Capstone Project - The Battle of Neighborhoods

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Capstone Project - The Battle of Neighborhoods

Munich vs. Berlin

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0.2 1. Introduction/Business Problem

0.3 1.1 Problem description

Two of Germany's most wanted cities are Berlin and Munich. The first cities that come to everybody's mind, when thinking about diversity and a place to be. However, if you think about having agony of choice to pic a restaurant, what would be your first thought? Exactly, - where can I find a restaurant? - which restaurants have the highest user ratings? - and of course, can I afford that?

0.4 1.2 focus and compromise

In this analysis, we will focus on picking the right borough to find a suitable restaurant. If you do not use any Foursquare premium API requests, this will be the compromise to select your destination. Afterwards you can easily search the right restaurant via your mobile app and get the missing information. We use free ***explore*** requests to communicate with Foursquare database. As we decide for one borough, we will start one free premium request for ***trending*** venues.

0.5 1.3 approach and target

First we'll have a look at different venue categories offered by Foursquare. Second, we will create an array for relevant restaurants categories. So data of both cities are quite comparable as we start to evaluate amount of suitable restaurant categories. In addition, we will use the k-means clustering algorithm to splitt restaurant into clusters according to venue categories by Foursquare. Finally, we will use the Folium library to visualize the neighborhoods in Berlin and Munich and their emerging clusters. Based on the results, my wife can decide whether she will have dinner in Munich or Berlin and to which borough I have to navigate her. Anyway, she will only decide with her stomach. Rational evaluation of Foursquare data would exceed my competencies and is going to be outvoted. But as soon as we arrive, we will look for the places with the highest foot traffic. So let's do that and get the trending venues around.

0.6 1.5 define restaurant categories

Since we like to eat in different restaurants and experience new kitchens, we just need the number of restaurants for the first step, regardless of quality, price or user rating. To be comparable, here's a list of venue categories, we would like to compare the cities:

[2]:
```
restaurants = ['American Restaurant',
    'Asian Restaurant',
    'Argentinian Restaurant',
    'Fast Food Restaurant',
    'Bavarian Restaurant',
    'Chinese Restaurant',
    'Eastern European Restaurant',
    'English Restaurant',
    'Falafel Restaurant',
    'German Restaurant',
    'Greek Restaurant',
    'Indian Restaurant',
    'Israeli Restaurant',
    'Italian Restaurant',
    'Mediterranean Restaurant',
    'Mexican Restaurant',
    'Middle Eastern Restaurant',
    'Modern European Restaurant',
    'Restaurant',
    'Seafood Restaurant',
    'Sushi Restaurant',
    'Thai Restaurant',
    'Theme Restaurant',
    'Vegetarian / Vegan Restaurant',
    'Vietnamese Restaurant',
    'Beer Garden',
    'Bistro',
    'Burger Joint',
    'Burrito Place',
```

```
    'Creperie',
    'Fried Chicken Joint',
    'Pizza Place',
    'Steakhouse']
```

[3]:
```
#munich_venues.to_csv('venue_categories_munich.csv', sep=';', decimal=',',␣
 ↪index=True)
#berlin_venues.to_csv('venue_categories_berlin.csv', sep=';', decimal=',',␣
 ↪index=True)
```

0.7 2. Munich: Data import and cleaning

0.8 2.1 libary import

[4]:
```
import pandas as pd
import numpy as np

!pip install BeautifulSoup4
from bs4 import BeautifulSoup
import requests

!pip install lxml
!pip install geopandas
!pip install geopy
import geopy as geo
import geopandas as gpd

import folium
from sklearn.cluster import KMeans

import matplotlib.cm as cm
import matplotlib.colors as colors

pd.options.mode.chained_assignment = None  # default='warn'
print('Done!')
```

```
Collecting BeautifulSoup4
  Downloading https://files.pythonhosted.org/packages/d1/41/e6495bd7d3781c
ee623ce23ea6ac73282a373088fcd0ddc809a047b18eae/beautifulsoup4-4.9.3-py3-none-
any.whl (115kB)
     |                  | 122kB 5.4MB/s eta 0:00:01
Collecting soupsieve>1.2; python_version >= "3.0" (from BeautifulSoup4)
  Downloading https://files.pythonhosted.org/packages/02/fb/1c65691a9aeb7bd6ac2a
a505b84cb8b49ac29c976411c6ab3659425e045f/soupsieve-2.1-py3-none-any.whl
Installing collected packages: soupsieve, BeautifulSoup4
Successfully installed BeautifulSoup4-4.9.3 soupsieve-2.1
Collecting lxml
```

```
  Downloading https://files.pythonhosted.org/packages/bd/78/56a7c88a57d0d1
4945472535d0df9fb4bbad7d34ede658ec7961635c790e/lxml-4.6.2-cp36-cp36m-manylinux1_
x86_64.whl (5.5MB)
     |                 | 5.5MB 8.5MB/s eta 0:00:01
Installing collected packages: lxml
Successfully installed lxml-4.6.2
Collecting geopandas
  Downloading https://files.pythonhosted.org/packages/f7/a4/e66aafbefcbb71
7813bf3a355c8c4fc3ed04ea1dd7feb2920f2f4f868921/geopandas-0.8.1-py2.py3-none-
any.whl (962kB)
     |                 | 972kB 6.4MB/s eta 0:00:01
Collecting shapely (from geopandas)
  Downloading https://files.pythonhosted.org/packages/9d/18/557d4f55453fe0
0f59807b111cc7b39ce53594e13ada88e16738fb4ff7fb/Shapely-1.7.1-cp36-cp36m-manylinu
x1_x86_64.whl (1.0MB)
     |                 | 1.0MB 20.0MB/s eta 0:00:01
Collecting fiona (from geopandas)
  Downloading https://files.pythonhosted.org/packages/37/94/4910fd55246c1d
963727b03885ead6ef1cd3748a465f7b0239ab25dfc9a3/Fiona-1.8.18-cp36-cp36m-manylinux
1_x86_64.whl (14.8MB)
     |                 | 14.8MB 38.8MB/s eta 0:00:01
|                           | 3.5MB 9.1MB/s eta 0:00:02
|                    | 12.4MB 38.8MB/s eta 0:00:01
Collecting pyproj>=2.2.0 (from geopandas)
  Downloading https://files.pythonhosted.org/packages/e4/ab/280e80a67cfc10
9d15428c0ec56391fc03a65857b7727cf4e6e6f99a4204/pyproj-3.0.0.post1-cp36-cp36m-man
ylinux2010_x86_64.whl (6.4MB)
     |                 | 6.5MB 8.6MB/s eta 0:00:01
|                  | 6.0MB 8.6MB/s eta 0:00:01
Requirement already satisfied: pandas>=0.23.0 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from geopandas)
(1.1.5)
Requirement already satisfied: six>=1.7 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
fiona->geopandas) (1.15.0)
Collecting cligj>=0.5 (from fiona->geopandas)
  Downloading https://files.pythonhosted.org/packages/42/1e/947eadf10d6804bf276e
b8a038bd5307996dceaaa41cfd21b7a15ec62f5d/cligj-0.7.1-py3-none-any.whl
Collecting click-plugins>=1.0 (from fiona->geopandas)
  Downloading https://files.pythonhosted.org/packages/e9/da/824b92d9942f4e472702
488857914bdd50f73021efea15b4cad9aca8ecef/click_plugins-1.1.1-py2.py3-none-
any.whl
Requirement already satisfied: certifi in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
fiona->geopandas) (2020.12.5)
Collecting munch (from fiona->geopandas)
  Downloading https://files.pythonhosted.org/packages/cc/ab/85d8da5c9a45e072301b
eb37ad7f833cd344e04c817d97e0cc75681d248f/munch-2.5.0-py2.py3-none-any.whl
```

```
Requirement already satisfied: click<8,>=4.0 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
fiona->geopandas) (7.1.2)
Requirement already satisfied: attrs>=17 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
fiona->geopandas) (20.3.0)
Requirement already satisfied: pytz>=2017.2 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
pandas>=0.23.0->geopandas) (2020.4)
Requirement already satisfied: python-dateutil>=2.7.3 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
pandas>=0.23.0->geopandas) (2.8.1)
Requirement already satisfied: numpy>=1.15.4 in
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages (from
pandas>=0.23.0->geopandas) (1.19.4)
Installing collected packages: shapely, cligj, click-plugins, munch, fiona,
pyproj, geopandas
  Found existing installation: pyproj 1.9.6
    Uninstalling pyproj-1.9.6:
      Successfully uninstalled pyproj-1.9.6
Successfully installed click-plugins-1.1.1 cligj-0.7.1 fiona-1.8.18
geopandas-0.8.1 munch-2.5.0 pyproj-3.0.0.post1 shapely-1.7.1
Collecting geopy
  Downloading https://files.pythonhosted.org/packages/0c/67/915668d0e286ca
a21a1da82a85ffe3d20528ec7212777b43ccd027d94023/geopy-2.1.0-py3-none-any.whl
(112kB)
     |                 | 112kB 7.1MB/s eta 0:00:01
Collecting geographiclib<2,>=1.49 (from geopy)
  Downloading https://files.pythonhosted.org/packages/8b/62/26ec95a98ba642991631
99e95ad1b0e34ad3f4e176e221c40245f211e425/geographiclib-1.50-py3-none-any.whl
Installing collected packages: geographiclib, geopy
Successfully installed geographiclib-1.50 geopy-2.1.0
Done!
```

[ ]:

```

```

0.9 2.2 Munich Data import with beautifulSoup

[5]:

```
url='http://www.places-in-germany.com/
↪21179-places-within-a-radius-of-15km-around-muenchen.html'
req=requests.get(url)
soup=BeautifulSoup(req.text,"html.parser")
table = soup.find_all('table')
df=pd.read_html(str(table), header=0)[0]
```

[6]:

```
df.head()
```

[6]:

```
               Distance  Route          Postal code / Place Population
0  3.4 km (2.1 miles)    NaN            81675 Bogenhausen          -
1  4.3 km (2.7 miles)    NaN           81671 Berg am Laim          -
2  5.1 km (3.2 miles)    NaN  80796 Milbertshofen-Am Hart          -
3  6.7 km (4.2 miles)    NaN                80634 Moosach          -
4  8.7 km (5.4 miles)    NaN           85774 Unterföhring       7553
```

[7]:

```
df.rename({'Postal code / Place':'Borough'},axis=1, inplace=True)
munich=df.Borough.str.split(" ",n=1,expand=True)
munich.rename({0:'postalcode', 1:'borough'}, axis=1, inplace=True)
munich.shape
```

[7]: (88, 2)

test for NaN values

[8]:

```
if munich['borough'].isnull().sum() > 0:
    munich.dropna(axis=0, inplace=True)
    print('NaN values deleted')
else:
    print('no NaN values')
```

```
no NaN values
```

web adresse offers data with same postal code and borough name but different distances to our search request. Therefore we will *drop duplicates()*

[9]:

```
munich.drop_duplicates(keep='first', inplace=True)
munich.shape
```

[9]: (82, 2)

0.10 2.3 Folium Map Munich

[10]:

```
from geopy.geocoders import Nominatim
from geopy.extra.rate_limiter import RateLimiter

lat=[]
lon=[]

geolocator = Nominatim(user_agent='Cousera')

for line, borough in munich.iterrows():

    try:
        adress= borough[0], ' München ', borough[1]
        location = geolocator.geocode(adress)
        #print(location)
```

```
        lat.append(location.latitude)
        lon.append(location.longitude)
    except:
        lat.append(np.nan)
        lon.append(np.nan)

munich['latitude']=lat
munich['longitude']=lon
```

[11]:
```
munich.dropna(axis=0, inplace=True)
munich.shape
```

[11]:
```
(67, 4)
```

[12]:
```
munich
```

[12]:
```
   postalcode                borough   latitude  longitude
0       81675            Bogenhausen  48.158487  11.636682
1       81671           Berg am Laim  48.123483  11.633451
2       80796  Milbertshofen-Am Hart  48.182385  11.575043
3       80634                Moosach  48.179895  11.510571
4       85774           Unterföhring  48.190718  11.644580
..        …                      …        …          …
79      82110           Neugermering  48.127735  11.363372
82      85764             Mittenheim  48.263084  11.557159
83      82065            Baierbrunn  48.020477  11.486546
85      85630            Neukeferloh  48.096429  11.760195
86      85737          Fischerhäuser  48.251850  11.695184

[67 rows x 4 columns]
```

add city center to dataset Folium Map shows, that there's no entry for the searched geo tag itself. It just returns positions around the search tag. So let's add it manually to the results of www.places-in-germany.com.

