.000000   0.000000    0.000000   0.000000          0.00
3        0.000000   0.000000    0.000000   0.000000          0.00
4        0.000000   0.000000    0.000000   0.000000          0.00
5        0.000000   0.000000    0.000000   0.000000          0.00
6        0.025641   0.000000    0.000000   0.000000          0.00
7        0.000000   0.017857    0.000000   0.000000          0.00
8        0.000000   0.000000    0.034483   0.000000          0.00
9        0.000000   0.000000    0.000000   0.000000          0.00
10       0.000000   0.000000    0.000000   0.000000          0.00
11       0.014706   0.000000    0.000000   0.000000          0.00
12       0.000000   0.000000    0.000000   0.037037          0.00
13       0.000000   0.000000    0.000000   0.000000          0.00
14       0.030000   0.000000    0.000000   0.000000          0.01

    Pakistani Restaurant      Park  Peruvian Restaurant  Pet Store  Pharmacy  \
0               0.000000  0.000000             0.000000   0.000000  0.000000
1               0.000000  0.000000             0.000000   0.000000  0.000000
```

```
2               0.026316  0.026316             0.000000   0.000000  0.000000
3               0.000000  0.000000             0.000000   0.000000  0.000000
4               0.000000  0.000000             0.000000   0.000000  0.000000
5               0.000000  0.000000             0.000000   0.000000  0.037037
6               0.000000  0.025641             0.000000   0.000000  0.000000
7               0.000000  0.000000             0.017857   0.000000  0.000000
8               0.000000  0.000000             0.000000   0.000000  0.000000
9               0.000000  0.000000             0.000000   0.083333  0.000000
10              0.000000  0.000000             0.000000   0.000000  0.000000
11              0.000000  0.000000             0.000000   0.000000  0.000000
12              0.000000  0.000000             0.000000   0.000000  0.000000
13              0.000000  0.000000             0.000000   0.000000  0.000000
14              0.000000  0.000000             0.000000   0.000000  0.000000

    Pizza Place  Playground     Plaza      Pool       Pub  Racetrack  \
0      0.000000    0.000000  0.000000  0.000000  0.000000       0.00
1      0.031250    0.000000  0.000000  0.000000  0.000000       0.00
2      0.000000    0.000000  0.000000  0.000000  0.000000       0.00
3      0.000000    0.000000  0.000000  0.000000  0.000000       0.00
4      0.000000    0.000000  0.000000  0.000000  0.000000       0.00
5      0.037037    0.000000  0.000000  0.000000  0.000000       0.00
6      0.000000    0.000000  0.000000  0.000000  0.000000       0.00
7      0.000000    0.000000  0.017857  0.017857  0.000000       0.00
8      0.034483    0.000000  0.000000  0.000000  0.000000       0.00
9      0.083333    0.000000  0.000000  0.250000  0.000000       0.00
10     0.000000    0.000000  0.000000  0.000000  0.000000       0.00
11     0.029412    0.014706  0.000000  0.000000  0.014706       0.00
12     0.000000    0.000000  0.000000  0.000000  0.000000       0.00
13     0.000000    0.000000  0.000000  0.000000  0.000000       0.00
14     0.010000    0.000000  0.000000  0.000000  0.000000       0.01

    Residential Building (Apartment / Condo)    Resort  Restaurant  \
0                                   0.000000  0.000000    0.000000
1                                   0.000000  0.000000    0.000000
2                                   0.000000  0.000000    0.026316
3                                   0.000000  0.000000    0.000000
4                                   0.000000  0.000000    0.000000
5                                   0.000000  0.037037    0.037037
6                                   0.000000  0.025641    0.025641
7                                   0.017857  0.017857    0.000000
8                                   0.000000  0.000000    0.000000
9                                   0.083333  0.000000    0.000000
10                                  0.000000  0.000000    0.000000
11                                  0.000000  0.000000    0.014706
12                                  0.000000  0.000000    0.037037
13                                  0.000000  0.000000    0.000000
14                                  0.000000  0.010000    0.000000
```

