Capstone Project - The Battle of Neighbourhoods

1. *Introduction Section*

Singapore, officially termed the Republic of Singapore, is also known as the Lion City (Singapura) and consists of the main island and about 64 smaller offshore islands, including Sentosa (the largest of the offshore islands), Pulau Ubin, St John's Island and the Sisters' Islands. The city-state occupies an area of 718 km², compared, it is the smallest state in Southeast Asia.

In 2020, the population of Singapore is about 5.7 million people and resident population of 4 million. Today, Singapore is the most densely populated independent country in the world.

Singapore was hit severely with the infectious coronavirus disease, Covid-19. In response, the government implemented various safety management measures (SMMs) such as the Circuit-Breaker which was a partial lockdown and the three phases of planned re-opening for businesses. Currently in Phase 3, Singapore has progressed into strategic re-opening of businesses with the recommendations of the Multi-Ministry Taskforce (MTF). Specifically, selected bars and pubs are allowed to reopen for 2 months to boost the nightlife industry in Singapore as part of a pilot programme.

This capstone project will highlight the data science skills acquired in the IBM Data Science courses offered by the Coursera platform.

2. *Problem Statement*

Preliminary Analysis and Clustering of the Bar Locations & Nightlife Estates in Singapore for Re-Opening in Next Phase of Covid-19

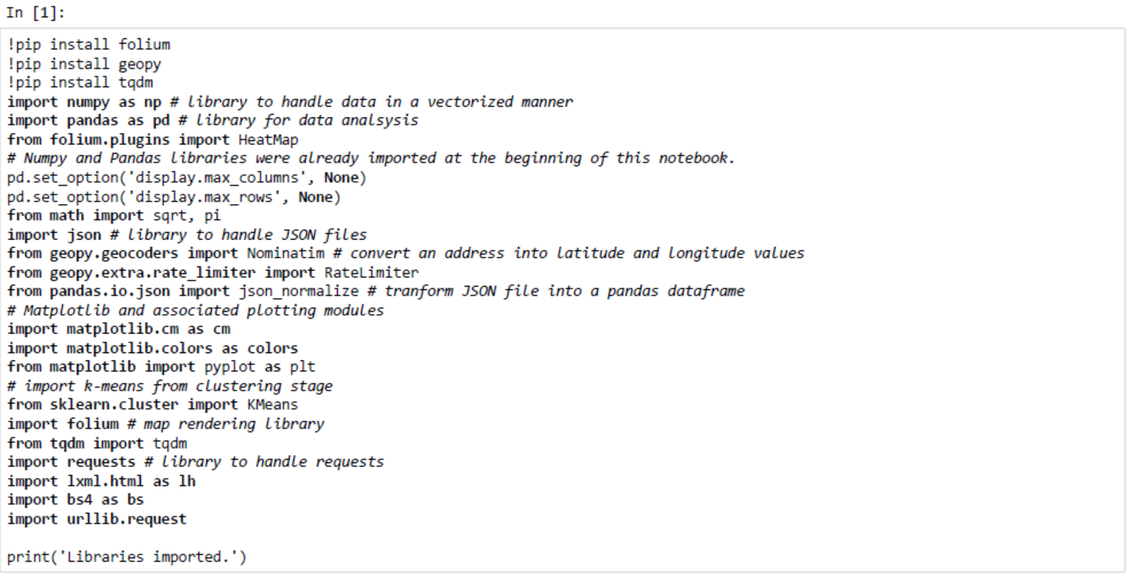
3. *Data*

For this project, the following data will be required and imported.

Importing of Data from Wikipedia – Singapore Neighbourhood / Estates Information
Importing of Data from Folium - Bar Locations in Singapore Neighbourhood / Estates

4. *Approach*

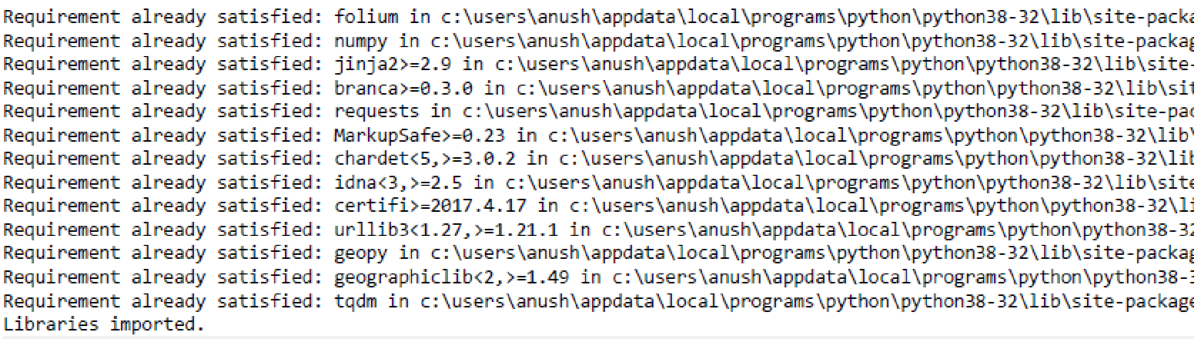
- Identify the Names of the Bars in Singapore and its Locations through Web-Scrapping.
- Use Foursquare Data to Obtain info about Most Popular Venues.
- Use Clustering to identify Close-Proximity of Bar Locations.
- Visualization using Folium and HeatMap



In [1]:

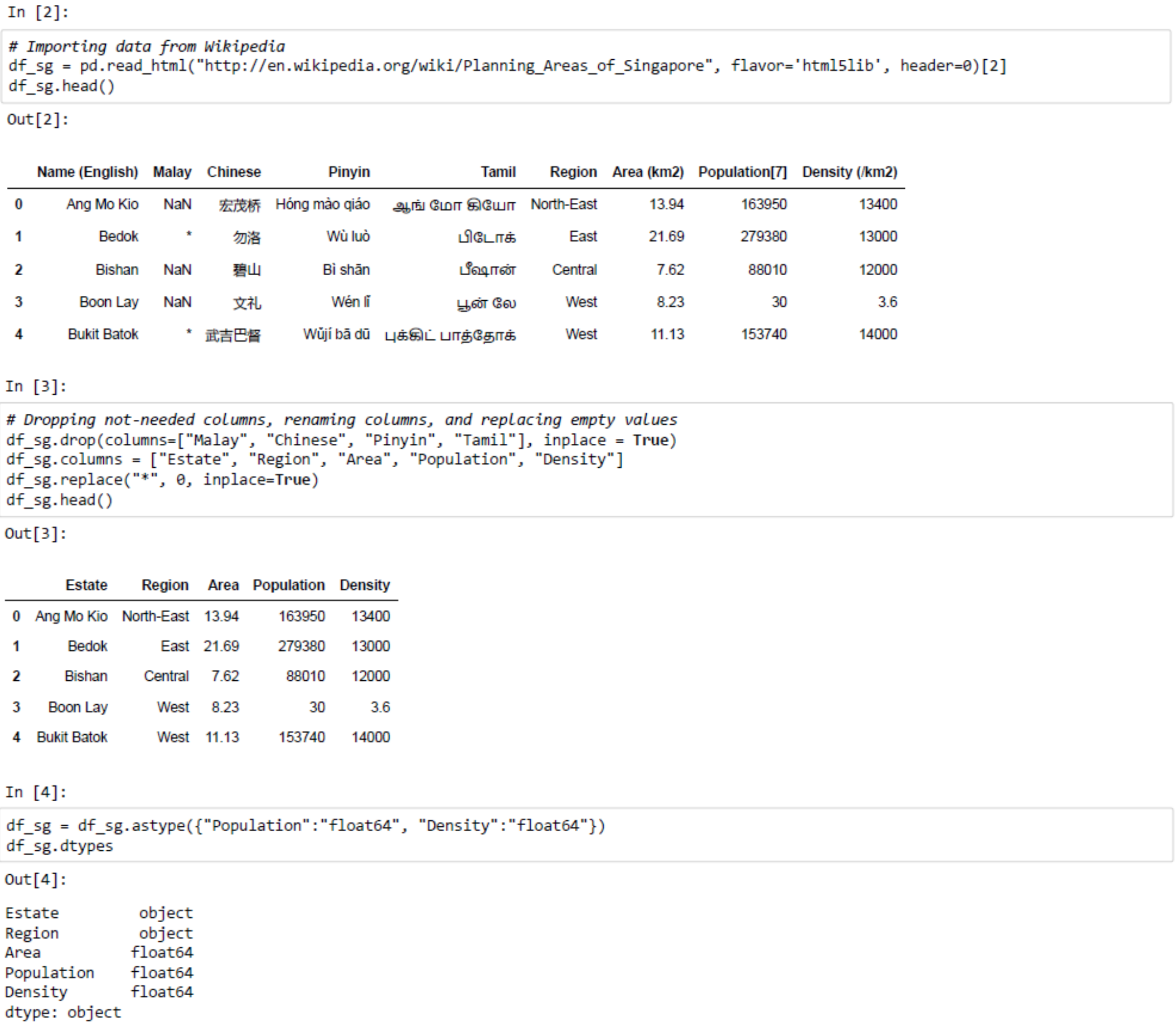
```
!pip install folium
!pip install geopy
!pip install tqdm
import numpy as np # library to handle data in a vectorized manner
import pandas as pd # library for data analsysis
from folium.plugins import HeatMap
# Numpy and Pandas libraries were already imported at the beginning of this notebook.
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)
from math import sqrt, pi
import json # library to handle JSON files
from geopy.geocoders import Nominatim # convert an address into latitude and longitude values
from geopy.extra.rate_limiter import RateLimiter
from pandas.io.json import json_normalize # tranform JSON file into a pandas dataframe
# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors
from matplotlib import pyplot as plt
# import k-means from clustering stage
from sklearn.cluster import KMeans
import folium # map rendering library
from tqdm import tqdm
import requests # library to handle requests
import lxml.html as lh
import bs4 as bs
import urllib.request

print('Libraries imported.')
```



```
Requirement already satisfied: folium in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-packa
Requirement already satisfied: numpy in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-packag
Requirement already satisfied: jinja2>=2.9 in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-
Requirement already satisfied: branca>=0.3.0 in c:\users\anush\appdata\local\programs\python\python38-32\lib\sit
Requirement already satisfied: requests in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-pac
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\anush\appdata\local\programs\python\python38-32\lib\
Requirement already satisfied: chardet<5,>=3.0.2 in c:\users\anush\appdata\local\programs\python\python38-32\lib
Requirement already satisfied: idna<3,>=2.5 in c:\users\anush\appdata\local\programs\python\python38-32\lib\site
Requirement already satisfied: certifi>=2017.4.17 in c:\users\anush\appdata\local\programs\python\python38-32\li
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\anush\appdata\local\programs\python\python38-32
Requirement already satisfied: geopy in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-packag
Requirement already satisfied: geographiclib<2,>=1.49 in c:\users\anush\appdata\local\programs\python\python38-3
Requirement already satisfied: tqdm in c:\users\anush\appdata\local\programs\python\python38-32\lib\site-package
Libraries imported.
```

4.1. Web Scrapping from Wikipedia



In [2]:

```
# Importing data from Wikipedia
df_sg = pd.read_html("http://en.wikipedia.org/wiki/Planning_Areas_of_Singapore", flavor='html5lib', header=0)[2]
df_sg.head()
```

Out[2]:

	Name (English)	Malay	Chinese	Pinyin	Tamil	Region	Area (km2)	Population[7]	Density (/km2)
0	Ang Mo Kio	NaN	宏茂桥	Hóng mào qiáo	ஆங் மோ கியோ	North-East	13.94	163950	13400
1	Bedok	*	勿洛	Wù luò	பிடோக்	East	21.69	279380	13000
2	Bishan	NaN	碧山	Bì shān	பீஷான்	Central	7.62	88010	12000
3	Boon Lay	NaN	文礼	Wén lǐ	பூன் லே	West	8.23	30	3.6
4	Bukit Batok	*	武吉巴督	Wǔjí bā dū	புக்கிட் பாத்தோக்	West	11.13	153740	14000

In [3]:

```
# Dropping not-needed columns, renaming columns, and replacing empty values
df_sg.drop(columns=["Malay", "Chinese", "Pinyin", "Tamil"], inplace = True)
df_sg.columns = ["Estate", "Region", "Area", "Population", "Density"]
df_sg.replace("*", 0, inplace=True)
df_sg.head()
```

Out[3]:

	Estate	Region	Area	Population	Density
0	Ang Mo Kio	North-East	13.94	163950	13400
1	Bedok	East	21.69	279380	13000
2	Bishan	Central	7.62	88010	12000
3	Boon Lay	West	8.23	30	3.6
4	Bukit Batok	West	11.13	153740	14000

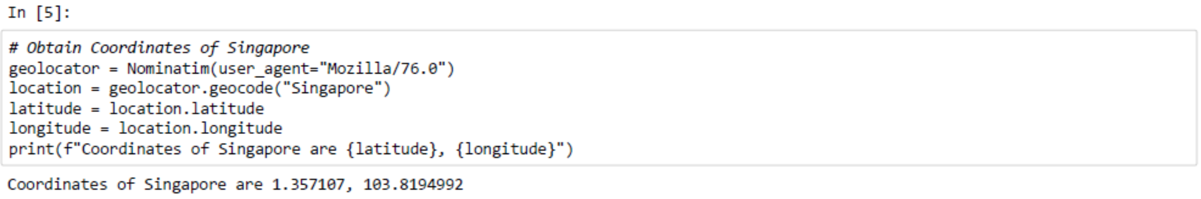
In [4]:

```
df_sg = df_sg.astype({"Population":"float64", "Density":"float64"})
df_sg.dtypes
```