[13]:
```
df_city = pd.DataFrame({"postalcode":['80331', '80335'],"borough":['Zentrum␣
↪Marienplatz', 'Hauptbahnhof'], "latitude":[48.137187, 48.140458],␣
↪"longitude":[11.575501, 11.557766]})
df_city
```

[13]:
```
  postalcode              borough   latitude  longitude
0      80331  Zentrum Marienplatz  48.137187  11.575501
1      80335         Hauptbahnhof  48.140458  11.557766
```

[14]:
```
munich = munich.append(df_city, ignore_index=True)
```

```
[15]: address = 'munich'

geolocator = Nominatim(user_agent="Cousera")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('geo-coordinates of Munich {}, {}.'.format(latitude, longitude))



# Creating Folium Map
map_munich = folium.Map(location=[latitude, longitude], zoom_start=11)

# add markers to map
for lat, lng, borough in zip(munich['latitude'], munich['longitude'],␣
 ↪munich['borough']):
    label = '{}'.format(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_munich)

map_munich
```

```
geo-coordinates of Munich 48.1371079, 11.5753822.
```

```
[15]: <folium.folium.Map at 0x7f70e5a15c88>
```

```
[ ]:
```

0.11 2.4 Explore Venues with 4square

```
[16]: CLIENT_ID = 'MIXA2M5FTBG1IILFL5ATNOBSNUP4BU4J1BUOGIM03E1UJOBE' # your␣
 ↪Foursquare ID
CLIENT_SECRET = 'ETQCTK31Z04IOFVKYEEEHG2M0JGL0G4DCLQ1R1ECOOPHX33D' # your␣
 ↪Foursquare Secret
VERSION = '20180604'
LIMIT = 100
radius = 500
print("ID loaded")
```

ID loaded

[17]:
```
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 = ['borough',
                  'Latitude',
                  'Longitude',
                  'Venue',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Venue Category']

    return(nearby_venues)
```

[18]:
```
munich_venues = getNearbyVenues(names=munich['borough'],
                                   latitudes=munich['latitude'],
                                   longitudes=munich['longitude']
```

```
)
```

```
Bogenhausen
Berg am Laim
Milbertshofen-Am Hart
Moosach
Unterföhring
Dornach
Neuherberg
Pasing
Neubiberg
Pullach
Gronsdorf, Kreis München
Winning, Kreis München
Taufkirchen, Kreis München
Gräfelfing
Martinsried
Großhesselohe, Isartal
Pullach im Isartal
Ottobrunn
Westerham
Salmdorf, Kreis München
Unterhaching
Hochmutting
Oedenstockach
Steinkirchen
Solalinden
Taufkirchen
Aschheim
Dirnismaning bei München
Feldkirchen
Potzham, Kreis München
Gerblinghausen
Kreuzpullach
Laufzorn
Oberbiberg
Oberhaching bei München
Ödenpullach
Karlsfeld bei München
Putzbrunn
Ottendichl, Kreis München
Haar bei München
Planegg
Lustheim
Oberschleißheim
Hochbrück bei München
Badersfeld
```

```
Eglfing, Kreis München
Waldbrunn
Deisenhofen bei München
Ismaning
Buchenhain, Isartal
Hohenbrunn
Riemerling
Krailling
Garching
Garching bei München
Kirchheim bei München
Kirchheim
Grasbrunn
Frundsbergerhöhe
Kirchstockach, Kreis München
Rothschwaige
Harthaus
Neugermering
Mittenheim
Baierbrunn
Neukeferloh
Fischerhäuser
Zentrum Marienplatz
Hauptbahnhof
```

[19]:
```python
print('4square provided', munich_venues.shape , 'venues')
munich_venues.head(5)
```

```
4square provided (697, 7) venues
```

[19]:
```
       borough   Latitude  Longitude              Venue  Venue Latitude  \
0  Bogenhausen  48.158487  11.636682         Martinelli       48.155396
1  Bogenhausen  48.158487  11.636682  dm-drogerie markt       48.159468
2  Bogenhausen  48.158487  11.636682             Pyrsos       48.154944
3  Bogenhausen  48.158487  11.636682           Rossmann       48.157856
4  Bogenhausen  48.158487  11.636682    Bäckerei Wimmer       48.158156

   Venue Longitude      Venue Category
0        11.637115  Italian Restaurant
1        11.643064           Drugstore
2        11.637708    Greek Restaurant
3        11.641590           Drugstore
4        11.641109              Bakery
```

[20]:
```python
print('There are {} uniques categories.'.format(len(munich_venues['Venue␣
 ↪Category'].unique())))
munich_venues.groupby('Venue Category').Venue.count()
```

```
There are 163 uniques categories.
```

[20]:
```
Venue Category
American Restaurant            1
Argentinian Restaurant         1
Art Museum                     1
Arts & Crafts Store            1
Asian Restaurant              11
                              ..
Trattoria/Osteria              4
Vegetarian / Vegan Restaurant  1
Vietnamese Restaurant          5
Warehouse Store                1
Wine Bar                       2
Name: Venue, Length: 163, dtype: int64
```

0.12 3. Analyze Boroughs of Munich

[21]:
```
munich_restaurants = munich_venues[munich_venues['Venue Category'].str.
↪contains('|'.join(restaurants))]
```

[22]:
```
munich_restaurants.head()
```

[22]:
```
                   borough   Latitude  Longitude         Venue  Venue Latitude  \
0              Bogenhausen  48.158487  11.636682    Martinelli       48.155396
2              Bogenhausen  48.158487  11.636682        Pyrsos       48.154944
20  Milbertshofen-Am Hart  48.182385  11.575043  Rabiang Thai       48.180777
21  Milbertshofen-Am Hart  48.182385  11.575043    Synantisis       48.179632
23  Milbertshofen-Am Hart  48.182385  11.575043  Wolfs-Burger       48.184465

    Venue Longitude      Venue Category
0         11.637115  Italian Restaurant
2         11.637708    Greek Restaurant
20        11.571211     Thai Restaurant
21        11.570367    Greek Restaurant
23        11.571378        Burger Joint
```

0.13 3.1 Frequency of occurance

[23]:
```
# one hot encoding
munich_onehot = pd.get_dummies(munich_restaurants[['Venue Category']],␣
↪prefix="", prefix_sep="")

# add neighborhood column back to dataframe
munich_onehot['borough'] = munich_restaurants['borough']

# move neighborhood column to the first column
```

```python
fixed_columns = [munich_onehot.columns[-1]] + list(munich_onehot.columns[:-1])
munich_onehot = munich_onehot[fixed_columns]

munich_onehot.head()
```

[23]:

```
                 borough  American Restaurant  Argentinian Restaurant  \
0            Bogenhausen                    0                       0
2            Bogenhausen                    0                       0
20  Milbertshofen-Am Hart                    0                       0
21  Milbertshofen-Am Hart                    0                       0
23  Milbertshofen-Am Hart                    0                       0

    Asian Restaurant  Bavarian Restaurant  Beer Garden  Bistro  Burger Joint  \
0                  0                    0            0       0             0
2                  0                    0            0       0             0
20                 0                    0            0       0             0
21                 0                    0            0       0             0
23                 0                    0            0       0             1

    Burrito Place  Chinese Restaurant  …  Modern European Restaurant  \
0               0                   0  …                           0
2               0                   0  …                           0
20              0                   0  …                           0
21              0                   0  …                           0
23              0                   0  …                           0

    Pizza Place  Restaurant  Seafood Restaurant  Steakhouse  Sushi Restaurant  \
0             0           0                   0           0                 0
2             0           0                   0           0                 0
20            0           0                   0           0                 0
21            0           0                   0           0                 0
23            0           0                   0           0                 0

    Thai Restaurant  Theme Restaurant  Vegetarian / Vegan Restaurant  \
0                 0                 0                              0
2                 0                 0                              0
20                1                 0                              0
21                0                 0                              0
23                0                 0                              0

    Vietnamese Restaurant
0                       0
2                       0
20                      0
21                      0
23                      0
```

```
[5 rows x 33 columns]
```

[ ]:

group rows by neighborhood and mean frequency of occurence of each category

[24]:
```
print('Size of One Hot is ', munich_onehot.shape, '.')
munich_grouped = munich_onehot.groupby('borough').mean().reset_index()
munich_grouped.head()
```

```
Size of One Hot is  (183, 33) .
```

[24]:
```
                   borough  American Restaurant  Argentinian Restaurant  \
0                 Aschheim                  0.0                     0.0
1               Baierbrunn                  0.0                     0.0
2              Bogenhausen                  0.0                     0.0
3       Buchenhain, Isartal                 0.0                     0.0
4  Deisenhofen bei München                  0.0                     0.0

   Asian Restaurant  Bavarian Restaurant  Beer Garden  Bistro  Burger Joint  \
0          0.333333                  0.0          0.0     0.0           0.0
1          0.000000                  0.0          0.0     0.0           0.0
2          0.000000                  0.0          0.0     0.0           0.0
3          0.000000                  1.0          0.0     0.0           0.0
4          0.500000                  0.0          0.0     0.0           0.0

   Burrito Place  Chinese Restaurant  …  Modern European Restaurant  \
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

   Pizza Place  Restaurant  Seafood Restaurant  Steakhouse  Sushi Restaurant  \
0          0.0         0.0                 0.0         0.0               0.0
1          0.0         0.0                 0.0         0.0               0.0
2          0.0         0.0                 0.0         0.0               0.0
3          0.0         0.0                 0.0         0.0               0.0
4          0.0         0.0                 0.0         0.0               0.0

   Thai Restaurant  Theme Restaurant  Vegetarian / Vegan Restaurant  \
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
```

```
   Vietnamese Restaurant
0                    0.0
1                    0.0
2                    0.0
3                    0.0
4                    0.0

[5 rows x 33 columns]
```

[25]:
```
print('confirm the new size:', munich_grouped.shape)
```

```
confirm the new size: (50, 33)
```