```
    Sandwich Place  Seafood Restaurant  Shawarma Place  Shoe Store  \
0         0.166667            0.000000        0.000000    0.000000   
1         0.000000            0.031250        0.000000    0.000000   
2         0.000000            0.000000        0.000000    0.000000   
3         0.000000            0.000000        0.058824    0.000000   
4         0.000000            0.000000        0.000000    0.000000   
5         0.000000            0.000000        0.000000    0.000000   
6         0.000000            0.025641        0.000000    0.000000   
7         0.000000            0.000000        0.000000    0.017857   
8         0.034483            0.034483        0.000000    0.000000   
9         0.000000            0.000000        0.000000    0.000000   
10        0.000000            0.000000        0.000000    0.000000   
11        0.014706            0.000000        0.000000    0.000000   
12        0.000000            0.000000        0.000000    0.000000   
13        0.000000            0.000000        0.000000    0.000000   
14        0.020000            0.000000        0.000000    0.000000   

    Shopping Mall  Snack Place  South Indian Restaurant       Spa  \
0        0.000000      0.00000                 0.000000  0.000000   
1        0.000000      0.03125                 0.000000  0.000000   
2        0.000000      0.00000                 0.026316  0.000000   
3        0.000000      0.00000                 0.000000  0.000000   
4        0.000000      0.00000                 0.000000  0.000000   
5        0.037037      0.00000                 0.000000  0.000000   
6        0.000000      0.00000                 0.000000  0.000000   
7        0.017857      0.00000                 0.000000  0.017857   
8        0.000000      0.00000                 0.000000  0.000000   
9        0.000000      0.00000                 0.000000  0.000000   
10       0.000000      0.00000                 0.000000  0.000000   
11       0.029412      0.00000                 0.000000  0.000000   
12       0.037037      0.00000                 0.000000  0.074074   
13       0.166667      0.00000                 0.000000  0.000000   
14       0.010000      0.00000                 0.000000  0.000000   

    Sporting Goods Shop  Sports Bar  Steakhouse  Supermarket  \
0                  0.00    0.000000    0.000000     0.000000   
1                  0.00    0.000000    0.000000     0.000000   
2                  0.00    0.000000    0.000000     0.026316   
3                  0.00    0.000000    0.000000     0.058824   
4                  0.00    0.000000    0.000000     0.000000   
5                  0.00    0.000000    0.000000     0.000000   
6                  0.00    0.025641    0.000000     0.000000   
7                  0.00    0.000000    0.035714     0.017857   
8                  0.00    0.000000    0.000000     0.000000   
9                  0.00    0.000000    0.000000     0.000000   
10                 0.00    0.000000    0.000000     0.000000   
```

```
11                 0.00    0.000000    0.000000     0.000000
12                 0.00    0.000000    0.037037     0.000000
13                 0.00    0.000000    0.000000     0.166667
14                 0.04    0.000000    0.030000     0.010000

    Sushi Restaurant  Tennis Court  Theater  Theme Park  \
0           0.000000      0.000000     0.00        0.00   
1           0.000000      0.000000     0.00        0.00   
2           0.000000      0.000000     0.00        0.00   
3           0.000000      0.000000     0.00        0.00   
4           0.000000      0.000000     0.00        0.00   
5           0.000000      0.000000     0.00        0.00   
6           0.000000      0.000000     0.00        0.00   
7           0.035714      0.000000     0.00        0.00   
8           0.000000      0.000000     0.00        0.00   
9           0.000000      0.083333     0.00        0.00   
10          0.000000      0.000000     0.00        0.00   
11          0.000000      0.000000     0.00        0.00   
12          0.000000      0.000000     0.00        0.00   
13          0.166667      0.000000     0.00        0.00   
14          0.000000      0.000000     0.01        0.03   

    Theme Park Ride / Attraction  Theme Restaurant  Toy / Game Store  \
0                           0.00          0.000000              0.00   
1                           0.00          0.000000              0.00   
2                           0.00          0.026316              0.00   
3                           0.00          0.000000              0.00   
4                           0.00          0.000000              0.00   
5                           0.00          0.000000              0.00   
6                           0.00          0.000000              0.00   
7                           0.00          0.000000              0.00   
8                           0.00          0.000000              0.00   
9                           0.00          0.000000              0.00   
10                          0.00          0.000000              0.00   
11                          0.00          0.000000              0.00   
12                          0.00          0.000000              0.00   
13                          0.00          0.000000              0.00   
14                          0.12          0.000000              0.03   