Out[4]:

```
Estate         object
Region         object
Area          float64
Population    float64
Density       float64
dtype: object
```

4.2. Data Acquisition – Geolocator Nominatim



In [5]:

```
# Obtain Coordinates of Singapore
geolocator = Nominatim(user_agent="Mozilla/76.0")
location = geolocator.geocode("Singapore")
latitude = location.latitude
longitude = location.longitude
print(f"Coordinates of Singapore are {latitude}, {longitude}")
```

```
Coordinates of Singapore are 1.357107, 103.8194992
```

In [6]:

```
# Coordinates of each Estate, and adding suffix to search query
tqdm.pandas()
geocode = RateLimiter(geolocator.geocode, min_delay_seconds=1)
coords = (df_sg["Estate"] + " suburb, Singapore").progress_apply(geocode)
```

```
timeout=1)'))

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\extra\rate_limiter.py",
    yield i  # Run the function.
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\extra\rate_limiter.py",
    res = self.func(*args, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\nominatim.py'
    return self._call_geocoder(url, callback, timeout=timeout)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\base.py", lir
    result = self.adapter.get_json(url, timeout=timeout, headers=req_headers)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\adapters.py", line 377,
    resp = self._request(url, timeout=timeout, headers=headers)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\adapters.py", line 399,
    raise GeocoderUnavailable(message)
geopy.exc.GeocoderUnavailable: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Max retries ex
 11%|█          | 6/55 [00:13<01:18,  1.60s/it]RateLimiter caught an error, retrying (0/2 tries). Called with (*(
Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connection.py", line
    conn = connection.create_connection(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\util\connection.py",
    raise err
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\util\connection.py",
    sock.connect(sa)
socket.timeout: timed out

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    httplib_response = self._make_request(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    self._validate_conn(conn)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    conn.connect()
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connection.py", line
    conn = self._new_conn()
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connection.py", line
    raise ConnectTimeoutError(
urllib3.exceptions.ConnectTimeoutError: (<urllib3.connection.HTTPSConnection object at 0x25BB5910>, 'Connection

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\adapters.py", line 4
    resp = conn.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    return self.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    return self.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    retries = retries.increment(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\util\retry.py", line
    raise MaxRetryError(_pool, url, error or ResponseError(cause))
urllib3.exceptions.MaxRetryError: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Max retries

During handling of the above exception, another exception occurred:

Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\adapters.py", line 387,
    resp = self.session.get(url, timeout=timeout, headers=headers)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 5
    return self.request('GET', url, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 5
    resp = self.send(prep, **send_kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 6
    r = adapter.send(request, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\adapters.py", line 5
    raise ConnectTimeout(e, request=request)
requests.exceptions.ConnectTimeout: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Max retri

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  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\extra\rate_limiter.py",
    res = self.func(*args, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\nominatim.py'
    return self._call_geocoder(url, callback, timeout=timeout)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\base.py", lir
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\socket.py", line 669, in readinto
    return self._sock.recv_into(b)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\ssl.py", line 1241, in recv_into
    return self.read(nbytes, buffer)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\ssl.py", line 1099, in read
    return self._sslobj.read(len, buffer)
socket.timeout: The read operation timed out

During handling of the above exception, another exception occurred:

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  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    httplib_response = self._make_request(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    self._raise_timeout(err=e, url=url, timeout_value=read_timeout)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    raise ReadTimeoutError(
urllib3.exceptions.ReadTimeoutError: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Read tim

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Traceback (most recent call last):
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\adapters.py", line 4
    resp = conn.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    return self.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    return self.urlopen(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\connectionpool.py", l
    retries = retries.increment(
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\urllib3\util\retry.py", line
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  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 5
    return self.request('GET', url, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 5
    resp = self.send(prep, **send_kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\sessions.py", line 6
    r = adapter.send(request, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\requests\adapters.py", line 5
    raise ConnectionError(e, request=request)
requests.exceptions.ConnectionError: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Max retr

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  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\extra\rate_limiter.py",
    res = self.func(*args, **kwargs)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\nominatim.py'
    return self._call_geocoder(url, callback, timeout=timeout)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\geocoders\base.py", lir
    result = self.adapter.get_json(url, timeout=timeout, headers=req_headers)
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    resp = self._request(url, timeout=timeout, headers=headers)
  File "C:\Users\anush\AppData\Local\Programs\Python\Python38-32\lib\site-packages\geopy\adapters.py", line 399,
    raise GeocoderUnavailable(message)
geopy.exc.GeocoderUnavailable: HTTPSConnectionPool(host='nominatim.openstreetmap.org', port=443): Max retries e
100%|██████████| 55/55 [01:46<00:00,  1.93s/it]
```
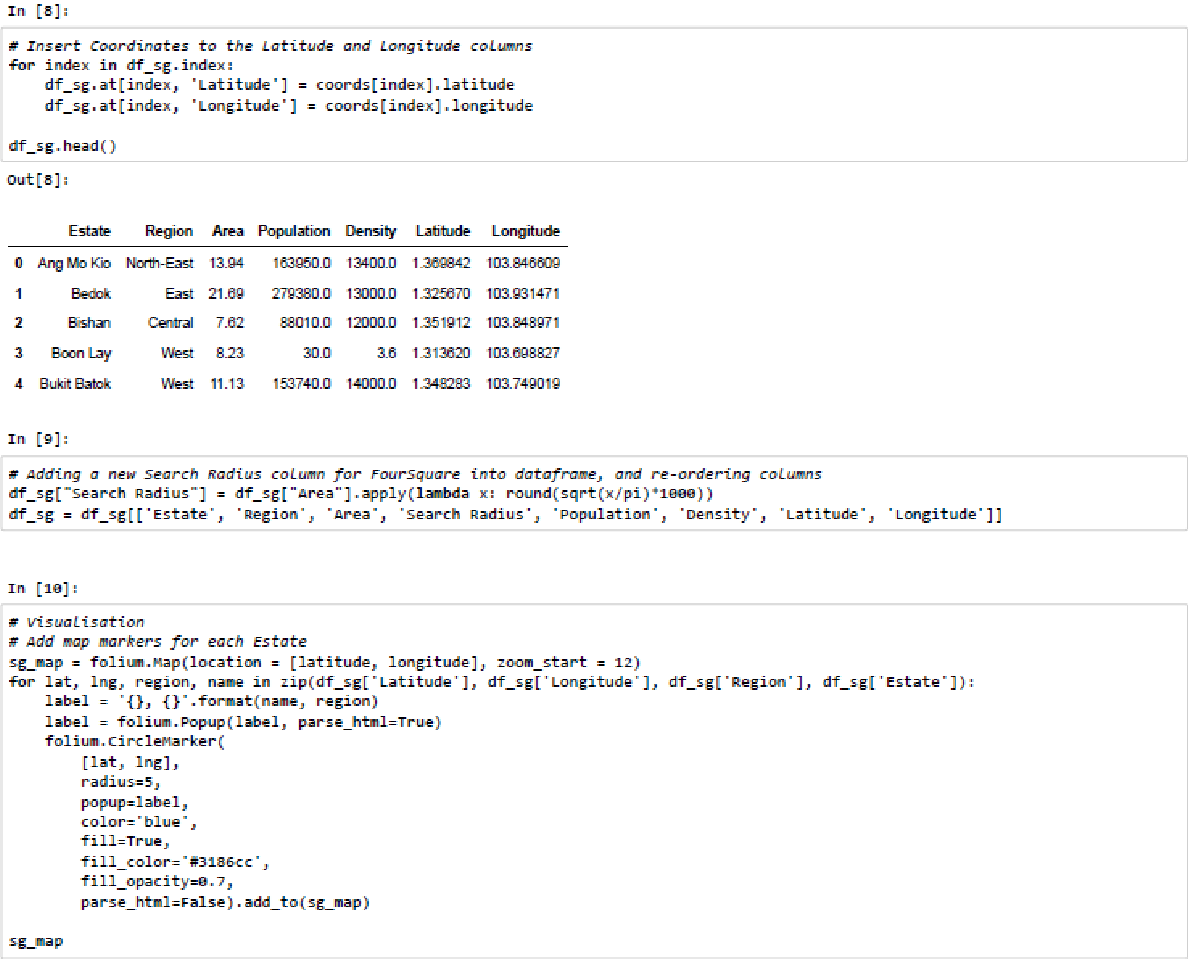