Let's print each neighborhood along with the top 5 most common venues

[26]:
```
num_top_venues = 5

for hood in munich_grouped['borough']:
    print("----"+hood+"----")
    temp = munich_grouped[munich_grouped['borough'] == 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')
```

```
----Aschheim----
                           venue  freq
0               Greek Restaurant  0.33
1               Asian Restaurant  0.33
2             Italian Restaurant  0.33
3              Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Baierbrunn----
                           venue  freq
0              German Restaurant   1.0
1            American Restaurant   0.0
2              Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Bogenhausen----
                           venue  freq
```

```
0              Greek Restaurant   0.5
1            Italian Restaurant   0.5
2        Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Buchenhain, Isartal----
                           venue  freq
0           Bavarian Restaurant   1.0
1           American Restaurant   0.0
2             Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Deisenhofen bei München----
                           venue  freq
0              Greek Restaurant   0.5
1              Asian Restaurant   0.5
2             Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Dornach----
                venue  freq
0     Thai Restaurant  0.33
1  Italian Restaurant  0.33
2   German Restaurant  0.33
3 American Restaurant  0.00
4   Indian Restaurant  0.00


----Eglfing, Kreis München----
                           venue  freq
0            Italian Restaurant   1.0
1           American Restaurant   0.0
2        Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Feldkirchen----
                           venue  freq
0              Greek Restaurant  0.25
1             German Restaurant  0.25
2            Italian Restaurant  0.25
```

```
3               Asian Restaurant  0.25
4  Vegetarian / Vegan Restaurant  0.00


----Garching----
                venue  freq
0    Greek Restaurant  0.22
1   German Restaurant  0.22
2  Italian Restaurant  0.22
3          Steakhouse  0.11
4   Indian Restaurant  0.11


----Garching bei München----
                venue  freq
0    Greek Restaurant  0.22
1   German Restaurant  0.22
2  Italian Restaurant  0.22
3          Steakhouse  0.11
4   Indian Restaurant  0.11


----Gronsdorf, Kreis München----
                           venue  freq
0          Vietnamese Restaurant  0.33
1                         Bistro  0.33
2             Italian Restaurant  0.33
3              Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Gräfelfing----
                           venue  freq
0             Italian Restaurant   1.0
1            American Restaurant   0.0
2         Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Haar bei München----
                           venue  freq
0                         Bistro   0.5
1             Italian Restaurant   0.5
2            American Restaurant   0.0
3              Indian Restaurant   0.0
4  Vegetarian / Vegan Restaurant   0.0
```

```
----Hauptbahnhof----
                        venue  freq
0  Middle Eastern Restaurant  0.18
1   Mediterranean Restaurant  0.09
2           Asian Restaurant  0.09
3        Bavarian Restaurant  0.09
4          German Restaurant  0.09


----Hochbrück bei München----
                            venue  freq
0             Italian Restaurant   1.0
1            American Restaurant   0.0
2         Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Hohenbrunn----
                            venue  freq
0             Italian Restaurant   0.5
1              German Restaurant   0.5
2            American Restaurant   0.0
3              Indian Restaurant   0.0
4  Vegetarian / Vegan Restaurant   0.0


----Ismaning----
                venue  freq
0   German Restaurant  0.33
1   Indian Restaurant  0.17
2     Thai Restaurant  0.17
3          Restaurant  0.17
4  Italian Restaurant  0.17


----Kirchheim----
                            venue  freq
0              German Restaurant   1.0
1            American Restaurant   0.0
2              Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Kirchheim bei München----
                            venue  freq
```

```
0             German Restaurant   1.0
1           American Restaurant   0.0
2             Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Krailling----
                          venue  freq
0            Italian Restaurant  0.50
1              Greek Restaurant  0.25
2                   Beer Garden  0.25
3             Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Lustheim----
                          venue  freq
0             German Restaurant   1.0
1           American Restaurant   0.0
2             Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Martinsried----
                          venue  freq
0              Greek Restaurant  0.25
1             Indian Restaurant  0.25
2            Italian Restaurant  0.25
3             German Restaurant  0.25
4  Vegetarian / Vegan Restaurant  0.00


----Milbertshofen-Am Hart----
              venue  freq
0   Greek Restaurant   0.4
1  German Restaurant   0.2
2    Thai Restaurant   0.2
3       Burger Joint   0.2
4        Pizza Place   0.0


----Mittenheim----
                          venue  freq
0            Chinese Restaurant   1.0
1           American Restaurant   0.0
2             Indian Restaurant   0.0
```

```
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Moosach----
                            venue  freq
0             American Restaurant  0.25
1               German Restaurant  0.25
2              Italian Restaurant  0.25
3                Asian Restaurant  0.25
4  Vegetarian / Vegan Restaurant  0.00


----Neubiberg----
                  venue  freq
0            Restaurant  0.33
1    Italian Restaurant  0.33
2     German Restaurant  0.33
3   American Restaurant  0.00
4     Indian Restaurant  0.00


----Neugermering----
                 venue  freq
0    Asian Restaurant   0.2
1   German Restaurant   0.2
2         Burger Joint   0.2
3  Italian Restaurant   0.2
4          Pizza Place   0.2


----Neukeferloh----
                            venue  freq
0             Bavarian Restaurant   1.0
1             American Restaurant   0.0
2               Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Oberbiberg----
                            venue  freq
0               German Restaurant   1.0
1             American Restaurant   0.0
2               Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0
```

```
----Oberhaching bei München----
                          venue  freq
0              Greek Restaurant   0.5
1              Asian Restaurant   0.5
2             Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Oberschleißheim----
                  venue  freq
0  Vietnamese Restaurant  0.25
1      German Restaurant  0.25
2     Chinese Restaurant  0.25
3     Italian Restaurant  0.25
4       Theme Restaurant  0.00


----Ottendichl, Kreis München----
                          venue  freq
0                    Restaurant   1.0
1           American Restaurant   0.0
2        Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4              Theme Restaurant   0.0


----Ottobrunn----
                  venue  freq
0     Italian Restaurant  0.29
1       Sushi Restaurant  0.14
2      German Restaurant  0.14
3      Indian Restaurant  0.14
4  Vietnamese Restaurant  0.14


----Pasing----
                  venue  freq
0     Italian Restaurant  0.17
1   Fast Food Restaurant  0.11
2      German Restaurant  0.11
3  Vietnamese Restaurant  0.11
4       Theme Restaurant  0.06


----Planegg----
                          venue  freq
```

```
0              German Restaurant  0.67
1             Italian Restaurant  0.33
2            American Restaurant  0.00
3              Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Potzham, Kreis München----
                           venue  freq
0             Italian Restaurant  0.67
1               Doner Restaurant  0.33
2            American Restaurant  0.00
3              Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Pullach----
                      venue  freq
0        Italian Restaurant  0.33
1          Asian Restaurant  0.33
2         German Restaurant  0.33
3                Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Pullach im Isartal----
                      venue  freq
0        Italian Restaurant  0.33
1          Asian Restaurant  0.33
2         German Restaurant  0.33
3                Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Putzbrunn----
                           venue  freq
0             Italian Restaurant   0.5
1              German Restaurant   0.5
2            American Restaurant   0.0
3              Indian Restaurant   0.0
4  Vegetarian / Vegan Restaurant   0.0


----Riemerling----
                           venue  freq
0               Asian Restaurant   1.0
1            American Restaurant   0.0
2              Indian Restaurant   0.0
```

```
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Rothschwaige----
                            venue  freq
0                Greek Restaurant   1.0
1          Argentinian Restaurant   0.0
2  Vegetarian / Vegan Restaurant   0.0
3                Theme Restaurant   0.0
4                 Thai Restaurant   0.0


----Salmdorf, Kreis München----
                            venue  freq
0                      Steakhouse   1.0
1             American Restaurant   0.0
2          Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Solalinden----
                            venue  freq
0               German Restaurant   1.0
1             American Restaurant   0.0
2               Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Taufkirchen----
                            venue  freq
0               German Restaurant   1.0
1             American Restaurant   0.0
2               Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4                Theme Restaurant   0.0


----Taufkirchen, Kreis München----
                            venue  freq
0              Italian Restaurant  0.67
1                Doner Restaurant  0.33
2             American Restaurant  0.00
3               Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00
```

```
----Unterföhring----
                           venue  freq
0             Italian Restaurant   1.0
1            American Restaurant   0.0
2         Argentinian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Unterhaching----
                           venue  freq
0               Greek Restaurant  0.50
1                    Pizza Place  0.25
2              German Restaurant  0.25
3              Indian Restaurant  0.00
4  Vegetarian / Vegan Restaurant  0.00


----Westerham----
                           venue  freq
0               Doner Restaurant   1.0
1            American Restaurant   0.0
2              Indian Restaurant   0.0
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Winning, Kreis München----
                           venue  freq
0             Chinese Restaurant   0.4
1             Italian Restaurant   0.4
2               Doner Restaurant   0.2
3  Vegetarian / Vegan Restaurant   0.0
4               Theme Restaurant   0.0


----Zentrum Marienplatz----
                 venue  freq
0  Bavarian Restaurant  0.21
1    German Restaurant  0.21
2          Pizza Place  0.08
3   Italian Restaurant  0.08
4           Restaurant  0.08
```

Let's put that into a *pandas* dataframe

[27]:
```
# First, let's write a function to sort 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]
```

create the new dataframe and display top 5 venues

[28]:
```
num_top_venues = 5

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

# create columns according to number of top venues
columns = ['borough']
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['borough'] = munich_grouped['borough']

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

neighborhoods_venues_sorted.head()
```

[28]:
```
                  borough 1st Most Common Venue  \
0                Aschheim      Greek Restaurant
1              Baierbrunn     German Restaurant
2             Bogenhausen      Greek Restaurant
3       Buchenhain, Isartal   Bavarian Restaurant
4  Deisenhofen bei München      Asian Restaurant

          2nd Most Common Venue          3rd Most Common Venue  \
0              Asian Restaurant             Italian Restaurant
1  Vegetarian / Vegan Restaurant          Argentinian Restaurant
2            Italian Restaurant          Vietnamese Restaurant
3         Vietnamese Restaurant  Vegetarian / Vegan Restaurant
4              Greek Restaurant          Vietnamese Restaurant
```

```
    4th Most Common Venue   5th Most Common Venue
0   Vietnamese Restaurant      Chinese Restaurant
1        Asian Restaurant     Bavarian Restaurant
2      Chinese Restaurant      Falafel Restaurant
3  Argentinian Restaurant        Asian Restaurant
4      Fried Chicken Joint  Argentinian Restaurant
```

0.14 3.2 Cluster Borough with k-means

[29]:
```
# set number of clusters
kclusters = 10

munich_grouped_clustering = munich_grouped.drop('borough', 1)

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

# check cluster labels generated for each row in the dataframe
kmeans.labels_[0:50]
```

[29]:
```
array([0, 1, 0, 3, 0, 8, 2, 0, 7, 7, 7, 2, 2, 7, 2, 8, 7, 1, 1, 7, 1, 7,
       0, 5, 7, 8, 7, 3, 1, 0, 7, 6, 7, 7, 8, 2, 8, 8, 8, 0, 0, 4, 1, 1,
       2, 2, 0, 9, 7, 7], dtype=int32)
```

create dataframe

[30]:
```
# add clustering labels
neighborhoods_venues_sorted.insert(0, 'Cluster Labels', kmeans.labels_)

munich_merged = munich

# merge manhattan_grouped with manhattan_data to add latitude/longitude for␣
↪each neighborhood
# munich_merged = munich_merged.join(neighborhoods_venues_sorted.
↪set_index('borough'), on='borough')

munich_merged = munich_merged.merge(neighborhoods_venues_sorted.
↪set_index('borough'), on='borough')

munich_merged
```

[30]:
```
  postalcode                 borough   latitude  longitude  \
0      81675             Bogenhausen  48.158487  11.636682
1      80796   Milbertshofen-Am Hart  48.182385  11.575043
2      80634                 Moosach  48.179895  11.510571
3      85774             Unterföhring  48.190718  11.644580
```

4	85609	Dornach	48.153899	11.689900
5	81241	Pasing	48.147785	11.460701
6	85579	Neubiberg	48.076994	11.661514
7	82049	Pullach	48.058962	11.521841
8	85540	Gronsdorf, Kreis München	48.108961	11.719957
9	82024	Winning, Kreis München	48.052210	11.605970
10	82024	Taufkirchen, Kreis München	48.048506	11.604389
11	82166	Gräfelfing	48.121204	11.429978
12	82152	Martinsried	48.108804	11.454734
13	82049	Pullach im Isartal	48.055612	11.521745
14	85521	Ottobrunn	48.064382	11.667504
15	82024	Westerham	48.051219	11.613601
16	85540	Salmdorf, Kreis München	48.130636	11.716920
17	82008	Unterhaching	48.066225	11.610224
18	85640	Solalinden	48.092209	11.706879
19	82024	Taufkirchen	48.045996	11.615190
20	85609	Aschheim	48.171348	11.716035
21	85622	Feldkirchen	48.147577	11.729921
22	82024	Potzham, Kreis München	48.048506	11.604389
23	82041	Oberbiberg	47.979905	11.571268
24	82041	Oberhaching bei München	48.021887	11.584537
25	85640	Putzbrunn	48.075308	11.715627
26	85540	Ottendichl, Kreis München	48.116420	11.741950
27	85540	Haar bei München	48.111625	11.725762
28	82152	Planegg	48.103742	11.422003
29	85764	Lustheim	48.251939	11.575141
30	85764	Oberschleißheim	48.254938	11.554606
31	85748	Hochbrück bei München	48.252378	11.634927
32	85540	Eglfing, Kreis München	48.110630	11.728781
33	82032	Deisenhofen bei München	48.019312	11.587387
34	85737	Ismaning	48.227225	11.676879
35	82065	Buchenhain, Isartal	48.029018	11.496768
36	85662	Hohenbrunn	48.048083	11.702163
37	85521	Riemerling	48.059283	11.680674
38	82152	Krailling	48.099184	11.417221
39	85748	Garching	48.251388	11.650966
40	85748	Garching bei München	48.251388	11.650966
41	85551	Kirchheim bei München	48.180638	11.752985
42	85551	Kirchheim	48.180638	11.752985
43	85757	Rothschwaige	48.183882	11.499586
44	82110	Neugermering	48.127735	11.363372
45	85764	Mittenheim	48.263084	11.557159
46	82065	Baierbrunn	48.020477	11.486546
47	85630	Neukeferloh	48.096429	11.760195
48	80331	Zentrum Marienplatz	48.137187	11.575501
49	80335	Hauptbahnhof	48.140458	11.557766