    Turkish Restaurant  Vegetarian / Vegan Restaurant  Wine Bar
0              0.00000                       0.000000  0.000000
1              0.03125                       0.000000  0.000000
2              0.00000                       0.026316  0.000000
3              0.00000                       0.000000  0.000000
4              0.00000                       0.000000  0.000000
5              0.00000                       0.000000  0.000000
6              0.00000                       0.000000  0.000000
```

```
7              0.00000                       0.000000  0.017857
8              0.00000                       0.000000  0.000000
9              0.00000                       0.000000  0.000000
10             0.00000                       0.000000  0.000000
11             0.00000                       0.000000  0.014706
12             0.00000                       0.000000  0.000000
13             0.00000                       0.000000  0.000000
14             0.00000                       0.000000  0.000000
```

We now have the frequency for each neighborhood.
What are the top 5 venues for each neighborhood?

[77]:

```
num_top_venues = 5

for hood in AD_grouped['Neighborhood']:
    print("----"+hood+"----")
    temp = AD_grouped[AD_grouped['Neighborhood'] == hood].T.reset_index()
    temp.columns = ['venue','freq']
    temp = temp.iloc[1:]
    temp['freq'] = temp['freq'].astype(float)
    temp = temp.round({'freq': 2})
    print(temp.sort_values('freq', ascending=False).reset_index(drop=True).
 ↪head(num_top_venues))
    print('\n')
```

```
----Al Aman----
                  venue  freq
0                 Hotel  0.33
1  Fast Food Restaurant  0.17
2           Coffee Shop  0.17
3        Sandwich Place  0.17
4                  Café  0.17


----Al Dhafrah----
                       venue  freq
0  Middle Eastern Restaurant  0.16
1                       Café  0.09
2              Movie Theater  0.06
3        Fried Chicken Joint  0.06
4       Fast Food Restaurant  0.06


----Al Karama----
               venue  freq
0  Indian Restaurant  0.45
1   Asian Restaurant  0.11
2             Bakery  0.08
```

```
3        Supermarket  0.03
4               Park  0.03


----Al Khubeirah----
                  venue  freq
0           Coffee Shop  0.24
1                  Café  0.24
2  Fast Food Restaurant  0.12
3           Supermarket  0.06
4        Shawarma Place  0.06


----Al Manhal----
            venue  freq
0            Café  0.43
1           Hotel  0.14
2      Hot Spring  0.14
3  Medical Center  0.14
4     Coffee Shop  0.14


----Al Maqtaa----
                       venue  freq
0                       Café  0.19
1  Middle Eastern Restaurant  0.07
2                Coffee Shop  0.07
3               Burger Joint  0.04
4          French Restaurant  0.04


----Al Markaziyah----
                  venue  freq
0  Fast Food Restaurant  0.13
1                 Hotel  0.13
2                  Café  0.08
3      Asian Restaurant  0.05
4    Italian Restaurant  0.05


----Al Maryah Island----
                venue  freq
0                Café  0.09
1         Coffee Shop  0.07
2  Mexican Restaurant  0.04
3       Jewelry Store  0.04
4    Sushi Restaurant  0.04
```

```
----Al Nahyan----
          venue  freq
0          Café  0.17
1   Coffee Shop  0.10
2   Flower Shop  0.07
3        Bakery  0.07
4  Dessert Shop  0.07


----Al Reef----
                                      venue  freq
0                                      Pool  0.25
1                                       Gym  0.17
2                              Tennis Court  0.08
3                                 Pet Store  0.08
4  Residential Building (Apartment / Condo)  0.08


----Al Rowdah----
            venue  freq
0            Café  0.62
1     Coffee Shop  0.25
2  Cosmetics Shop  0.12
3   Women's Store  0.00
4       Multiplex  0.00


----Al Zahiyah----
                       venue  freq
0  Middle Eastern Restaurant  0.09
1          Indian Restaurant  0.07
2                      Hotel  0.06
3               Dessert Shop  0.04
4       Fast Food Restaurant  0.04


----Bain Al Jisrain----
                 venue  freq
0          Coffee Shop  0.11
1                  Spa  0.07
2   Italian Restaurant  0.07
3                Hotel  0.07
4  Lebanese Restaurant  0.04