In [7]:

```
# Adding of Latitude and Longitude columns to dataframe
df_sg["Latitude"] = np.nan
df_sg["Longitude"] = np.nan
df_sg.head()
```

Out[7]:

	Estate	Region	Area	Population	Density	Latitude	Longitude
0	Ang Mo Kio	North-East	13.94	163950.0	13400.0	NaN	NaN
1	Bedok	East	21.69	279380.0	13000.0	NaN	NaN
2	Bishan	Central	7.62	88010.0	12000.0	NaN	NaN
3	Boon Lay	West	8.23	30.0	3.6	NaN	NaN
4	Bukit Batok	West	11.13	153740.0	14000.0	NaN	NaN



In [8]:

```
# Insert Coordinates to the Latitude and Longitude columns
for index in df_sg.index:
    df_sg.at[index, 'Latitude'] = coords[index].latitude
    df_sg.at[index, 'Longitude'] = coords[index].longitude

df_sg.head()
```

Out[8]:

	Estate	Region	Area	Population	Density	Latitude	Longitude
0	Ang Mo Kio	North-East	13.94	163950.0	13400.0	1.369842	103.846609
1	Bedok	East	21.69	279380.0	13000.0	1.325670	103.931471
2	Bishan	Central	7.62	88010.0	12000.0	1.351912	103.848971
3	Boon Lay	West	8.23	30.0	3.6	1.313620	103.698827
4	Bukit Batok	West	11.13	153740.0	14000.0	1.348283	103.749019

In [9]:

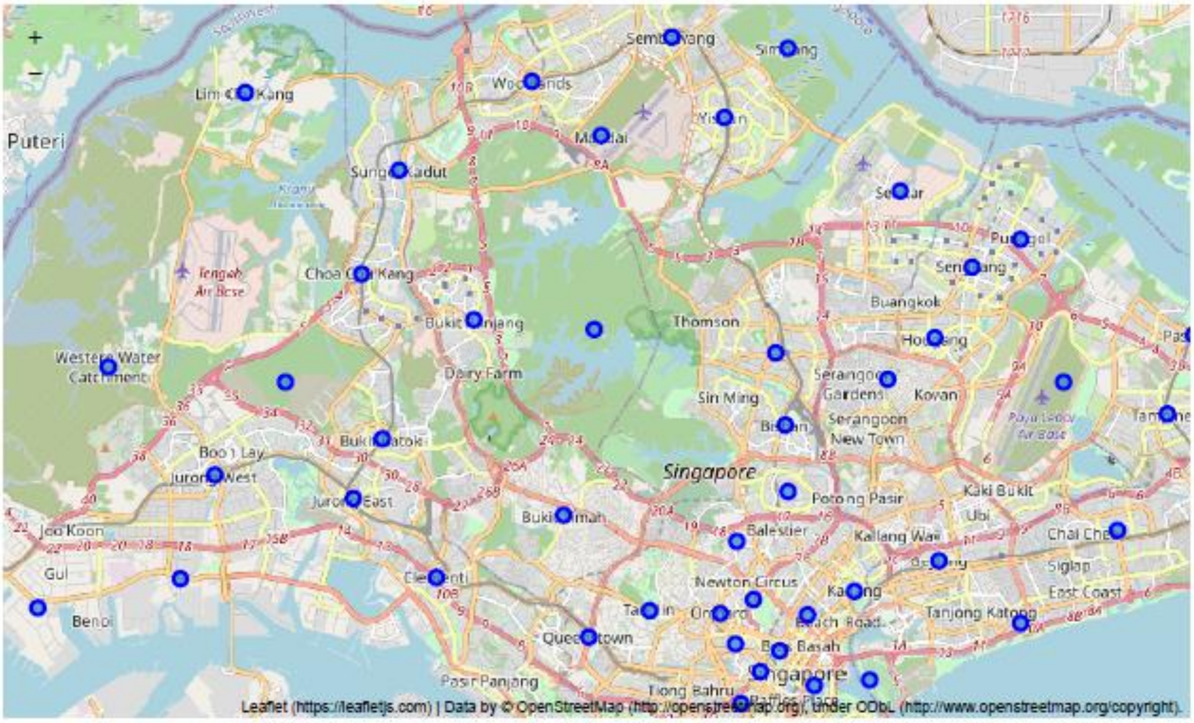
```
# Adding a new Search Radius column for FourSquare into dataframe, and re-ordering columns
df_sg["Search Radius"] = df_sg["Area"].apply(lambda x: round(sqrt(x/pi)*1000))
df_sg = df_sg[['Estate', 'Region', 'Area', 'Search Radius', 'Population', 'Density', 'Latitude', 'Longitude']]
```