	Cluster Labels	1st Most Common Venue	2nd Most Common Venue \
0	0	Greek Restaurant	Italian Restaurant
1	0	Greek Restaurant	German Restaurant
2	7	German Restaurant	Italian Restaurant
3	2	Italian Restaurant	Vietnamese Restaurant
4	8	German Restaurant	Thai Restaurant
5	7	Italian Restaurant	Vietnamese Restaurant
6	8	German Restaurant	Italian Restaurant
7	8	German Restaurant	Asian Restaurant
8	7	Vietnamese Restaurant	Bistro
9	7	Chinese Restaurant	Italian Restaurant
10	2	Italian Restaurant	Doner Restaurant
11	2	Italian Restaurant	Vietnamese Restaurant
12	7	German Restaurant	Greek Restaurant
13	8	German Restaurant	Asian Restaurant
14	7	Italian Restaurant	Vietnamese Restaurant
15	9	Doner Restaurant	Vietnamese Restaurant
16	4	Steakhouse	Vietnamese Restaurant
17	0	Greek Restaurant	German Restaurant
18	1	German Restaurant	Vegetarian / Vegan Restaurant
19	1	German Restaurant	Vegetarian / Vegan Restaurant
20	0	Greek Restaurant	Asian Restaurant
21	0	German Restaurant	Greek Restaurant
22	2	Italian Restaurant	Doner Restaurant
23	1	German Restaurant	Vegetarian / Vegan Restaurant
24	0	Asian Restaurant	Greek Restaurant
25	8	German Restaurant	Italian Restaurant
26	6	Restaurant	Vietnamese Restaurant
27	2	Bistro	Italian Restaurant
28	8	German Restaurant	Italian Restaurant
29	1	German Restaurant	Vegetarian / Vegan Restaurant
30	7	Vietnamese Restaurant	Italian Restaurant
31	2	Italian Restaurant	Vietnamese Restaurant
32	2	Italian Restaurant	Vietnamese Restaurant
33	0	Asian Restaurant	Greek Restaurant
34	7	German Restaurant	Thai Restaurant
35	3	Bavarian Restaurant	Vietnamese Restaurant
36	8	German Restaurant	Italian Restaurant
37	0	Asian Restaurant	Vietnamese Restaurant
38	7	Italian Restaurant	Greek Restaurant
39	7	German Restaurant	Greek Restaurant
40	7	German Restaurant	Greek Restaurant
41	1	German Restaurant	Vegetarian / Vegan Restaurant
42	1	German Restaurant	Vegetarian / Vegan Restaurant
43	0	Greek Restaurant	Vietnamese Restaurant
44	7	German Restaurant	Burger Joint
45	5	Chinese Restaurant	Vietnamese Restaurant

46	1	German Restaurant	Vegetarian / Vegan Restaurant
47	3	Bavarian Restaurant	Vietnamese Restaurant
48	7	German Restaurant	Bavarian Restaurant
49	7	Middle Eastern Restaurant	German Restaurant

	3rd Most Common Venue	4th Most Common Venue \
0	Vietnamese Restaurant	Chinese Restaurant
1	Thai Restaurant	Burger Joint
2	Asian Restaurant	American Restaurant
3	Fried Chicken Joint	Argentinian Restaurant
4	Italian Restaurant	Burrito Place
5	Fast Food Restaurant	German Restaurant
6	Restaurant	Burrito Place
7	Italian Restaurant	Fried Chicken Joint
8	Italian Restaurant	Fried Chicken Joint
9	Doner Restaurant	Vietnamese Restaurant
10	Vietnamese Restaurant	Fried Chicken Joint
11	Fried Chicken Joint	Argentinian Restaurant
12	Indian Restaurant	Italian Restaurant
13	Italian Restaurant	Fried Chicken Joint
14	Beer Garden	Indian Restaurant
15	Vegetarian / Vegan Restaurant	Argentinian Restaurant
16	Fried Chicken Joint	Argentinian Restaurant
17	Pizza Place	Asian Restaurant
18	Argentinian Restaurant	Asian Restaurant
19	Argentinian Restaurant	Asian Restaurant
20	Italian Restaurant	Vietnamese Restaurant
21	Asian Restaurant	Italian Restaurant
22	Vietnamese Restaurant	Fried Chicken Joint
23	Argentinian Restaurant	Asian Restaurant
24	Vietnamese Restaurant	Fried Chicken Joint
25	Fried Chicken Joint	Argentinian Restaurant
26	Fried Chicken Joint	Argentinian Restaurant
27	Vietnamese Restaurant	Fried Chicken Joint
28	Fried Chicken Joint	Argentinian Restaurant
29	Argentinian Restaurant	Asian Restaurant
30	Chinese Restaurant	German Restaurant
31	Fried Chicken Joint	Argentinian Restaurant
32	Fried Chicken Joint	Argentinian Restaurant
33	Vietnamese Restaurant	Fried Chicken Joint
34	Indian Restaurant	Italian Restaurant
35	Vegetarian / Vegan Restaurant	Argentinian Restaurant
36	Fried Chicken Joint	Argentinian Restaurant
37	Vegetarian / Vegan Restaurant	Argentinian Restaurant
38	Beer Garden	Vietnamese Restaurant
39	Italian Restaurant	Chinese Restaurant
40	Italian Restaurant	Chinese Restaurant

41	Argentinian Restaurant	Asian Restaurant
42	Argentinian Restaurant	Asian Restaurant
43	Fried Chicken Joint	Argentinian Restaurant
44	Italian Restaurant	Pizza Place
45	Vegetarian / Vegan Restaurant	Argentinian Restaurant
46	Argentinian Restaurant	Asian Restaurant
47	Vegetarian / Vegan Restaurant	Argentinian Restaurant
48	Pizza Place	Italian Restaurant
49	Bavarian Restaurant	Eastern European Restaurant

	5th Most Common Venue
0	Falafel Restaurant
1	Asian Restaurant
2	Sushi Restaurant
3	Asian Restaurant
4	Falafel Restaurant
5	Theme Restaurant
6	Falafel Restaurant
7	Argentinian Restaurant
8	Argentinian Restaurant
9	Fried Chicken Joint
10	Argentinian Restaurant
11	Asian Restaurant
12	Chinese Restaurant
13	Argentinian Restaurant
14	German Restaurant
15	Asian Restaurant
16	Asian Restaurant
17	Bavarian Restaurant
18	Bavarian Restaurant
19	Bavarian Restaurant
20	Chinese Restaurant
21	Chinese Restaurant
22	Argentinian Restaurant
23	Bavarian Restaurant
24	Argentinian Restaurant
25	Asian Restaurant
26	Asian Restaurant
27	Argentinian Restaurant
28	Asian Restaurant
29	Bavarian Restaurant
30	Sushi Restaurant
31	Asian Restaurant
32	Asian Restaurant
33	Argentinian Restaurant
34	Restaurant
35	Asian Restaurant

```
36          Asian Restaurant
37       Bavarian Restaurant
38        Chinese Restaurant
39         Indian Restaurant
40         Indian Restaurant
41       Bavarian Restaurant
42       Bavarian Restaurant
43          Asian Restaurant
44          Asian Restaurant
45          Asian Restaurant
46       Bavarian Restaurant
47          Asian Restaurant
48                Restaurant
49        Italian Restaurant
```

0.15 3.3 Cluster Visualization

[31]:
```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(munich_merged['latitude'],␣
 ↪munich_merged['longitude'], munich_merged['borough'], munich_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
```

[31]: `<folium.folium.Map at 0x7f70e400a668>`

0.16 3.4 evaluate target criteria according to 'munich_restaurants'

[32]:
```
munich_sum = pd.get_dummies(munich_restaurants[['Venue Category']], prefix="",␣
↪prefix_sep="")

munich_sum['borough'] = munich_restaurants['borough']

#Fix Column Order
fixed_columns = [munich_sum.columns[-1]] + list(munich_sum.columns[:-1])
munich_sum = munich_sum[fixed_columns]
```

Sum amount of each venues out of target definition 'munich_restaurants'

[82]:
```
munich_sum['amount of restaurants']=munich_sum.sum(axis=1)
munich_sum = munich_sum.groupby('borough').sum().reset_index()
```

keep only sum as criteria and add it to overview 'munich_merged' show only top5 boroughs according to amount of restaurants

[84]:
```
munich_sum = munich_sum[['borough','amount of restaurants']]

munich_merged = pd.merge(munich_merged, munich_sum, on = 'borough')
munich_merged.sort_values(by=['amount of restaurants'], ascending=False,␣
↪inplace=True)
munich_merged.head(5)
```

[84]:
```
  postalcode                borough   latitude  longitude  Cluster Labels  \
0      80331   Zentrum Marienplatz  48.137187  11.575501               7
1      81241                Pasing  48.147785  11.460701               7
2      80335           Hauptbahnhof  48.140458  11.557766               7
3      85748               Garching  48.251388  11.650966               7
4      85748  Garching bei München  48.251388  11.650966               7

     1st Most Common Venue  2nd Most Common Venue 3rd Most Common Venue  \
0        German Restaurant    Bavarian Restaurant           Pizza Place
1       Italian Restaurant  Vietnamese Restaurant  Fast Food Restaurant
2  Middle Eastern Restaurant      German Restaurant   Bavarian Restaurant
3        German Restaurant       Greek Restaurant    Italian Restaurant
4        German Restaurant       Greek Restaurant    Italian Restaurant

       4th Most Common Venue 5th Most Common Venue  Sum  \
0        Italian Restaurant            Restaurant   24
1         German Restaurant      Theme Restaurant   18
2  Eastern European Restaurant    Italian Restaurant   11
3        Chinese Restaurant      Indian Restaurant    9
4        Chinese Restaurant      Indian Restaurant    9

   amount of restaurants
```

```
0                        24
1                        18
2                        11
3                         9
4                         9
```

```
[ ]:
```

0.17 4. Berlin: Data import and cleaning

0.18 4.1 libary import

If necessary, please run code line from '2. Munich'.

0.19 4.2 Berlin Data import with beautifulSoup

```
[35]: url='http://www.places-in-germany.com/
       ↪14356-places-within-a-radius-of-15km-around-berlin.html'
      req=requests.get(url)
      soup=BeautifulSoup(req.text,"html.parser")
      table = soup.find_all('table')
      df=pd.read_html(str(table), header=0)[0]
```

```
[36]: df.head()
```

```
[36]:              Distance  Route              Postal code / Place Population
      0  1.2 km (0.8 miles)    NaN                     10115 Mitte       79582
      1  2.1 km (1.3 miles)    NaN            10119 Prenzlauer Berg      140881
      2  2.8 km (1.7 miles)    NaN                     10115 Mitte      333534
      3  2.9 km (1.8 miles)    NaN               13347 Gesundbrunnen       82110
      4  3.3 km (2.0 miles)    NaN  10243 Friedrichshain-Kreuzberg      269398
```

delete double entry manually

```
[37]: df.drop(index=0, inplace=True)
      df.shape
```

```
[37]: (97, 4)
```

```
[38]: df.rename({'Postal code / Place':'Borough'},axis=1, inplace=True)
      berlin=df.Borough.str.split(" ",n=1,expand=True)
      berlin.rename({0:'postalcode', 1:'borough'}, axis=1, inplace=True)
      berlin
```

```
[38]:    postalcode                          borough
      1       10119                  Prenzlauer Berg
      2       10115                            Mitte
      3       13347                    Gesundbrunnen
```

```
4       10243          Friedrichshain-Kreuzberg
5       10243                    Friedrichshain
..        …                             …
93      12459                          Köpenick
94      12524                      Altglienicke
95      16341  Schwanebeck bei Bernau bei Berlin
96      12305                        Lichtenrade
97      12157               Steglitz-Zehlendorf

[97 rows x 2 columns]
```

test for NaN values

[39]:
```python
if berlin['borough'].isnull().sum() > 0:
    berlin.dropna(axis=0, inplace=True)
    print('NaN values deleted. New size ',berlin.shape)
else:
    print('no NaN values')
```

```
NaN values deleted. New size  (96, 2)
```

0.20 4.3 Folium Map Berlin

[40]:
```python
from geopy.geocoders import Nominatim
from geopy.extra.rate_limiter import RateLimiter

lat=[]
lon=[]

geolocator = Nominatim(user_agent='Cousera')

for line, borough in berlin.iterrows():

    try:
        adress= borough[0], ' Berlin ', borough[1]
        location = geolocator.geocode(adress)
        print(location)
        lat.append(location.latitude)
        lon.append(location.longitude)
    except:
        lat.append(np.nan)
        lon.append(np.nan)

berlin['latitude']=lat
berlin['longitude']=lon
```

```
Prenzlauer Berg, Winsviertel, Prenzlauer Berg, Pankow, Berlin, 10405,
Deutschland
```