----Masdar City----
                  venue  freq
```

```
0         Shopping Mall  0.17
1      Sushi Restaurant  0.17
2    Italian Restaurant  0.17
3  Fast Food Restaurant  0.17
4                  Café  0.17


----Yas Island----
                          venue  freq
0  Theme Park Ride / Attraction  0.12
1                          Café  0.11
2                   Coffee Shop  0.07
3            Italian Restaurant  0.04
4           Sporting Goods Shop  0.04
```

Let's put this information in a dataframe, with the top 5 most common venues for each neighborhood.

[78]:

```python
#This function sorts the venues in descending order
def return_most_common_venues(row, num_top_venues):
    row_categories = row.iloc[1:]
    row_categories_sorted = row_categories.sort_values(ascending=False)

    return row_categories_sorted.index.values[0:num_top_venues]
```

[79]:

```python
num_top_venues = 5

indicators = ['st', 'nd', 'rd']

# create columns according to number of top venues
columns = ['Neighborhood']
for ind in np.arange(num_top_venues):
    try:
        columns.append('{}{} Most Common Venue'.format(ind+1, indicators[ind]))
    except:
        columns.append('{}th Most Common Venue'.format(ind+1))

# create a new dataframe
neighborhoods_venues_sorted = pd.DataFrame(columns=columns)
neighborhoods_venues_sorted['Neighborhood'] = AD_grouped['Neighborhood']

for ind in np.arange(AD_grouped.shape[0]):
    neighborhoods_venues_sorted.iloc[ind, 1:] =␣
 ↪return_most_common_venues(AD_grouped.iloc[ind, :], num_top_venues)

neighborhoods_venues_sorted.head()
```

[79]:

```
   Neighborhood      1st Most Common Venue 2nd Most Common Venue  \
0       Al Aman                      Hotel           Coffee Shop
1    Al Dhafrah  Middle Eastern Restaurant                  Café
2     Al Karama          Indian Restaurant      Asian Restaurant
3  Al Khubeirah                       Café           Coffee Shop
4     Al Manhal                       Café            Hot Spring

  3rd Most Common Venue   4th Most Common Venue 5th Most Common Venue
0  Fast Food Restaurant          Sandwich Place                  Café
1   Fried Chicken Joint  Furniture / Home Store  Fast Food Restaurant
2                Bakery          Ice Cream Shop             Cafeteria
3  Fast Food Restaurant              Donut Shop  Gym / Fitness Center
4        Medical Center             Coffee Shop                 Hotel
```

Let's have a look at the whole thing...

[80]:

```
neighborhoods_venues_sorted
```

[80]:

```
        Neighborhood         1st Most Common Venue 2nd Most Common Venue  \
0            Al Aman                         Hotel           Coffee Shop
1         Al Dhafrah     Middle Eastern Restaurant                  Café
2          Al Karama             Indian Restaurant      Asian Restaurant
3       Al Khubeirah                          Café           Coffee Shop
4          Al Manhal                          Café            Hot Spring
5          Al Maqtaa                          Café           Coffee Shop
6      Al Markaziyah          Fast Food Restaurant                 Hotel
7   Al Maryah Island                          Café           Coffee Shop
8          Al Nahyan                          Café           Coffee Shop
9            Al Reef                          Pool                   Gym
10         Al Rowdah                          Café           Coffee Shop
11        Al Zahiyah     Middle Eastern Restaurant     Indian Restaurant
12   Bain Al Jisrain                   Coffee Shop                   Spa
13       Masdar City              Sushi Restaurant    Italian Restaurant
14        Yas Island  Theme Park Ride / Attraction                  Café

        3rd Most Common Venue      4th Most Common Venue 5th Most Common Venue
0        Fast Food Restaurant             Sandwich Place                  Café
1         Fried Chicken Joint     Furniture / Home Store  Fast Food Restaurant
2                      Bakery             Ice Cream Shop             Cafeteria
3        Fast Food Restaurant                 Donut Shop  Gym / Fitness Center
4              Medical Center                Coffee Shop                 Hotel
5   Middle Eastern Restaurant                   Pharmacy         Shopping Mall
6                        Café         Italian Restaurant      Asian Restaurant
7            Sushi Restaurant  Middle Eastern Restaurant   American Restaurant
8                Dessert Shop                Flower Shop                Bakery
9                 Pizza Place          Convenience Store           Coffee Shop
10             Cosmetics Shop                   Wine Bar            Donut Shop
```