In [10]:

```
# Visualisation
# Add map markers for each Estate
sg_map = folium.Map(location = [latitude, longitude], zoom_start = 12)
for lat, lng, region, name in zip(df_sg['Latitude'], df_sg['Longitude'], df_sg['Region'], df_sg['Estate']):
    label = '{}, {}'.format(name, region)
    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(sg_map)

sg_map
```

4.3. Neighbourhoods in Singapore

Out[10]:



In [11]:

```
# Four Square API credentials
CLIENT_ID = [redacted]' # your Foursquare ID
CLIENT_SECRET = [redacted]' # your Foursquare Secret
ACCESS_TOKEN = [redacted] # your FourSquare Access Token
VERSION = '20180604'
LIMIT = 100
print('Your credentails:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

```
Your credentails:
CLIENT_ID: [redacted]
CLIENT_SECR
```

In [12]:

```
# Function Defined to get nearby venues using the Foursquare API to extract relevant information from the JSON response

def getNearbyVenues(names, latitudes, longitudes, radius):

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

        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.forma
            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 = ['Estate',
                  'Est Latitude',
                  'Est Longitude',
                  'Venue',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Venue Category']

    return(nearby_venues)
```

In [13]:

```
# Calling of the user-defined function for SG Dataframe
sg_venues = getNearbyVenues(names=df_sg['Estate'],
                            latitudes=df_sg['Latitude'],
                            longitudes=df_sg['Longitude'],
                            radius=df_sg['Search Radius']
                           )
```

```
Ang Mo Kio
Bedok
Bishan
Boon Lay
Bukit Batok
Bukit Merah
Bukit Panjang
Bukit Timah
Central Water Catchment
Changi
Changi Bay
Choa Chu Kang
Clementi
Downtown Core
Geylang
Hougang
Jurong East
Jurong West
Kallang
Lim Chu Kang
Mandai
Marina East
Marina South
Marine Parade
Museum
Newton
North-Eastern Islands
Novena
Orchard
Outram
Pasir Ris
Paya Lebar
Pioneer
Punggol
Queenstown
River Valley
Rochor
Seletar
Sembawang
Sengkang
Serangoon
Simpang
Singapore River
Southern Islands
Straits View
Sungei Kadut
Tampines
Tanglin
Tengah
Toa Payoh
Tuas
Western Islands
Western Water Catchment
Woodlands
Yishun
```

In [14]:

```
sg_venues.head(10)
```

Out[14]:

	Estate	Est Latitude	Est Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Ang Mo Kio	1.369842	103.846609	Bishan - Ang Mo Kio Park	1.362219	103.846250	Park
1	Ang Mo Kio	1.369842	103.846609	Aramsa ~ The Garden Spa	1.362292	103.847602	Spa
2	Ang Mo Kio	1.369842	103.846609	Old Chang Kee	1.369094	103.848389	Snack Place
3	Ang Mo Kio	1.369842	103.846609	FairPrice Xtra	1.369279	103.848686	Supermarket
4	Ang Mo Kio	1.369842	103.846609	MOS Burger	1.369170	103.847631	Burger Joint
5	Ang Mo Kio	1.369842	103.846609	NTUC FairPrice	1.371507	103.847062	Supermarket
6	Ang Mo Kio	1.369842	103.846609	Face Ban Mian 非板面 (Ang Mo Kio)	1.372031	103.847504	Noodle House
7	Ang Mo Kio	1.369842	103.846609	A&W	1.369541	103.849043	Fast Food Restaurant
8	Ang Mo Kio	1.369842	103.846609	Pepper Lunch	1.369107	103.847791	Japanese Restaurant
9	Ang Mo Kio	1.369842	103.846609	Bangkok Street Mookata	1.365688	103.853186	BBQ Joint

4.4. One Hot Encoding

```
In [15]:
```

```
# Using of One Hot Encoding Method
sg_onehot = pd.get_dummies(sg_venues[['Venue Category']], prefix="", prefix_sep="")

# add neighborhood column back to dataframe
sg_onehot.insert(loc = 0, column = 'Estate', value = sg_venues['Estate'])

# summing one-hot values
sg_onehot = sg_onehot.groupby('Estate').sum().reset_index()
sg_onehot.head()
```

```
Out[15]:
```

	Estate	Accessories Store	Airport	Airport Lounge	Airport Service	Airport Terminal	American Restaurant	Aquarium	Art Gallery	Art Museum	Arts & Crafts Store	Asian Restaurant	Athletics & Sports	Austra Restau
0	Ang Mo Kio	0	0	0	0	0	0	0	0	0	0	3	0	
1	Bedok	0	0	0	0	0	2	0	0	0	0	5	0	
2	Bishan	0	0	0	0	0	0	0	0	0	0	4	0	
3	Boon Lay	0	0	0	0	0	0	0	0	0	0	0	0	
4	Bukit Batok	1	0	0	0	0	1	0	0	0	0	1	0	

4.5. Data Exploration

```
In [16]:
```

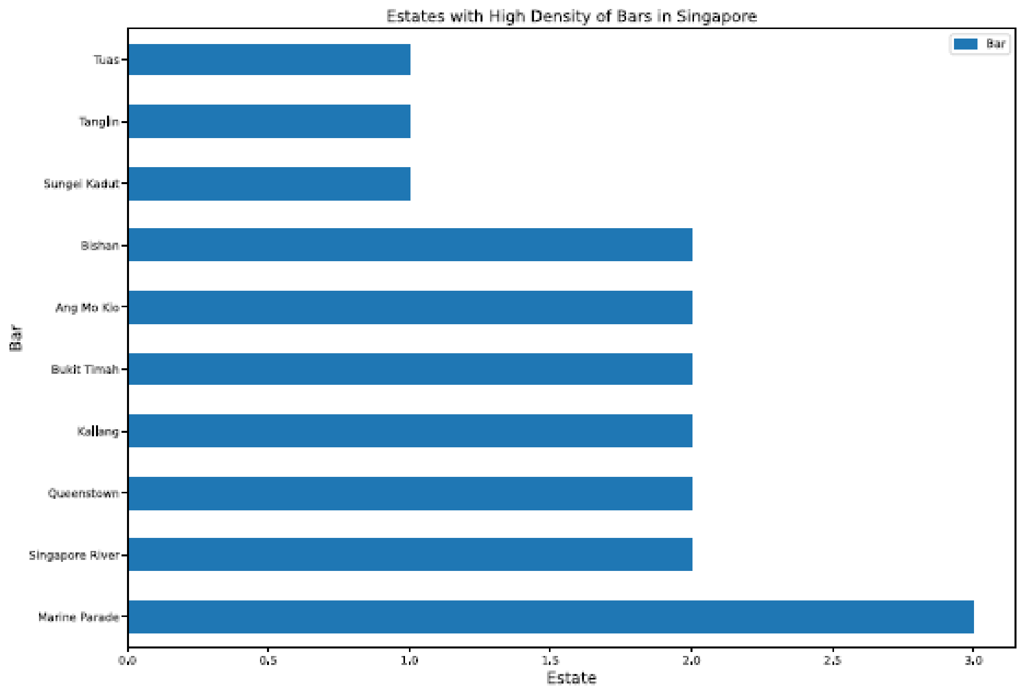
```
# Select Bars in Estate
sg_barh = sg_onehot[['Estate','Bar']]
sg_barh = sg_barh.sort_values(by='Bar', ascending=False)
sg_barh.reset_index(drop=True, inplace=True)
sg_barh10 = sg_barh.head(10)
sg_barh10
```