Mitte, Berlin, Deutschland
Gesundbrunnen, Mitte, Berlin, Deutschland
Friedrichshain-Kreuzberg, Berlin, Deutschland
Friedrichshain, Friedrichshain-Kreuzberg, Berlin, Deutschland
Tiergarten, Mitte, Berlin, Deutschland
Wedding, Mitte, Berlin, Deutschland
Moabit, Mitte, Berlin, Deutschland
U Platz der Luftbrücke, Mehringdamm, Kreuzberg, Friedrichshain-Kreuzberg, Berlin, 10965, Deutschland
Hansaviertel, Mitte, Berlin, Deutschland
Fennpfuhl, Lichtenberg, Berlin, 10369, Deutschland
Alt-Treptow, Treptow-Köpenick, Berlin, Deutschland
Weißensee, Pankow, Berlin, Deutschland
Pankow, Berlin, Deutschland
Heinersdorf, Romain-Rolland-Straße, Heinersdorf, Pankow, Berlin, 13089, Deutschland
Neukölln, Berlin, Deutschland
Lichtenberg, Berlin, Deutschland
Schöneberg, Tempelhof-Schöneberg, Berlin, Deutschland
Lichtenberg, Berlin, Deutschland
Rummelsburg, Lichtenberg, Berlin, Deutschland
Niederschönhausen, Pankow, Berlin, 13156, Deutschland
Tempelhof, Tempelhof-Schöneberg, Berlin, Deutschland
Stadtrandsiedlung Malchow, Pankow, Berlin, Deutschland
Reinickendorf, Berlin, Deutschland
Plänterwald, Treptow-Köpenick, Berlin, 12435, Deutschland
Charlottenburg, Charlottenburg-Wilmersdorf, Berlin, Deutschland
Wilhelmsruh, Pankow, Berlin, Deutschland
Alt-Hohenschönhausen, Lichtenberg, Berlin, Deutschland
Wilmersdorf, Charlottenburg-Wilmersdorf, Berlin, Deutschland
Charlottenburg-Nord, Charlottenburg-Wilmersdorf, Berlin, 13627, Deutschland
Friedenau, Tempelhof-Schöneberg, Berlin, Deutschland
Neu-Hohenschönhausen, Lichtenberg, Berlin, 13051, Deutschland
Charlottenburg-Wilmersdorf, Berlin, Deutschland
Friedrichsfelde, Lichtenberg, Berlin, Deutschland
Malchow, Lichtenberg, Berlin, Deutschland
Rosenthal, Pankow, Berlin, 13158, Deutschland
Baumschulenweg, Treptow-Köpenick, Berlin, 12437, Deutschland
Tempelhof-Schöneberg, Berlin, Deutschland
Halensee, Charlottenburg-Wilmersdorf, Berlin, 10711, Deutschland
Blankenburg, Pankow, Berlin, 13129, Deutschland
Grunewald, Charlottenburg-Wilmersdorf, Berlin, Deutschland
Märkisches Viertel, Reinickendorf, Berlin, 13439, Deutschland
Britz, Neukölln, Berlin, Deutschland
Steglitz, Steglitz-Zehlendorf, Berlin, Deutschland
Westend, Charlottenburg-Wilmersdorf, Berlin, Deutschland
Karlshorst, Lichtenberg, Berlin, 10318, Deutschland
Wartenberg, Lichtenberg, Berlin, 13059, Deutschland

Schmargendorf, Charlottenburg-Wilmersdorf, Berlin, 14199, Deutschland
Wittenau, Reinickendorf, Berlin, Deutschland
Siemensstadt, Spandau, Berlin, 13629, Deutschland
Französisch Buchholz, Pankow, Berlin, 13127, Deutschland
Marzahn, Marzahn-Hellersdorf, Berlin, Deutschland
Mariendorf, Tempelhof-Schöneberg, Berlin, Deutschland
Biesdorf, Marzahn-Hellersdorf, Berlin, 12683, Deutschland
Falkenberg, Lichtenberg, Berlin, 13057, Deutschland
Tegel, Reinickendorf, Berlin, Deutschland
Niederschöneweide, Treptow-Köpenick, Berlin, 12439, Deutschland
Lübars, Reinickendorf, Berlin, Deutschland
Oberschöneweide, Treptow-Köpenick, Berlin, 12459, Deutschland
Waidmannslust, Reinickendorf, Berlin, 13469, Deutschland
Lankwitz, Steglitz-Zehlendorf, Berlin, Deutschland
Blankenfelde, Pankow, Berlin, 13159, Deutschland
Dahlem, Steglitz-Zehlendorf, Berlin, 14195, Deutschland
Karow, Pankow, Berlin, 13125, Deutschland
Johannisthal, Treptow-Köpenick, Berlin, 12487, Deutschland
Haselhorst, Spandau, Berlin, 13599, Deutschland
Gropiusstadt, Neukölln, Berlin, Deutschland
None
Buckow, Neukölln, Berlin, Deutschland
Lichterfelde, Steglitz-Zehlendorf, Berlin, Deutschland
Hermsdorf, Reinickendorf, Berlin, 13467, Deutschland
Kaulsdorf, Marzahn-Hellersdorf, Berlin, 12621, Deutschland
Marzahn-Hellersdorf, Berlin, Deutschland
Lübarser Weg, Schildow-Waldeck, Blankenfelde, Pankow, Berlin, 13159, Deutschland
Marienfelde, Tempelhof-Schöneberg, Berlin, Deutschland
Hellersdorf, Marzahn-Hellersdorf, Berlin, Deutschland
Ahrensfelde, Ahrensfelder Chaussee, Marzahn, Marzahn-Hellersdorf, Berlin, 12689, Deutschland
None
None
Verlauf der Berliner Mauer, Am Sandkrug, Entenschnabel, Glienicke/Nordbahn, Oberhavel, Brandenburg, 16548, Deutschland
Rudow, Neukölln, Berlin, Deutschland
Adlershof, Treptow-Köpenick, Berlin, 12489, Deutschland
Buch, Pankow, Berlin, Deutschland
Konradshöhe, Reinickendorf, Berlin, 13505, Deutschland
Zehlendorf, Steglitz-Zehlendorf, Berlin, Deutschland
Frohnau, Reinickendorf, Berlin, 13465, Deutschland
Spandau, Berlin, Deutschland
Mahlsdorf, Marzahn-Hellersdorf, Berlin, 12623, Deutschland
Treptow-Köpenick, Berlin, Deutschland
None
None
Köpenick, Treptow-Köpenick, Berlin, Deutschland
Altglienicke, Treptow-Köpenick, Berlin, 12524, Deutschland

```
None
Lichtenrade, Tempelhof-Schöneberg, Berlin, Deutschland
Steglitz-Zehlendorf, Berlin, Deutschland
```

[41]:
```
berlin.dropna(axis=0, inplace=True)
berlin.shape
```

[41]:
```
(90, 4)
```

[42]:
```
address = 'berlin'

geolocator = Nominatim(user_agent="Cousera")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('geo-coordinates of Berlin {}, {}.'.format(latitude, longitude))



# Creating Folium Map
map_berlin = folium.Map(location=[latitude, longitude], zoom_start=11)

# add markers to map
for lat, lng, borough in zip(berlin['latitude'], berlin['longitude'],␣
 ↪berlin['borough']):
    label = '{}'.format(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_berlin)

map_berlin
```

```
geo-coordinates of Berlin 52.5170365, 13.3888599.
```

[42]:
```
<folium.folium.Map at 0x7f70e40415f8>
```

[ ]:
```

```

0.21 4.4 Explore Venues with 4square

[43]:
```
CLIENT_ID = 'MIXA2M5FTBG1IILFL5ATNOBSNUP4BU4J1BUOGIM03E1UJOBE' # your␣
↪Foursquare ID
CLIENT_SECRET = 'ETQCTK31ZO4IOFVKYEEEHG2MOJGLOG4DCLQ1R1ECOOPHX33D' # your␣
↪Foursquare Secret
VERSION = '20180604'
LIMIT = 100
radius = 500
print("ID loaded")
```

ID loaded

[44]:
```
berlin_venues = getNearbyVenues(names=berlin['borough'],
                                   latitudes=berlin['latitude'],
                                   longitudes=berlin['longitude']
                                  )
```

```
Prenzlauer Berg
Mitte
Gesundbrunnen
Friedrichshain-Kreuzberg
Friedrichshain
Tiergarten
Wedding
Moabit
Kreuzberg
Hansaviertel
Fennpfuhl
Alt-Treptow
Weißensee
Pankow
Heinersdorf
Neukölln
Lichtenberg
Schöneberg
Lichtenberg
Rummelsburg
Niederschönhausen
Tempelhof
Stadtrandsiedlung Malchow
Reinickendorf
Plänterwald
Charlottenburg
Wilhelmsruh
Alt-Hohenschönhausen
Wilmersdorf
Charlottenburg-Nord
```

Friedenau
Neu-Hohenschönhausen
Charlottenburg-Wilmersdorf
Friedrichsfelde
Malchow
Rosenthal
Baumschulenweg
Tempelhof-Schöneberg
Halensee
Blankenburg
Grunewald
Märkisches Viertel
Britz
Steglitz
Westend
Karlshorst
Wartenberg
Schmargendorf
Wittenau
Siemensstadt
Französisch Buchholz
Marzahn
Mariendorf
Biesdorf
Falkenberg
Tegel
Niederschöneweide
Lübars
Oberschöneweide
Waidmannslust
Lankwitz
Blankenfelde
Dahlem
Karow
Johannisthal
Haselhorst
Gropiusstadt
Buckow
Lichterfelde
Hermsdorf
Kaulsdorf
Marzahn-Hellersdorf
Schildow
Marienfelde
Hellersdorf
Ahrensfelde
Glienicke / Nordbahn
Rudow

```
Adlershof
Buch
Konradshöhe
Zehlendorf
Frohnau
Spandau
Mahlsdorf
Treptow-Köpenick
Köpenick
Altglienicke
Lichtenrade
Steglitz-Zehlendorf
```

[45]:
```python
print('4square provided', berlin_venues.shape , 'venues')
berlin_venues.head(5)
```

```
4square provided (1483, 7) venues
```

[45]:
```
           borough   Latitude  Longitude                           Venue  \
0  Prenzlauer Berg  52.528634  13.420105                 Bötzow Brauerei
1  Prenzlauer Berg  52.528634  13.420105               Soho House Cinema
2  Prenzlauer Berg  52.528634  13.420105                  Cowshed Active
3  Prenzlauer Berg  52.528634  13.420105  The Store x Soho House Berlin
4  Prenzlauer Berg  52.528634  13.420105              Rooftop Soho House

   Venue Latitude  Venue Longitude        Venue Category
0       52.530242        13.417293         Historic Site
1       52.527359        13.415775         Movie Theater
2       52.527378        13.415791  Gym / Fitness Center
3       52.527525        13.415868              Boutique
4       52.527533        13.415599             Roof Deck
```

[46]:
```python
print('There are {} uniques categories.'.format(len(berlin_venues['Venue␣
↪Category'].unique())))
berlin_venues.groupby('Venue Category').Venue.count()
```

```
There are 245 uniques categories.
```

[46]:
```
Venue Category
ATM                        2
Adult Boutique             1
African Restaurant         1
American Restaurant        2
Argentinian Restaurant     2
                          ..
Windmill                   1
Wine Bar                   2
Wine Shop                  5
```

```
Yoga Studio              2
Zoo Exhibit              2
Name: Venue, Length: 245, dtype: int64
```

0.22 5. Analyze Boroughs of Berlin

[47]:
```python
berlin_restaurants = berlin_venues[berlin_venues['Venue Category'].str.
 ↪contains('|'.join(restaurants))]
```

[48]:
```python
berlin_restaurants.head()
```

[48]:
```
           borough   Latitude  Longitude                Venue  Venue Latitude  \
10  Prenzlauer Berg  52.528634  13.420105    The Store Kitchen       52.527506
11  Prenzlauer Berg  52.528634  13.420105  La Soupe Populaire       52.530595
12  Prenzlauer Berg  52.528634  13.420105         Mondo Sardo       52.531076
19  Prenzlauer Berg  52.528634  13.420105          Leibhaftig       52.531392
20  Prenzlauer Berg  52.528634  13.420105  MontRaw Restaurant       52.531860

    Venue Longitude              Venue Category
10        13.415744                      Bistro
11        13.416777  Modern European Restaurant
12        13.422782          Italian Restaurant
19        13.416966           German Restaurant
20        13.415882          Israeli Restaurant
```