```
11                  Hotel           Coffee Shop  Fast Food Restaurant
12                  Hotel   Italian Restaurant   Lebanese Restaurant
13                   Café           Supermarket  Fast Food Restaurant
14            Coffee Shop        Clothing Store   Sporting Goods Shop
```

Now we can attempt to cluster these neighborhoods based on how similar its businesses are.

[81]:
```
# set number of clusters
kclusters = 5

AD_grouped_clustering = AD_grouped.drop('Neighborhood', 1)

# run k-means clustering
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(AD_grouped_clustering)

# check cluster labels generated for each row in the dataframe
kmeans.labels_[0:5]
```

[81]:
```
array([0, 1, 3, 1, 2], dtype=int32)
```

[82]:
```
# add clustering labels
neighborhoods_venues_sorted.insert(0, 'Cluster_Labels', kmeans.labels_)

AD_merged = df

# merge AD_grouped with AD_data to add latitude/longitude for each neighborhood
AD_merged = AD_merged.join(neighborhoods_venues_sorted.
 ↪set_index('Neighborhood'), on='Neighborhood')

AD_merged.head()
```

[82]:
```
  Neighborhood      Lat      Lon  Cluster_Labels      1st Most Common Venue  \
0      Al Aman   24.432  54.4266             0.0                      Hotel
1    Al Bateen  24.2151  55.6263             NaN                        NaN
2   Al Dhafrah  24.4761  54.3694             1.0  Middle Eastern Restaurant
3     Al Falah  24.4447  54.7282             NaN                        NaN
4    Al Karama  25.2444  55.3048             3.0         Indian Restaurant

  2nd Most Common Venue 3rd Most Common Venue   4th Most Common Venue  \
0           Coffee Shop  Fast Food Restaurant          Sandwich Place
1                   NaN                   NaN                     NaN
2                  Café    Fried Chicken Joint  Furniture / Home Store
3                   NaN                   NaN                     NaN
4     Asian Restaurant                 Bakery          Ice Cream Shop

  5th Most Common Venue
0                  Café
```

```
1                    NaN
2   Fast Food Restaurant
3                    NaN
4              Cafeteria
```

[83]:
```
AD_merged
```

[83]:
```
                 Neighborhood      Lat      Lon  Cluster_Labels  \
0                     Al Aman   24.432  54.4266             0.0
1                   Al Bateen  24.2151  55.6263             NaN
2                  Al Dhafrah  24.4761  54.3694             1.0
3                    Al Falah  24.4447  54.7282             NaN
4                   Al Karama  25.2444  55.3048             3.0
5                Al Khubeirah  24.4652  54.3368             1.0
6              Al Lulu Island  24.4996  54.3457             NaN
7                   Al Madina  24.3409  54.4907             NaN
8            Al Maryah Island  24.5021  54.3902             1.0
9                   Al Manhal  24.4666   54.366             2.0
10                  Al Maqtaa  24.4346  54.4544             1.0
11              Al Markaziyah  24.4933  54.3667             1.0
12                 Al Mushrif  24.4369   54.391             NaN
13                  Al Nahyan  24.4684  54.3852             1.0
14                    Al Reef  24.4577  54.6737             4.0
15             Al Reem Island  24.4867  54.4105             NaN
16                  Al Rowdah  24.4564  54.3596             2.0
17                 Al Shamkha  24.3885  54.7184             NaN
18                 Al Zahiyah  24.4933  54.3799             1.0
19                  Al Zahraa  24.4392  54.4352             NaN
20            Bain Al Jisrain  24.4092  54.4954             1.0
21               Khalifa City  24.4214  54.5774             NaN
22                Masdar City  24.4259  54.6193             1.0
23    Mohammed Bin Zayed City  24.3279  54.5624             NaN
24            Saadiyat Island  24.5303  54.4409             NaN
25             Shakhbout City  24.3622   54.631             NaN
26              Officers City  24.3824   54.535             NaN
27               Qasr El Bahr  24.4746  54.3966             NaN
28                 Yas Island  24.4864  54.6091             1.0