```
Out[16]:
```

	Estate	Bar
0	Marine Parade	3
1	Singapore River	2
2	Queenstown	2
3	Kallang	2
4	Bukit Timah	2
5	Ang Mo Kio	2
6	Bishan	2
7	Sungei Kadut	1
8	Tanglin	1
9	Tuas	1

```
In [17]:
```

```
# Plotting bar chart
sg_barh10.plot(kind='barh', x='Estate', y='Bar', figsize=(14,10))
plt.xlabel('Estate', fontsize=14)
plt.ylabel('Bar', fontsize=14)
plt.title(f'Estates with High Density of Bars in Singapore', fontsize=14)

plt.show()
```



4.6. Visualisation of Bars in Singapore

In [18]:

```
sg_bar = sg_venues[sg_venues['Venue Category'].str.match('Bar')].reset_index(drop=True)
sg_bar = sg_bar.drop(columns=['Est Latitude', 'Est Longitude'])
sg_bar.head()
```

Out[18]:

	Estate	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Ang Mo Kio	Middle Rock Garden Bar	1.362181	103.847203	Bar
1	Ang Mo Kio	Canopy Garden Dining & Bar	1.362303	103.847399	Bar
2	Bishan	Middle Rock Garden Bar	1.362181	103.847203	Bar
3	Bishan	Canopy Garden Dining & Bar	1.362303	103.847399	Bar
4	Bukit Merah	Junior	1.278958	103.844180	Bar

In [19]:

```
sg_bar.shape
```

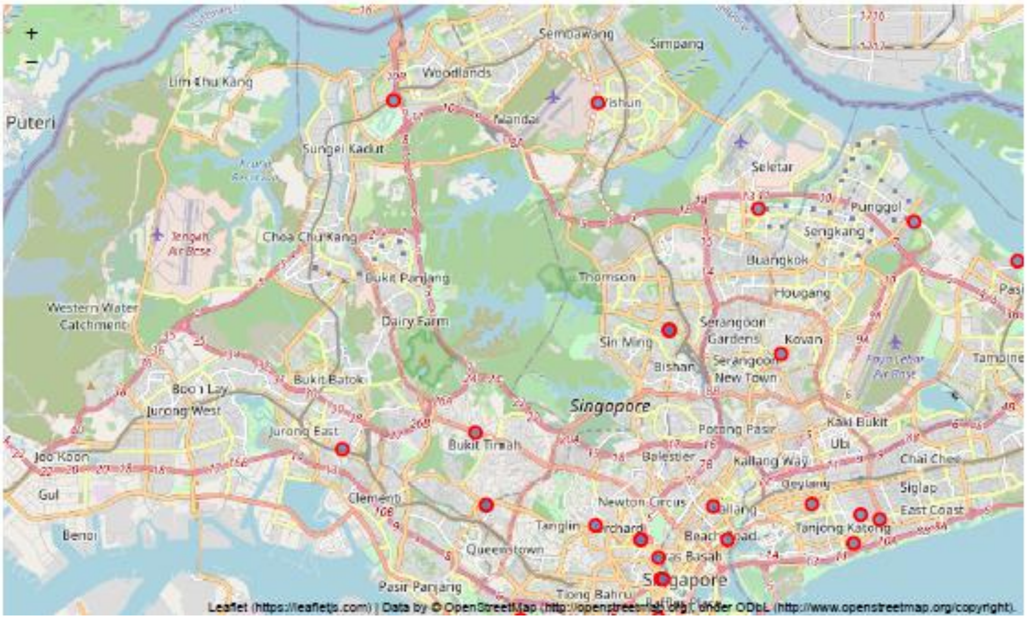
Out[19]:

```
(29, 5)
```

In [20]:

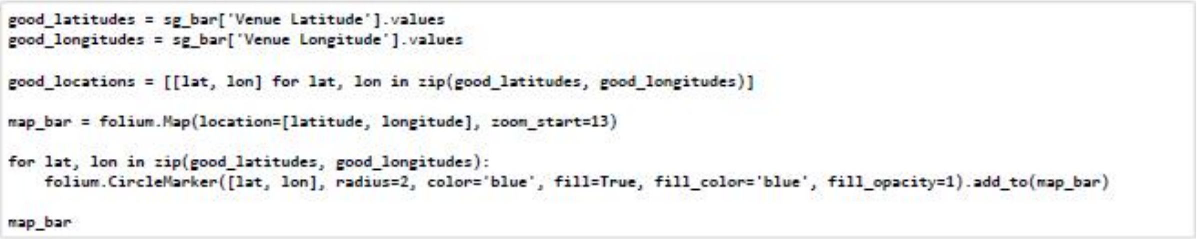
```
barmap_sg = folium.Map(location=[latitude, longitude], zoom_start=12)

# add markers to map
for lat, lng, bar in zip(sg_bar['Venue Latitude'], sg_bar['Venue Longitude'], sg_bar['Venue']):
    label = '{}'.format(bar)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='red',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(barmap_sg)