0.23 5.1 Frequency of occurance

[49]:
```python
# one hot encoding
berlin_onehot = pd.get_dummies(berlin_restaurants[['Venue Category']],␣
 ↪prefix="", prefix_sep="")

# add neighborhood column back to dataframe
berlin_onehot['borough'] = berlin_restaurants['borough']

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

berlin_onehot.head()
```

[49]:
```
           borough  African Restaurant  American Restaurant  \
10  Prenzlauer Berg                   0                    0
11  Prenzlauer Berg                   0                    0
12  Prenzlauer Berg                   0                    0
19  Prenzlauer Berg                   0                    0
20  Prenzlauer Berg                   0                    0
```

```
    Argentinian Restaurant  Asian Restaurant  Austrian Restaurant  \
10                       0                 0                    0
11                       0                 0                    0
12                       0                 0                    0
19                       0                 0                    0
20                       0                 0                    0

    Bavarian Restaurant  Beer Garden  Bistro  Brazilian Restaurant  …  \
10                    0            0       1                     0  …
11                    0            0       0                     0  …
12                    0            0       0                     0  …
19                    0            0       0                     0  …
20                    0            0       0                     0  …

    Silesian Restaurant  Spanish Restaurant  Steakhouse  Sushi Restaurant  \
10                    0                   0           0                 0
11                    0                   0           0                 0
12                    0                   0           0                 0
19                    0                   0           0                 0
20                    0                   0           0                 0

    Syrian Restaurant  Tapas Restaurant  Thai Restaurant  Turkish Restaurant  \
10                  0                 0                0                   0
11                  0                 0                0                   0
12                  0                 0                0                   0
19                  0                 0                0                   0
20                  0                 0                0                   0

    Vegetarian / Vegan Restaurant  Vietnamese Restaurant
10                              0                      0
11                              0                      0
12                              0                      0
19                              0                      0
20                              0                      0

[5 rows x 53 columns]
```

[ ]:

group rows by neighborhood and mean frequency of occurence of each category

[50]:
```
print('Size of One Hot is ', berlin_onehot.shape, '.')
berlin_grouped = berlin_onehot.groupby('borough').mean().reset_index()
berlin_grouped.head()
```

```
Size of One Hot is  (392, 53) .
```

[50]:

```
                borough  African Restaurant  American Restaurant  \
0             Adlershof                 0.0                  0.0
1  Alt-Hohenschönhausen                 0.0                  0.0
2            Alt-Treptow                 0.0                  0.0
3            Blankenburg                 0.0                  0.0
4                  Britz                 0.0                  0.0

   Argentinian Restaurant  Asian Restaurant  Austrian Restaurant  \
0                     0.0              0.00                  0.0
1                     0.0              0.25                  0.0
2                     0.0              0.00                  0.0
3                     0.0              0.00                  0.0
4                     0.0              0.00                  0.0

   Bavarian Restaurant  Beer Garden  Bistro  Brazilian Restaurant  …  \
0                  0.0     0.000000     0.0                   0.0  …
1                  0.0     0.000000     0.0                   0.0  …
2                  0.0     0.142857     0.0                   0.0  …
3                  0.0     0.000000     0.0                   0.0  …
4                  0.0     0.000000     0.0                   0.0  …

   Silesian Restaurant  Spanish Restaurant  Steakhouse  Sushi Restaurant  \
0                  0.0                 0.0        0.25               0.0
1                  0.0                 0.0        0.00               0.0
2                  0.0                 0.0        0.00               0.0
3                  0.0                 0.0        0.00               0.0
4                  0.0                 0.0        0.00               0.0

   Syrian Restaurant  Tapas Restaurant  Thai Restaurant  Turkish Restaurant  \
0                0.0          0.000000              0.0                 0.0
1                0.0          0.000000              0.0                 0.0
2                0.0          0.142857              0.0                 0.0
3                0.0          0.000000              0.0                 0.0
4                0.0          0.000000              0.0                 0.0

   Vegetarian / Vegan Restaurant  Vietnamese Restaurant
0                            0.0               0.000000
1                            0.0               0.000000
2                            0.0               0.142857
3                            0.0               0.000000
4                            0.0               0.000000

[5 rows x 53 columns]
```

[51]:

```python
print('confirm the new size:', berlin_grouped.shape)
```

```
confirm the new size: (70, 53)
```

Let's print each neighborhood along with the top 5 most common venues

[52]:
```
num_top_venues = 5

for hood in berlin_grouped['borough']:
    print("----"+hood+"----")
    temp = berlin_grouped[berlin_grouped['borough'] == 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')
```

```
----Adlershof----
                venue  freq
0  Italian Restaurant  0.25
1    Greek Restaurant  0.25
2          Steakhouse  0.25
3         Pizza Place  0.25
4          Restaurant  0.00


----Alt-Hohenschönhausen----
                venue  freq
0    Doner Restaurant  0.25
1    Asian Restaurant  0.25
2   Indian Restaurant  0.25
3    Greek Restaurant  0.25
4  African Restaurant  0.00


----Alt-Treptow----
                venue  freq
0  Italian Restaurant  0.14
1         Beer Garden  0.14
2    Tapas Restaurant  0.14
3  Seafood Restaurant  0.14
4  Mexican Restaurant  0.14


----Blankenburg----
                      venue  freq
0          Greek Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
```

```
4  Mediterranean Restaurant   0.0


----Britz----
                      venue  freq
0         German Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Buch----
                      venue  freq
0        Italian Restaurant   1.0
1       American Restaurant   0.0
2         Korean Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Buckow----
                 venue  freq
0          Pizza Place   1.0
1   African Restaurant   0.0
2  American Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0


----Charlottenburg----
                        venue  freq
0          Chinese Restaurant  0.20
1                 Pizza Place  0.20
2          Italian Restaurant  0.13
3            Sushi Restaurant  0.07
4  Middle Eastern Restaurant  0.07


----Charlottenburg-Wilmersdorf----
                 venue  freq
0   Italian Restaurant  0.50
1    Indian Restaurant  0.25
2          Pizza Place  0.25
3  Japanese Restaurant  0.00
4  Lebanese Restaurant  0.00
```

```
----Dahlem----
                      venue  freq
0         German Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Fennpfuhl----
                 venue  freq
0   Italian Restaurant   0.5
1     Sushi Restaurant   0.5
2           Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0


----Französisch Buchholz----
                      venue  freq
0        Chinese Restaurant   1.0
1        African Restaurant   0.0
2   Scandinavian Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Friedenau----
                   venue  freq
0  Vietnamese Restaurant  0.25
1                 Bistro  0.25
2      Korean Restaurant  0.25
3       Greek Restaurant  0.12
4           Burger Joint  0.12


----Friedrichsfelde----
                 venue  freq
0           Restaurant   1.0
1   African Restaurant   0.0
2  American Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0


----Friedrichshain----
                           venue  freq
0      Middle Eastern Restaurant  0.23
```

```
1              Doner Restaurant  0.23
2            Italian Restaurant  0.08
3  Vegetarian / Vegan Restaurant  0.08
4               Thai Restaurant  0.08


----Friedrichshain-Kreuzberg----
                           venue  freq
0          Vietnamese Restaurant  0.14
1                    Pizza Place  0.14
2             Falafel Restaurant  0.07
3              Indian Restaurant  0.07
4  Vegetarian / Vegan Restaurant  0.03


----Frohnau----
                venue  freq
0   Italian Restaurant  0.25
1          Pizza Place  0.25
2     Doner Restaurant  0.25
3           Restaurant  0.25
4  Japanese Restaurant  0.00


----Gesundbrunnen----
                 venue  freq
0    Turkish Restaurant  0.36
1    Italian Restaurant  0.18
2      Halal Restaurant  0.09
3     Syrian Restaurant  0.09
4  Pakistani Restaurant  0.09


----Gropiusstadt----
                venue  freq
0           Restaurant   1.0
1   African Restaurant   0.0
2  American Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0


----Grunewald----
                         venue  freq
0            German Restaurant   0.4
1           Italian Restaurant   0.2
2                  Beer Garden   0.2
3  Eastern European Restaurant   0.2
```

```
4      Scandinavian Restaurant   0.0


----Halensee----
                     venue  freq
0        Italian Restaurant  0.18
1        Spanish Restaurant  0.09
2       Japanese Restaurant  0.09
3  Mediterranean Restaurant  0.09
4          Greek Restaurant  0.09


----Hansaviertel----
                     venue  freq
0        Turkish Restaurant  0.33
1  Mediterranean Restaurant  0.33
2                    Bistro  0.33
3        African Restaurant  0.00
4    Scandinavian Restaurant  0.00


----Heinersdorf----
                     venue  freq
0        Chinese Restaurant   1.0
1        African Restaurant   0.0
2   Scandinavian Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Hellersdorf----
                venue  freq
0     Greek Restaurant   0.5
1   Mexican Restaurant   0.5
2   African Restaurant   0.0
3  Japanese Restaurant   0.0
4  Lebanese Restaurant   0.0


----Hermsdorf----
               venue  freq
0    Sushi Restaurant  0.33
1  Seafood Restaurant  0.33
2  Chinese Restaurant  0.33
3  African Restaurant  0.00
4          Restaurant  0.00
```

```
----Johannisthal----
                    venue  freq
0         Sushi Restaurant  0.33
1             Burger Joint  0.33
2              Pizza Place  0.33
3       African Restaurant  0.00
4  Scandinavian Restaurant  0.00


----Karlshorst----
                   venue  freq
0     Italian Restaurant  0.38
1       Doner Restaurant  0.12
2  Argentinian Restaurant  0.12
3       Greek Restaurant  0.12
4       Sushi Restaurant  0.12


----Karow----
                venue  freq
0          Restaurant   1.0
1  African Restaurant   0.0
2 American Restaurant   0.0
3   Korean Restaurant   0.0
4 Lebanese Restaurant   0.0


----Konradshöhe----
                venue  freq
0  Italian Restaurant   0.5
1          Restaurant   0.5
2 American Restaurant   0.0
3   Korean Restaurant   0.0
4 Lebanese Restaurant   0.0


----Kreuzberg----
                          venue  freq
0            Italian Restaurant  0.22
1             German Restaurant  0.22
2    Eastern European Restaurant  0.11
3 Vegetarian / Vegan Restaurant  0.11
4             Indian Restaurant  0.11


----Köpenick----
                   venue  freq
0      Indian Restaurant  0.33
```

```
1        German Restaurant  0.33
2             Burger Joint  0.33
3       African Restaurant  0.00
4  Scandinavian Restaurant  0.00


----Lankwitz----
                  venue  freq
0     German Restaurant   0.5
1  Fast Food Restaurant   0.5
2    African Restaurant   0.0
3            Restaurant   0.0
4   Lebanese Restaurant   0.0


----Lichtenrade----
                      venue  freq
0         Doner Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Lichterfelde----
                         venue  freq
0           Italian Restaurant  0.50
1  Eastern European Restaurant  0.25
2           Chinese Restaurant  0.25
3      Scandinavian Restaurant  0.00
4          Lebanese Restaurant  0.00


----Lübars----
                      venue  freq
0   Comfort Food Restaurant   1.0
1       Japanese Restaurant   0.0
2       Lebanese Restaurant   0.0
3  Mediterranean Restaurant   0.0
4        Mexican Restaurant   0.0


----Mahlsdorf----
                      venue  freq
0        Italian Restaurant   0.5
1          Greek Restaurant   0.5
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
```

```
4  Mediterranean Restaurant   0.0


----Malchow----
                      venue  freq
0         German Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Mariendorf----
                venue  freq
0    Greek Restaurant  0.25
1   German Restaurant  0.25
2          Steakhouse  0.25
3  Chinese Restaurant  0.25
4  African Restaurant  0.00


----Marienfelde----
                  venue  freq
0     German Restaurant   0.2
1  Fast Food Restaurant   0.2
2           Pizza Place   0.2
3    Chinese Restaurant   0.2
4            Restaurant   0.2


----Marzahn----
                     venue  freq
0         Asian Restaurant   0.5
1        German Restaurant   0.5
2       African Restaurant   0.0
3  Scandinavian Restaurant   0.0
4      Lebanese Restaurant   0.0


----Marzahn-Hellersdorf----
                      venue  freq
0          Doner Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0
```

```
----Mitte----
                   venue  freq
0      German Restaurant  0.67
1     Italian Restaurant  0.08
2     Spanish Restaurant  0.08
3             Restaurant  0.08
4  Vietnamese Restaurant  0.08


----Moabit----
                           venue  freq
0              Doner Restaurant  0.15
1             German Restaurant  0.15
2                  Burger Joint  0.15
3            Italian Restaurant  0.10
4  Vegetarian / Vegan Restaurant  0.10


----Märkisches Viertel----
                      venue  freq
0        Italian Restaurant  0.67
1       American Restaurant  0.33
2         Korean Restaurant  0.00
3       Lebanese Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Neukölln----
                           venue  freq
0            Italian Restaurant  0.14
1                        Bistro  0.14
2     Middle Eastern Restaurant  0.14
3  Vegetarian / Vegan Restaurant  0.09
4           Lebanese Restaurant  0.09


----Niederschöneweide----
                  venue  freq
0    Italian Restaurant   0.2
1            Restaurant   0.2
2     Indian Restaurant   0.2
3      Greek Restaurant   0.2
4  Fast Food Restaurant   0.2


----Niederschönhausen----
                 venue  freq
0   Italian Restaurant   0.5
```

```
1      Thai Restaurant   0.5
2           Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0


----Oberschöneweide----
               venue  freq
0       Burger Joint  0.29
1   Doner Restaurant  0.14
2   Asian Restaurant  0.14
3  German Restaurant  0.14
4        Pizza Place  0.14


----Pankow----
                         venue  freq
0           Italian Restaurant   0.1
1  Eastern European Restaurant   0.1
2          Japanese Restaurant   0.1
3           Mexican Restaurant   0.1
4    Middle Eastern Restaurant   0.1


----Prenzlauer Berg----
                venue  freq
0   German Restaurant  0.29
1  Italian Restaurant  0.14
2  Israeli Restaurant  0.14
3     Thai Restaurant  0.14
4              Bistro  0.14


----Rosenthal----
                      venue  freq
0         German Restaurant   1.0
1        African Restaurant   0.0
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Rudow----
                     venue  freq
0       Chinese Restaurant   0.5
1         Doner Restaurant   0.5
2       African Restaurant   0.0
3  Scandinavian Restaurant   0.0
```

```
4      Lebanese Restaurant   0.0


----Rummelsburg----
                      venue  freq
0                  Creperie  0.33
1         Indian Restaurant  0.33
2         German Restaurant  0.33
3        African Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Schmargendorf----
                      venue  freq
0        Italian Restaurant  0.67
1        Chinese Restaurant  0.33
2   Scandinavian Restaurant  0.00
3       Lebanese Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Schöneberg----
                   venue  freq
0     Italian Restaurant  0.11
1       Doner Restaurant  0.11
2             Restaurant  0.11
3  Vietnamese Restaurant  0.11
4     African Restaurant  0.05


----Spandau----
                venue  freq
0  Italian Restaurant  0.25
1          Restaurant  0.25
2    Doner Restaurant  0.12
3    Asian Restaurant  0.12
4              Bistro  0.12


----Stadtrandsiedlung Malchow----
                 venue  freq
0           Restaurant   1.0
1   African Restaurant   0.0
2  American Restaurant   0.0
3    Korean Restaurant   0.0
4  Lebanese Restaurant   0.0
```

```
----Steglitz----
                      venue  freq
0          Sushi Restaurant  0.29
1          Doner Restaurant  0.14
2         Korean Restaurant  0.07
3         Indian Restaurant  0.07
4  Mediterranean Restaurant  0.07


----Steglitz-Zehlendorf----
                      venue  freq
0        Italian Restaurant   1.0
1       American Restaurant   0.0
2         Korean Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Tegel----
                      venue  freq
0                Restaurant  0.21
1         Indian Restaurant  0.14
2        Italian Restaurant  0.07
3        Seafood Restaurant  0.07
4  Mediterranean Restaurant  0.07


----Tempelhof----
                   venue  freq
0     Italian Restaurant  0.29
1       Doner Restaurant  0.29
2     Fried Chicken Joint  0.29
3  Vietnamese Restaurant  0.14
4    Austrian Restaurant  0.00


----Tiergarten----
                      venue  freq
0   Scandinavian Restaurant   0.5
1         German Restaurant   0.5
2       Japanese Restaurant   0.0
3       Lebanese Restaurant   0.0
4  Mediterranean Restaurant   0.0


----Waidmannslust----
                      venue  freq
0        Italian Restaurant  0.67
```

```
1      Fast Food Restaurant  0.33
2       Japanese Restaurant  0.00
3       Lebanese Restaurant  0.00
4  Mediterranean Restaurant  0.00


----Wartenberg----
                venue  freq
0   Indian Restaurant   0.5
1   German Restaurant   0.5
2  African Restaurant   0.0
3          Restaurant   0.0
4 Lebanese Restaurant   0.0


----Weißensee----
                     venue  freq
0    Vietnamese Restaurant   0.5
1        German Restaurant   0.5
2      Japanese Restaurant   0.0
3      Lebanese Restaurant   0.0
4 Mediterranean Restaurant   0.0


----Westend----
                     venue  freq
0       Italian Restaurant   1.0
1      American Restaurant   0.0
2        Korean Restaurant   0.0
3      Lebanese Restaurant   0.0
4 Mediterranean Restaurant   0.0


----Wilhelmsruh----
                venue  freq
0  Mexican Restaurant   1.0
1  African Restaurant   0.0
2 American Restaurant   0.0
3   Korean Restaurant   0.0
4 Lebanese Restaurant   0.0


----Wilmersdorf----
                  venue  freq
0    Italian Restaurant   0.1
1          Burger Joint   0.1
2     French Restaurant   0.1
3      Doner Restaurant   0.1
```

```
4  Vietnamese Restaurant   0.1


----Wittenau----
                        venue  freq
0            German Restaurant   0.4
1           Italian Restaurant   0.2
2                   Restaurant   0.2
3  Eastern European Restaurant   0.2
4          Lebanese Restaurant   0.0


----Zehlendorf----
                      venue  freq
0        Italian Restaurant   0.2
1          Doner Restaurant   0.2
2          Asian Restaurant   0.1
3  Middle Eastern Restaurant   0.1
4         German Restaurant   0.1
```