           1st Most Common Venue 2nd Most Common Venue  \
0                          Hotel           Coffee Shop
1                            NaN                   NaN
2      Middle Eastern Restaurant                  Café
3                            NaN                   NaN
4              Indian Restaurant      Asian Restaurant
5                           Café           Coffee Shop
6                            NaN                   NaN
7                            NaN                   NaN
```

```
8                           Café           Coffee Shop
9                           Café            Hot Spring
10                          Café           Coffee Shop
11          Fast Food Restaurant                 Hotel
12                           NaN                   NaN
13                          Café           Coffee Shop
14                          Pool                   Gym
15                           NaN                   NaN
16                          Café           Coffee Shop
17                           NaN                   NaN
18     Middle Eastern Restaurant     Indian Restaurant
19                           NaN                   NaN
20                   Coffee Shop                   Spa
21                           NaN                   NaN
22              Sushi Restaurant    Italian Restaurant
23                           NaN                   NaN
24                           NaN                   NaN
25                           NaN                   NaN
26                           NaN                   NaN
27                           NaN                   NaN
28  Theme Park Ride / Attraction                  Café

        3rd Most Common Venue      4th Most Common Venue 5th Most Common Venue
0        Fast Food Restaurant             Sandwich Place                  Café
1                         NaN                        NaN                   NaN
2         Fried Chicken Joint     Furniture / Home Store  Fast Food Restaurant
3                         NaN                        NaN                   NaN
4                      Bakery             Ice Cream Shop             Cafeteria
5        Fast Food Restaurant                 Donut Shop  Gym / Fitness Center
6                         NaN                        NaN                   NaN
7                         NaN                        NaN                   NaN
8            Sushi Restaurant  Middle Eastern Restaurant   American Restaurant
9              Medical Center                Coffee Shop                 Hotel
10  Middle Eastern Restaurant                   Pharmacy         Shopping Mall
11                       Café         Italian Restaurant      Asian Restaurant
12                        NaN                        NaN                   NaN
13               Dessert Shop                Flower Shop                Bakery
14                Pizza Place          Convenience Store           Coffee Shop
15                        NaN                        NaN                   NaN
16             Cosmetics Shop                   Wine Bar            Donut Shop
17                        NaN                        NaN                   NaN
18                      Hotel                Coffee Shop  Fast Food Restaurant
19                        NaN                        NaN                   NaN
20                      Hotel         Italian Restaurant   Lebanese Restaurant
21                        NaN                        NaN                   NaN
22                       Café                Supermarket  Fast Food Restaurant
23                        NaN                        NaN                   NaN
```

```
24                   NaN                   NaN                 NaN
25                   NaN                   NaN                 NaN
26                   NaN                   NaN                 NaN
27                   NaN                   NaN                 NaN
28           Coffee Shop        Clothing Store  Sporting Goods Shop
```

Since we used our original dataframe some of the neighborhoods in which no venues were found on Foursquare reappeared here.
Let's drop these NA's. Also we will change the cluster values to integer.

[84]:

```
AD_merged=AD_merged.dropna()
AD_merged['Cluster_Labels'] = AD_merged.Cluster_Labels.astype(int)
```

```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-
packages/ipykernel_launcher.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