barmap_sg
```

Out[20]:



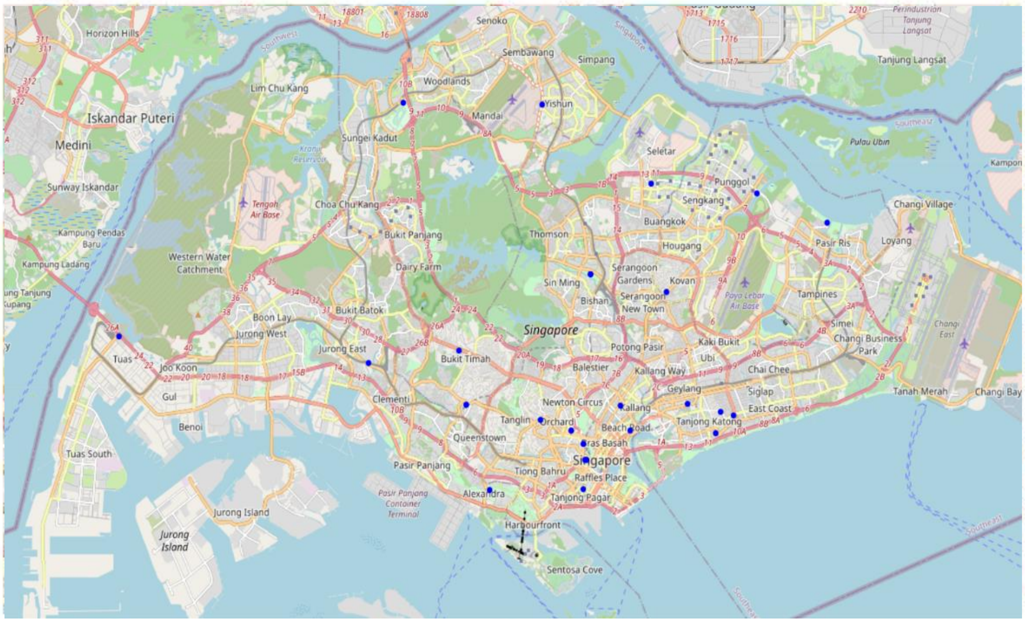
4.7. K – Means Clustering

In [21]:



```
good_latitudes = sg_bar['Venue Latitude'].values
good_longitudes = sg_bar['Venue Longitude'].values

good_locations = [[lat, lon] for lat, lon in zip(good_latitudes, good_longitudes)]

map_bar = folium.Map(location=[latitude, longitude], zoom_start=13)

for lat, lon in zip(good_latitudes, good_longitudes):
    folium.CircleMarker([lat, lon], radius=2, color='blue', fill=True, fill_color='blue', fill_opacity=1).add_to(map_bar)

map_bar
```

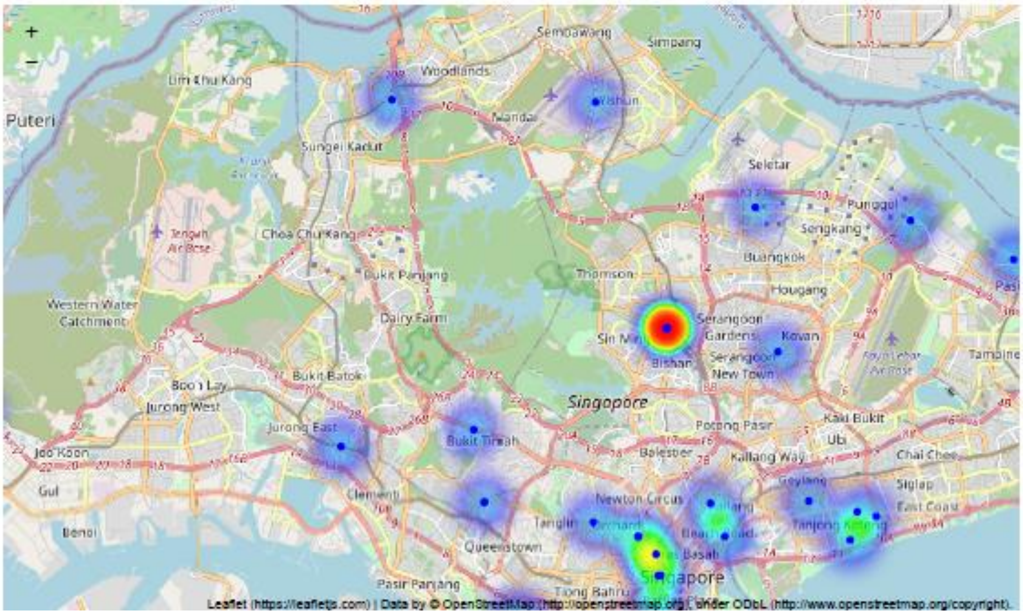
Out[21]:



In [22]:

```
map_bar = folium.Map(location=[latitude, longitude], zoom_start=12.4)
HeatMap(good_locations, radius=25).add_to(map_bar)

for lat, lon in zip(good_latitudes, good_longitudes):
    folium.CircleMarker([lat, lon], radius=2, color='blue', fill=True, fill_color='blue', fill_opacity=1).add_to(map_bar)

map_bar
```

Out[22]:

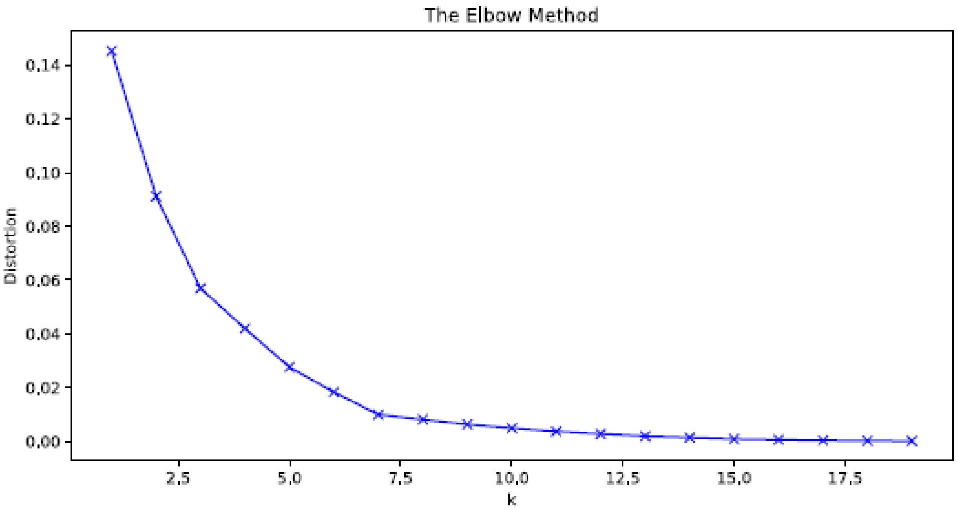


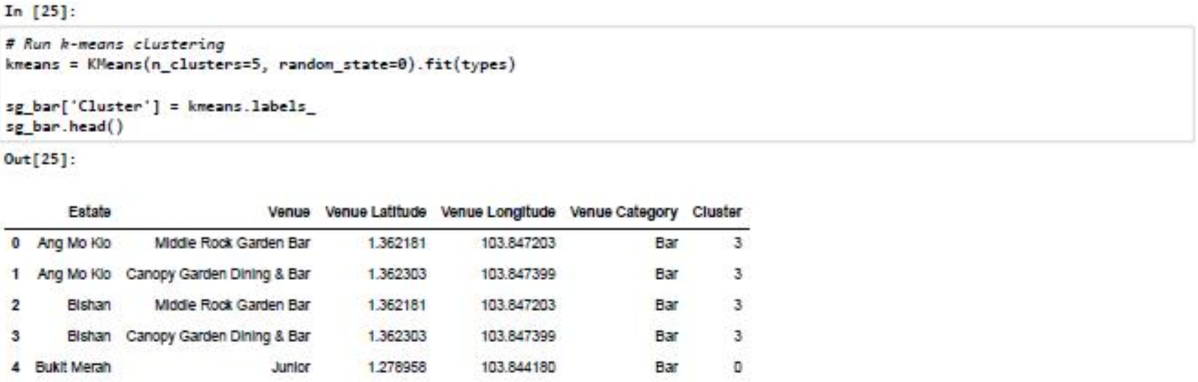
In [23]:

```
distortions = []
types = sg_bar[['Venue Latitude','Venue Longitude']]
K = range(1,20)
for k in K:
    kmean = KMeans(n_clusters=k, random_state=0, n_init = 50, max_iter = 500)
    kmean.fit(types)
    distortions.append(kmean.inertia_)
```

In [24]:

```
plt.figure(figsize=(10,5))
plt.plot(K, distortions, 'bx-')
plt.xlabel('k')
plt.ylabel('Distortion')
plt.title('The Elbow Method')
plt.show()
```



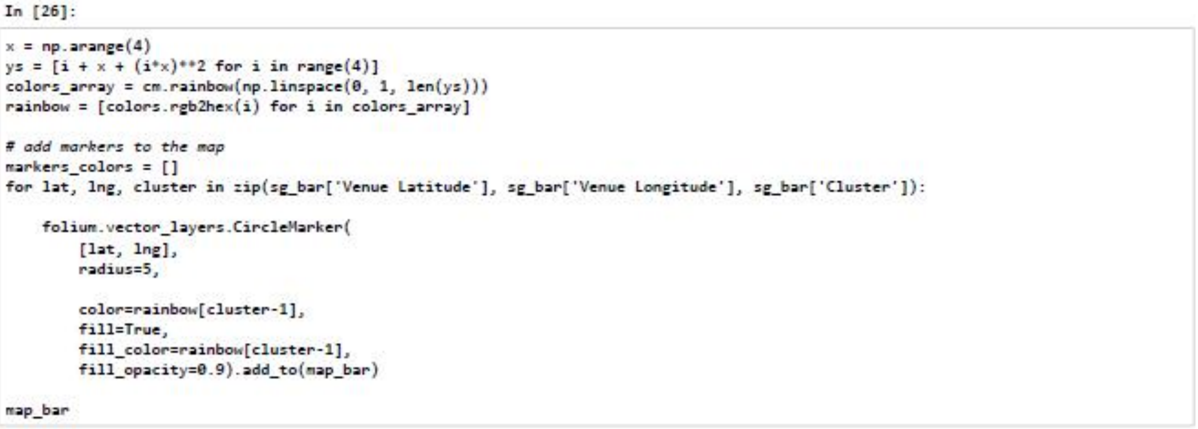


In [25]:

```
# Run k-means clustering
kmeans = KMeans(n_clusters=5, random_state=0).fit(types)

sg_bar['Cluster'] = kmeans.labels_
sg_bar.head()
```

Out[25]:

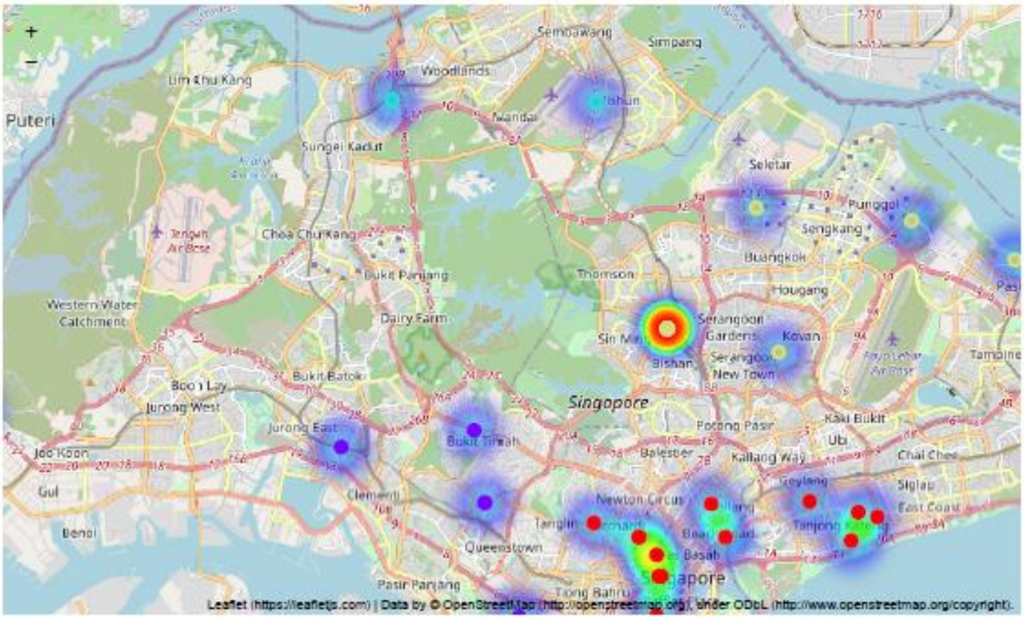
	Estate	Venue	Venue Latitude	Venue Longitude	Venue Category	Cluster
0	Ang Mo Kio	Middle Rock Garden Bar	1.362181	103.847203	Bar	3
1	Ang Mo Kio	Canopy Garden Dining & Bar	1.362303	103.847399	Bar	3
2	Bishan	Middle Rock Garden Bar	1.362181	103.847203	Bar	3
3	Bishan	Canopy Garden Dining & Bar	1.362303	103.847399	Bar	3
4	Bukit Merah	Junior	1.278958	103.844180	Bar	0



In [26]:

```
x = np.arange(4)
ys = [i + x + (i*x)**2 for i in range(4)]
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, lng, cluster in zip(sg_bar['Venue Latitude'], sg_bar['Venue Longitude'], sg_bar['Cluster']):

    folium.vector_layers.CircleMarker(
        [lat, lng],
        radius=5,

        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.9).add_to(map_bar)

map_bar
```

Out[26]:



5. *Conclusion*

From the preliminary analysis performed using the K-Means Clustering algorithm, it was observed that the red clusters that represent bars in neighbourhoods of Newton, Orchard, Tanglin, Tiong Bahru, Kallang and Tanjong Katong have to be strategically opened. Comparatively, bars in other estates that were grouped in other clusters such as the blue and yellow clusters contain lower number of bars. This indicates that it is likely to have less human traffic and interaction.

6. Discussion

However, this project is a preliminary analysis and further study is required to obtain insights on the re-opening of the bars in Singapore. The popularity factor of bars can also be studied to obtain an accurate representation of the bars in Singapore.