Let's put that into a *pandas* dataframe create the new dataframe and display top 5 venues

[53]:
```
num_top_venues = 5

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

# create columns according to number of top venues
columns = ['borough']
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
berlin_neighborhoods_venues_sorted = pd.DataFrame(columns=columns)
berlin_neighborhoods_venues_sorted['borough'] = berlin_grouped['borough']

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


#pd.set_option('display.max_rows', None)
berlin_neighborhoods_venues_sorted.head()
```

```
[53]:                  borough  1st Most Common Venue  2nd Most Common Venue  \
      0              Adlershof       Greek Restaurant     Italian Restaurant
      1   Alt-Hohenschönhausen      Indian Restaurant       Greek Restaurant
      2            Alt-Treptow  Vietnamese Restaurant     Italian Restaurant
      3            Blankenburg       Greek Restaurant  Vietnamese Restaurant
      4                  Britz      German Restaurant  Vietnamese Restaurant

             3rd Most Common Venue 4th Most Common Venue  \
      0                  Steakhouse           Pizza Place
      1            Asian Restaurant      Doner Restaurant
      2            Tapas Restaurant           Beer Garden
      3   Vegetarian / Vegan Restaurant      Halal Restaurant
      4   Vegetarian / Vegan Restaurant      Halal Restaurant

         5th Most Common Venue
      0       Chinese Restaurant
      1  Comfort Food Restaurant
      2       Seafood Restaurant
      3        German Restaurant
      4         Greek Restaurant
```

0.24 5.2 Cluster Borough with k-means

```
[54]: # set number of clusters
      kclusters = 10

      berlin_grouped_clustering = berlin_grouped.drop('borough', 1)

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

      # check cluster labels generated for each row in the dataframe
      kmeans.labels_[0:50]
```

```
[54]: array([0, 0, 0, 9, 4, 2, 6, 0, 2, 4, 2, 8, 0, 1, 0, 0, 0, 0, 1, 3, 0, 0,
             8, 9, 0, 0, 0, 1, 2, 0, 3, 3, 5, 2, 7, 2, 4, 0, 0, 3, 5, 4, 0, 2,
             0, 0, 2, 0, 0, 0], dtype=int32)
```

create dataframe 'berlin_merged'

```
[55]: # add clustering labels
      berlin_neighborhoods_venues_sorted.insert(0, 'Cluster Labels', kmeans.labels_)
```

```
[56]: berlin_merged = berlin
```

```python
# merge manhattan_grouped with manhattan_data to add latitude/longitude for␣
↪each neighborhood
berlin_merged = berlin_merged.merge(berlin_neighborhoods_venues_sorted.
↪set_index('borough'), on='borough')

#pd.set_option('display.max_rows', None)
berlin_merged
```

[56]:

```
    postalcode                    borough   latitude  longitude  Cluster Labels  \
0        10119             Prenzlauer Berg  52.528634  13.420105               0
1        10115                       Mitte  52.517885  13.404060               4
2        13347                Gesundbrunnen  52.550920  13.384846               0
3        10243  Friedrichshain-Kreuzberg  52.501115  13.444285               0
4        10243               Friedrichshain  52.512215  13.450290               0
..         …                          …          …          …              …
65       13581                     Spandau  52.535788  13.197792               0
66       12623                   Mahlsdorf  52.508699  13.613162               2
67       12459                    Köpenick  52.453910  13.576413               3
68       12305                 Lichtenrade  52.393456  13.402040               5
69       12157          Steglitz-Zehlendorf  52.429205  13.229974               2

         1st Most Common Venue   2nd Most Common Venue  \
0            German Restaurant      Israeli Restaurant
1            German Restaurant   Vietnamese Restaurant
2           Turkish Restaurant      Italian Restaurant
3        Vietnamese Restaurant             Pizza Place
4    Middle Eastern Restaurant        Doner Restaurant
..                          …                       …
65                  Restaurant      Italian Restaurant
66          Italian Restaurant        Greek Restaurant
67           Indian Restaurant       German Restaurant
68            Doner Restaurant   Vietnamese Restaurant
69          Italian Restaurant       Indian Restaurant

             3rd Most Common Venue         4th Most Common Venue  \
0               Italian Restaurant               Thai Restaurant
1               Spanish Restaurant            Italian Restaurant
2                 Halal Restaurant             Syrian Restaurant
3                Indian Restaurant            Falafel Restaurant
4                  Thai Restaurant  Vegetarian / Vegan Restaurant
..                               …                             …
65                Asian Restaurant                        Bistro
66               Indian Restaurant              Halal Restaurant
67                     Burger Joint       Comfort Food Restaurant
68   Vegetarian / Vegan Restaurant              Halal Restaurant
69                Halal Restaurant              Greek Restaurant
```

```
   5th Most Common Venue
0                  Bistro
1              Restaurant
2      Falafel Restaurant
3        Asian Restaurant
4      Italian Restaurant
..                    …
65   Fast Food Restaurant
66      German Restaurant
67       Halal Restaurant
68       Greek Restaurant
69      German Restaurant

[70 rows x 10 columns]
```

0.25 5.3 Cluster Visualization

[57]:
```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(berlin_merged['latitude'],␣
 ↪berlin_merged['longitude'], berlin_merged['borough'], berlin_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
```

[57]: <folium.folium.Map at 0x7f70dfbbf908>

0.26 5.4 evaluate target criteria according to 'berlin_restaurants'

[58]:
```
berlin_sum = pd.get_dummies(berlin_restaurants[['Venue Category']], prefix="",␣
↪prefix_sep="")

berlin_sum['borough'] = berlin_restaurants['borough']

#Fix Column Order
#fixed_columns = [berlin_sum.columns[-1]] + list(berlin_sum.columns[:-1])
#berlin_sum = berlin_sum[fixed_columns]
berlin_sum
```

[58]:
```
      African Restaurant  American Restaurant  Argentinian Restaurant  \
10                     0                    0                       0
11                     0                    0                       0
12                     0                    0                       0
19                     0                    0                       0
20                     0                    0                       0
…                    …                    …                     …
1455                   0                    0                       0
1476                   0                    0                       0
1477                   0                    0                       0
1478                   0                    0                       0
1479                   0                    0                       0

      Asian Restaurant  Austrian Restaurant  Bavarian Restaurant  Beer Garden  \
10                   0                    0                    0            0
11                   0                    0                    0            0
12                   0                    0                    0            0
19                   0                    0                    0            0
20                   0                    0                    0            0
…                  …                    …                    …          …
1455                 0                    0                    0            0
1476                 0                    0                    0            0
1477                 0                    0                    0            0
1478                 0                    0                    0            0
1479                 0                    0                    0            0

      Bistro  Brazilian Restaurant  Burger Joint  …  Spanish Restaurant  \
10         1                     0             0  …                   0
11         0                     0             0  …                   0
12         0                     0             0  …                   0
19         0                     0             0  …                   0
20         0                     0             0  …                   0
…       …                   …           …  …                 …
1455       0                     0             0  …                   0
1476       0                     0             0  …                   0
```

```
1477       0                     0             0  ...                    0
1478       0                     0             0  ...                    0
1479       0                     0             0  ...                    0

      Steakhouse  Sushi Restaurant  Syrian Restaurant  Tapas Restaurant  \
10             0                 0                  0                 0
11             0                 0                  0                 0
12             0                 0                  0                 0
19             0                 0                  0                 0
20             0                 0                  0                 0
…            …                 …                  …                 …
1455           0                 0                  0                 0
1476           0                 0                  0                 0
1477           0                 0                  0                 0
1478           0                 0                  0                 0
1479           0                 0                  0                 0

      Thai Restaurant  Turkish Restaurant  Vegetarian / Vegan Restaurant  \
10                  0                   0                              0
11                  0                   0                              0
12                  0                   0                              0
19                  0                   0                              0
20                  0                   0                              0
…                 …                   …                              …
1455                0                   0                              0
1476                0                   0                              0
1477                0                   0                              0
1478                0                   0                              0
1479                0                   0                              0

      Vietnamese Restaurant              borough
10                        0      Prenzlauer Berg
11                        0      Prenzlauer Berg
12                        0      Prenzlauer Berg
19                        0      Prenzlauer Berg
20                        0      Prenzlauer Berg
…                       …                  …
1455                      0             Köpenick
1476                      0          Lichtenrade
1477                      0  Steglitz-Zehlendorf
1478                      0  Steglitz-Zehlendorf
1479                      0  Steglitz-Zehlendorf

[392 rows x 53 columns]
```

Sum amount of each venues out of target definition 'berlin_restaurants'

[59]:
```
berlin_sum['amount of restaurants']=berlin_sum.sum(axis=1)
berlin_sum = berlin_sum.groupby('borough').sum().reset_index()
berlin_sum
```

[59]:
```
                 borough  African Restaurant  American Restaurant  \
0              Adlershof                   0                    0
1    Alt-Hohenschönhausen                  0                    0
2             Alt-Treptow                  0                    0
3             Blankenburg                  0                    0
4                  Britz                   0                    0
..                   ...                 ...                  ...
65               Westend                   0                    0
66            Wilhelmsruh                  0                    0
67            Wilmersdorf                  0                    0
68              Wittenau                   0                    0
69            Zehlendorf                   0                    0

    Argentinian Restaurant  Asian Restaurant  Austrian Restaurant  \
0                        0                 0                    0
1                        0                 1                    0
2                        0                 0                    0
3                        0                 0                    0
4                        0                 0                    0
..                     ...               ...                  ...
65                       0                 0                    0
66                       0                 0                    0
67                       0                 0                    0
68                       0                 0                    0
69                       0                 1                    0

    Bavarian Restaurant  Beer Garden  Bistro  Brazilian Restaurant  ...  \
0                     0            0       0                     0  ...
1                     0            0       0                     0  ...
2                     0            1       0                     0  ...
3                     0            0       0                     0  ...
4                     0            0       0                     0  ...
..                  ...          ...     ...                   ...  ...
65                    0            0       0                     0  ...
66                    0            0       0                     0  ...
67                    1            0       0                     0  ...
68                    0            0       0                     0  ...
69                    0            0       0                     0  ...

    Spanish Restaurant  Steakhouse  Sushi Restaurant  Syrian Restaurant  \
0                    0           1                 0                  0
1                    0           0                 0                  0
2                    0           0                 0                  0
```

```
3                    0           0                 0                  0
4                    0           0                 0                  0
..                 …         …               …                …
65                   0           0                 0                  0
66                   0           0                 0                  0
67                   0           0                 1                  0
68                   0           0                 0                  0
69                   0           1                 0                  0

    Tapas Restaurant  Thai Restaurant  Turkish Restaurant  \
0                  0                0                   0
1                  0                0                   0
2                  1                0                   0
3                  0                0                   0
4                  0                0                   0
..               …              …                 …
65                 0                0                   0
66                 0                0                   0
67                 0                1                   0
68                 0                0                   0
69                 0                0                   0

    Vegetarian / Vegan Restaurant  Vietnamese Restaurant  \
0                               0                      0
1                               0                      0
2                               0                      1
3                               0                      0
4                               0                      0
..                            …                    …
65                              0                      0
66                              0                      0
67                              0                      2
68                              0                      0
69                              0                      0

    amount of restaurants
0                       4
1                       4
2                       7
3                       1
4                       1
..                    …
65                      1
66                      1
67                     20
68                      5
69                     10
```

```
[70 rows x 54 columns]
```

keep only sum as criteria and add it to overview 'berlin_merged' show only top5 boroughs according to amount of restaurants

[60]:
```
berlin_sum = berlin_sum[['borough','amount of restaurants']]

berlin_merged = pd.merge(berlin_merged, berlin_sum, on = 'borough')
berlin_merged.sort_values(by=['amount of restaurants'], ascending=False,␣
 ↪inplace=True)
berlin_merged.head(5)
```

[60]:
```
    postalcode                   borough   latitude  longitude  Cluster Labels  \
3        10243  Friedrichshain-Kreuzberg  52.501115  13.444285               0
14       12043                  Neukölln  52.481150  13.435350               0
23       10707               Wilmersdorf  52.487115  13.320330               0
6        10551                    Moabit  52.530102  13.342542               0
15       10777                Schöneberg  52.482157  13.355190               0

     1st Most Common Venue      2nd Most Common Venue 3rd Most Common Venue  \
3   Vietnamese Restaurant                Pizza Place     Indian Restaurant
14     Italian Restaurant  Middle Eastern Restaurant                Bistro
23  Vietnamese Restaurant           Doner Restaurant     French Restaurant
6       German Restaurant           Doner Restaurant           Burger Joint
15  Vietnamese Restaurant                 Restaurant      Doner Restaurant

            4th Most Common Venue    5th Most Common Venue  \
3              Falafel Restaurant        Asian Restaurant
14  Vegetarian / Vegan Restaurant     Lebanese Restaurant
23             Italian Restaurant            Burger Joint
6   Vegetarian / Vegan Restaurant      Italian Restaurant
15             Italian Restaurant  Argentinian Restaurant

    amount of restaurants
3                      29
14                     22
23                     20
6                      20
15                     19
```

[ ]:

0.27 6. result and discussion

Now we've got a top5 list of each City with amount and most frequent kind of restaurantof restaurants:

0.27.1 6.1 Berlin

[61]:
```
berlin_merged.head(5)
```

[61]:
```
   postalcode                    borough   latitude  longitude  Cluster Labels  \
3       10243  Friedrichshain-Kreuzberg  52.501115  13.444285               0
14      12043                  Neukölln  52.481150  13.435350               0
23      10707               Wilmersdorf  52.487115  13.320330               0
6       10551                     Moabit  52.530102  13.342542               0
15      10777                Schöneberg  52.482157  13.355190               0

    1st Most Common Venue      2nd Most Common Venue 3rd Most Common Venue  \
3   Vietnamese Restaurant                Pizza Place     Indian Restaurant
14     Italian Restaurant  Middle Eastern Restaurant                Bistro
23  Vietnamese Restaurant          Doner Restaurant     French Restaurant
6       German Restaurant          Doner Restaurant          Burger Joint
15  Vietnamese Restaurant                 Restaurant      Doner Restaurant

            4th Most Common Venue    5th Most Common Venue  \
3              Falafel Restaurant        Asian Restaurant
14  Vegetarian / Vegan Restaurant     Lebanese Restaurant
23             Italian Restaurant            Burger Joint
6   Vegetarian / Vegan Restaurant      Italian Restaurant
15             Italian Restaurant  Argentinian Restaurant

    amount of restaurants
3                      29
14                     22
23                     20
6                      20
15                     19
```

0.27.2 6.2 Munich

[85]:
```
munich_merged.head(5)
```

[85]:
```
  postalcode                 borough   latitude  longitude  Cluster Labels  \
0      80331     Zentrum Marienplatz  48.137187  11.575501               7
1      81241                  Pasing  48.147785  11.460701               7
2      80335             Hauptbahnhof  48.140458  11.557766               7
3      85748                Garching  48.251388  11.650966               7
4      85748  Garching bei München  48.251388  11.650966               7

       1st Most Common Venue  2nd Most Common Venue 3rd Most Common Venue  \
0          German Restaurant    Bavarian Restaurant           Pizza Place
1         Italian Restaurant  Vietnamese Restaurant  Fast Food Restaurant
2  Middle Eastern Restaurant      German Restaurant   Bavarian Restaurant
```

```
3          German Restaurant       Greek Restaurant    Italian Restaurant
4          German Restaurant       Greek Restaurant    Italian Restaurant

         4th Most Common Venue 5th Most Common Venue  Sum  \
0           Italian Restaurant            Restaurant   24
1            German Restaurant      Theme Restaurant   18
2  Eastern European Restaurant    Italian Restaurant   11
3           Chinese Restaurant     Indian Restaurant    9
4           Chinese Restaurant     Indian Restaurant    9

   amount of restaurants
0                     24
1                     18
2                     11
3                      9
4                      9
```

`Berlin - Friedrichshain-Kreuzberg` has the highest number of restaurants of 29. But `Munich - Marienplatz` seems also to be a good choice with 24 different restaurants. So she will decide based on most common restaurants.

0.28 6.3 Explore Trending Venues

Since it's possible to get at least *one* premium request, we use ***trending*** API. Most probably she will pick `Friedrichshain-Kreuzberg` with the highest number of restaurants of 29. As soon as we arrive, we will look for the places with the highest foot traffic. So let's do that and get the trending venues around.

[78]:
```
latitude = berlin_merged._get_value(3, 'latitude')
longitude = berlin_merged._get_value(3, 'longitude')
print("borough =", berlin_merged._get_value(3, 'borough'), ", latitude =",␣
 ↪latitude, ", longitude =", longitude)
```

```
borough = Friedrichshain-Kreuzberg , latitude = 52.5011154 , longitude =
13.4442848
```

[79]:
```
# define URL
url = 'https://api.foursquare.com/v2/venues/trending?
 ↪client_id={}&client_secret={}&ll={},{}&v={}'.format(CLIENT_ID,␣
 ↪CLIENT_SECRET, latitude, longitude, VERSION)

# send GET request and get trending venues
results = requests.get(url).json()
results
```

[79]:

```
{'meta': {'code': 200, 'requestId': '5ffd6f19aca2493433cd08d3'},
 'response': {'venues': []}}
```

0.28.1 Check if any venues are trending at this time

[80]:
```
if len(results['response']['venues']) == 0:
    trending_venues_df = 'No trending venues are available at the moment!'

else:
    trending_venues = results['response']['venues']
    trending_venues_df = json_normalize(trending_venues)

    # filter columns
    columns_filtered = ['name', 'categories'] + ['location.distance', 'location.
↪city', 'location.postalCode', 'location.state', 'location.country',␣
↪'location.lat', 'location.lng']
    trending_venues_df = trending_venues_df.loc[:, columns_filtered]

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

[81]:
```
# display trending venues
trending_venues_df
```

[81]:
```
'No trending venues are available at the moment!'
```

Now, depending on when you run the above code, you might get different venues since the venues with the highest foot traffic are fetched live.

0.28.2 Visualize trending venues

[ ]:
```
if len(results['response']['venues']) == 0:
    venues_map = 'Cannot generate visual as no trending venues are available at␣
↪the moment!'

else:
    venues_map = folium.Map(location=[latitude, longitude], zoom_start=15) #␣
↪generate map centred around Ecco


    # add Ecco as a red circle mark
    folium.CircleMarker(
        [latitude, longitude],
        radius=10,
        popup='Ecco',
        fill=True,
        color='red',
        fill_color='red',
        fill_opacity=0.6
```

```
    ).add_to(venues_map)


    # add the trending venues as blue circle markers
    for lat, lng, label in zip(trending_venues_df['location.lat'],␣
↪trending_venues_df['location.lng'], trending_venues_df['name']):
        folium.CircleMarker(
            [lat, lng],
            radius=5,
            poup=label,
            fill=True,
            color='blue',
            fill_color='blue',
            fill_opacity=0.6
        ).add_to(venues_map)
```

[ ]:
```
# display map
venues_map
```

[ ]:
```

```

Section ??

[ ]:
```

```