[85]:

```
AD_merged
```

[85]:

```
        Neighborhood      Lat      Lon  Cluster_Labels  \
0            Al Aman   24.432  54.4266               0
2         Al Dhafrah  24.4761  54.3694               1
4          Al Karama  25.2444  55.3048               3
5        Al Khubeirah  24.4652  54.3368               1
8   Al Maryah Island  24.5021  54.3902               1
9          Al Manhal  24.4666   54.366               2
10         Al Maqtaa  24.4346  54.4544               1
11      Al Markaziyah  24.4933  54.3667               1
13         Al Nahyan  24.4684  54.3852               1
14           Al Reef  24.4577  54.6737               4
16         Al Rowdah  24.4564  54.3596               2
18        Al Zahiyah  24.4933  54.3799               1
20    Bain Al Jisrain  24.4092  54.4954               1
22       Masdar City  24.4259  54.6193               1
28        Yas Island  24.4864  54.6091               1

        1st Most Common Venue 2nd Most Common Venue  \
0                       Hotel           Coffee Shop
2    Middle Eastern Restaurant                 Café
4           Indian Restaurant      Asian Restaurant
5                        Café           Coffee Shop
8                        Café           Coffee Shop
```

```
9                           Café            Hot Spring
10                          Café           Coffee Shop
11          Fast Food Restaurant                 Hotel
13                          Café           Coffee Shop
14                          Pool                   Gym
16                          Café           Coffee Shop
18     Middle Eastern Restaurant     Indian Restaurant
20                   Coffee Shop                   Spa
22              Sushi Restaurant    Italian Restaurant
28  Theme Park Ride / Attraction                  Café

        3rd Most Common Venue      4th Most Common Venue 5th Most Common Venue
0        Fast Food Restaurant             Sandwich Place                  Café
2         Fried Chicken Joint     Furniture / Home Store  Fast Food Restaurant
4                      Bakery             Ice Cream Shop             Cafeteria
5        Fast Food Restaurant                 Donut Shop  Gym / Fitness Center
8            Sushi Restaurant  Middle Eastern Restaurant   American Restaurant
9              Medical Center                Coffee Shop                 Hotel
10  Middle Eastern Restaurant                   Pharmacy         Shopping Mall
11                       Café         Italian Restaurant      Asian Restaurant
13               Dessert Shop                Flower Shop                Bakery
14                Pizza Place          Convenience Store           Coffee Shop
16             Cosmetics Shop                   Wine Bar            Donut Shop
18                      Hotel                Coffee Shop  Fast Food Restaurant
20                      Hotel         Italian Restaurant   Lebanese Restaurant
22                       Café                Supermarket  Fast Food Restaurant
28                Coffee Shop             Clothing Store   Sporting Goods Shop
```

Now we can map the neighborhoods differentiating the clusters with different colors.

[86]:

```python
# create map
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=11)

# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(AD_merged['Lat'], AD_merged['Lon'],␣
 ↪AD_merged['Neighborhood'], AD_merged['Cluster_Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

```
[86]: <folium.folium.Map at 0x7fb4ca8455f8>
```

Let’s inspect cluster 1, the most common one.

```
[87]: AD_merged.loc[AD_merged['Cluster_Labels'] == 1, AD_merged.columns[[0] +␣
       ↪list(range(4, AD_merged.shape[1]))]]
```

```
[87]:         Neighborhood         1st Most Common Venue 2nd Most Common Venue  \
      2          Al Dhafrah     Middle Eastern Restaurant                  Café
      5        Al Khubeirah                          Café           Coffee Shop
      8     Al Maryah Island                          Café           Coffee Shop
      10          Al Maqtaa                          Café           Coffee Shop
      11      Al Markaziyah          Fast Food Restaurant                 Hotel
      13           Al Nahyan                          Café           Coffee Shop
      18          Al Zahiyah     Middle Eastern Restaurant     Indian Restaurant
      20     Bain Al Jisrain                   Coffee Shop                   Spa
      22        Masdar City               Sushi Restaurant    Italian Restaurant
      28          Yas Island  Theme Park Ride / Attraction                  Café

              3rd Most Common Venue      4th Most Common Venue 5th Most Common Venue
      2          Fried Chicken Joint     Furniture / Home Store  Fast Food Restaurant
      5         Fast Food Restaurant                Donut Shop  Gym / Fitness Center
      8             Sushi Restaurant  Middle Eastern Restaurant   American Restaurant
      10  Middle Eastern Restaurant                   Pharmacy         Shopping Mall
      11                        Café        Italian Restaurant      Asian Restaurant
      13                Dessert Shop               Flower Shop                Bakery
      18                       Hotel               Coffee Shop  Fast Food Restaurant
      20                       Hotel        Italian Restaurant   Lebanese Restaurant
      22                        Café               Supermarket  Fast Food Restaurant
      28                 Coffee Shop            Clothing Store   Sporting Goods Shop
```

We can already get some insights from this table. We see that our business idea, a coffee shop, is very present is most areas. But let’s take a look at Al Zahiyah.

```
[88]: AD_merged.loc[AD_merged['Neighborhood'] == 'Al Zahiyah']
```

```
[88]:    Neighborhood      Lat      Lon  Cluster_Labels      1st Most Common Venue  \
      18   Al Zahiyah  24.4933  54.3799               1  Middle Eastern Restaurant

         2nd Most Common Venue 3rd Most Common Venue 4th Most Common Venue  \
      18     Indian Restaurant                 Hotel          Coffee Shop

         5th Most Common Venue
      18  Fast Food Restaurant
```

Ok, coffee shop appears only in 4th place. So perhaps there is an opportunity here. This could give a potential business owner a starting point to hers/his research.

I would like to remove coffee shops from the equation and recluster (is that a word?) the neighborhoods. It would be nice to see if maybe we get different neighborhoods that might be clustered together, which could suggest that a coffee shop would be a good investment in area X, because neighborhood Y has a couple, but it was clustered together with X when we removed coffee shops.

However, our current database does not have enough venues to attemp this.

Before we go, let's take a look at our other clusters.

```
[89]: AD_merged.loc[AD_merged['Cluster_Labels'] == 0, AD_merged.columns[[0] +␣
       ↪list(range(4, AD_merged.shape[1]))]]
```

```
[89]:   Neighborhood 1st Most Common Venue 2nd Most Common Venue  \
      0      Al Aman                   Hotel          Coffee Shop

        3rd Most Common Venue 4th Most Common Venue 5th Most Common Venue
      0  Fast Food Restaurant        Sandwich Place                  Café
```

```
[90]: AD_merged.loc[AD_merged['Cluster_Labels'] == 2, AD_merged.columns[[0] +␣
       ↪list(range(4, AD_merged.shape[1]))]]
```

```
[90]:    Neighborhood 1st Most Common Venue 2nd Most Common Venue  \
      9     Al Manhal                    Café            Hot Spring
      16    Al Rowdah                    Café           Coffee Shop

         3rd Most Common Venue 4th Most Common Venue 5th Most Common Venue
      9         Medical Center           Coffee Shop                 Hotel
      16        Cosmetics Shop              Wine Bar            Donut Shop
```

```
[91]: AD_merged.loc[AD_merged['Cluster_Labels'] == 3, AD_merged.columns[[0] +␣
       ↪list(range(4, AD_merged.shape[1]))]]
```

```
[91]:   Neighborhood 1st Most Common Venue 2nd Most Common Venue  \
      4    Al Karama      Indian Restaurant      Asian Restaurant

        3rd Most Common Venue 4th Most Common Venue 5th Most Common Venue
      4                Bakery        Ice Cream Shop             Cafeteria
```

```
[92]: AD_merged.loc[AD_merged['Cluster_Labels'] == 4, AD_merged.columns[[0] +␣
       ↪list(range(4, AD_merged.shape[1]))]]
```

[92]:

```
   Neighborhood 1st Most Common Venue 2nd Most Common Venue  \
14      Al Reef                  Pool                   Gym

   3rd Most Common Venue 4th Most Common Venue 5th Most Common Venue
14           Pizza Place     Convenience Store           Coffee Shop
```

For this last cluster we see Al Reef, which is an up-and-coming residential area. Maybe it could use another coffee shop?

1.4 Discussion and Final Thoughts...

As you can see, there a lot of tools to work with here and make some interesting analysis. Of course, we could always use more data. We can find the locations of the other neighborhoods, even if we have to do it manually.

We showed that there aren't many venues listed on Foursquare for some areas. We could use other databases to see if we get better results. It would also be interesting to integrate this with information about if an area is a business area or a more residential one. As mentioned, we can also explore further the clustering method as well.

However, even with limitations, even if we do not get clear cut conclusions for this exercise, we do get some things from it: * We can at least get some insights and give a direction or focus for our research/work. * This was a great learning experience. Even though I had seen most of these methods during my Master's, I had done everything with R. A refreshment on the subject with Python was a great way to learn a new programming language. * Also, there was much more learned during the course that is not being used in this report. SQL, for example. Plus, as already mentioned in the Methodology, I was presented to a couple of really cool platforms to code and do analysis on, in IBM Skills Network Labs and IBM Cloud with Watson services. Have a look on those.

Thank you for reading this.

[ ]: