Capstone Project - Final Assignment (Week 2)

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1. Introduction: The Challenge

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A good friend of mine, Lingling (a nickname), whoes dream is to open a Chinese restaurant one day to share the joy of good food with others. Now, everything is ready, she can finally realize her dream. She has chosen Amsterdam to be the place that her dream starts. Not only because Amsterdam is one of the most populous and visited cities in Europe but also because the diverse culture the city embraces.

My challenge as a data scientist is to help her to find the ideal location in Amsterdam using whatever data I can access.

1.1. A Cooperative Iterative Approach

It's important to emphasize that even though I might know how to deal with data better, Lingling definitely knows food business a lot more. Throughout this project, we will work closely together to take full advantage of our expertises.

The process is also iterative. Not all decisions made at the begining of the project remains the best ones. We both fully understand that when we learn more about Amsterdam and the its residences, we need to continuously re-examine and fine tune our decisions.

1.2. About Amsterdam

Amsterdam (https://en.wikipedia.org/wiki/Amsterdam) is the capital city and most populous municipality of the Netherlands (https://en.wikipedia.org/wiki/Netherlands). Here are some facts about its residences:

- Amsterdam has a population of **854,047** within the city proper
- Amsterdam city proper has **4,457** inhabitants per square kilometer and **2,275** households per square kilometer.
- Amsterdam has more than **100 kilometers (60 miles)** of canals, most of which are navigable by boat.

As to tourism, Amsterdam is one of the most popular tourist destinations in Europe

- Number of international tourists per year: **20.63 million**.
- Out of which, the number of day-trippers is: **16 million**.

Reference: https://en.wikipedia.org/wiki/Amsterdam (https://en.wikipedia.org/wiki/Amsterdam)

1.3. Business Questions

To find the ideal location for the restaurant, we must first seek answers to a few quesions.

Question 1: How many restaurants already exist?

If this new restaurant would be the only one in a neighborhood, there will be more profit for Lingling. So, the number of existing restaurants in the neighborhood must be taken into consideration. Again, this question can be answered, hopefully, by using Foursquare API.

Question 2: How popular will Chinese food be in the neighborhood?

For Lingling, it's important to serve traditional Chinese food the way she knows. Even though Chinese food is widely loved, it makes sense to double check how existing Chinese restaurants (or Asian restaurants) are perceived. This question can be answered, hopefully, by using Foursquare API.

Question 3: Who are the target customers and where do they live?

It is going to be a small restaurant (5 to 7 tables) due to the limited investment. The primary income would be takeout and orders made online. From past experience, Lingling knows that people who live alone are more likely to buy takeout or use online food ordering apps such as Uber Eats. They are the ideal target customers for her new restaurant. So, we will look for an area with a relatively high density of one-person household. We need demographic information to answer this question.

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2. Data Requirements

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We have the big question, where to open a Chinese restaurant in Amsterdam. Now, we need to collect data that can help us answer the questions. We need to collect data from at least two sources:

- Data of the surroundings (density of similar restaurants nearby)
- Demographic data (per area in Amsterdam)

2.1. Data of Surroundings

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Foursquare API (https://developer.foursquare.com/docs/api/endpoints), or **Google API**.

Foursqaure API Endpoints that we need:

- **Search** (https://developer.foursquare.com/docs/api/venues/search): Returns a list of venues near the current location, optionally matching a search term.
- **Categories** (https://developer.foursquare.com/docs/api/venues/categories): Returns a hierarchical list of categories applied to venues. This list is also available on the categories page (https://developer.foursquare.com/docs/resources/categories).
- **Trending** (https://developer.foursquare.com/docs/api/venues/trending): Returns a list of venues near the current location with the most people currently checked in.

Information isn't available for a free account

- **Number of Liks**: Assumption: the more voting, the more the restaurant is visited. It can be used to see how often
  - **Unfortunately, this information needs a premium account.**

2.2 Demographic Data

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In order to know which neighborhoods are more interesting to investigate further, we need to look into demographic data to pick the neighborhoods that have more target customers in terms of quantity and density.

The Central Bureau of Statistics of the Netherlands, **CBS** in short, provides a large number of demographic data regarding who live and work in the Netherlands.
In this page (https://opendata.cbs.nl/statline/#/CBS/nl/dataset/84286NED/table?ts=1558337871247), you can choose whatever feature you need to solve the problem. The list of features is quite comprehensive. It is important, therefore, to define exactly what the data can be used.

Features that can be used to answer the question

- **Regional specifics** *(Regioaanduiding)*: This information can help me to link relative details to a specific area.
- **Total Households** *(Particulier huishouden)*: Number of households in a neighborhood.
- **One-person Households** *(Eenpersoonshuishoudens)*: Number of the households that with only one person.
- **Population density** *(Bevolkingsdichtheid)*: A more densely populated area means more customers for a restaurant. The unit of population density is **number of people per square kilometer**.

Information that isn't available

- **Origin of birth** *(Personen met een migratieachtergrond)*: This information can help us to determine the types of food the restaurant should offer.
  - Unfortunately, the categorization is not detailed enough. I am not able to single out people come from China in the data.
- **Income per household** *(Inkomen van huishoudens)*: Since restaurants are usually quite expensive comparing to home-cooking. Only people who have sufficient income can afford to go to restaurants often.
  - Unfortunately, this information is missing consistently from the database.

Features deliberately excluded

- **Civil status**: Since we can distinguish one-person households, it's not necessary to understand why people live alone (single or divorced does not seem to link to food strategy directly).
- **Gender**: Reason, in the Netherlands, there isn't a big difference between men and women in terms of the likeliness of cooking at home.
- **Type of house**: This has no direct correlation to people's choice of food.

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3. Analyze Demographic Data

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I selected necessary data from CBS (https://opendata.cbs.nl/statline/#/CBS/nl/dataset/84286NED/table?ts=1558337871247), as mentioned in chapter 2.2.
The data is in CSV format.

3.1 Load Data to a Dataframe

Load necessary libraries

In [3]:
```
# library to handle data in a vectorized manner
import numpy as np
# library to load dataframe
import pandas as pd

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

Load the CSV file

In [4]:
```
df = pd.read_csv('https://dl.dropboxusercontent.com/s/wfrh6g2nq4cs0c4/Amsterdam.csv')
df.head()
```

Out[4]:

	Neighborhood	ID	Total Residences	Total Households	One-person Households	Population Density	Lat	Lon
0	Burgwallen-Oude Zijde	WK036300	4305	3090	2180	12323	52.371946	4.896103
1	Burgwallen-Nieuwe Zijde	WK036301	3930	2835	2000	6881	52.373706	4.889922
2	Grachtengordel-West	WK036302	6385	4110	2570	14261	52.370837	4.885478
3	Grachtengordel-Zuid	WK036303	5350	3410	2140	10303	52.364422	4.894243
4	Nieuwmarkt	WK036304	9765	6485	4285	13741	52.372160	4.900096

In [5]:
```
df.shape
```

Out[5]:
```
(65, 8)
```

In total 65 neighborhoods

There are definitely more neighborhoods in Amsterdam municipality. However, for the sake of this challenge, we decided to focus on the neighborhoods that within or connected to Amsterdam city proper.

Sort the neighborhoods by the population density

In [6]:
```
df.sort_values(["Population Density"], axis=0, ascending=False, inplace=True)
df.head()
```

Out[6]:

	Neighborhood	ID	Total Residences	Total Households	One-person Households	Population Density	Lat	Lon
14	Staatsliedenbuurt	WK036314	13315	8105	4860	28139	52.380287	4.870951
19	Van Lennepbuurt	WK036319	6990	4535	3005	28005	52.365144	4.867845
31	Indische Buurt West	WK036331	12640	7060	3930	26985	52.361625	4.938813
21	Overtoomse Sluis	WK036321	7890	4840	2910	26482	52.359468	4.860689
18	Kinkerbuurt	WK036318	6590	3950	2460	26135	52.369167	4.866649

3.2. Drop Unnecessary Data

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As we mentioned earlier, we want to learn the population density together with how many households are with only one person. It seems that the total number of residences is not necessary to answer any of the questions. Therefore, we decide to remove it from the data from now on.

In [7]:
```
df.drop("Total Residences", axis=1, inplace=True)
df.head()
```

Out[7]:

	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon
14	Staatsliedenbuurt	WK036314	8105	4860	28139	52.380287	4.870951
19	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845
31	Indische Buurt West	WK036331	7060	3930	26985	52.361625	4.938813
21	Overtoomse Sluis	WK036321	4840	2910	26482	52.359468	4.860689
18	Kinkerbuurt	WK036318	3950	2460	26135	52.369167	4.866649

3.3. Observe Data using a Bar Chart

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In order to better decide what to do with the data, I want to take a good look at the data. Visualizing the data will help a lot. I choose to use a horizontal bar chart, because I want the neighborhood names to be very easy to read. Due to the number of neighborhoods (65), the vertical bar might not offer enough room to show all the bars.

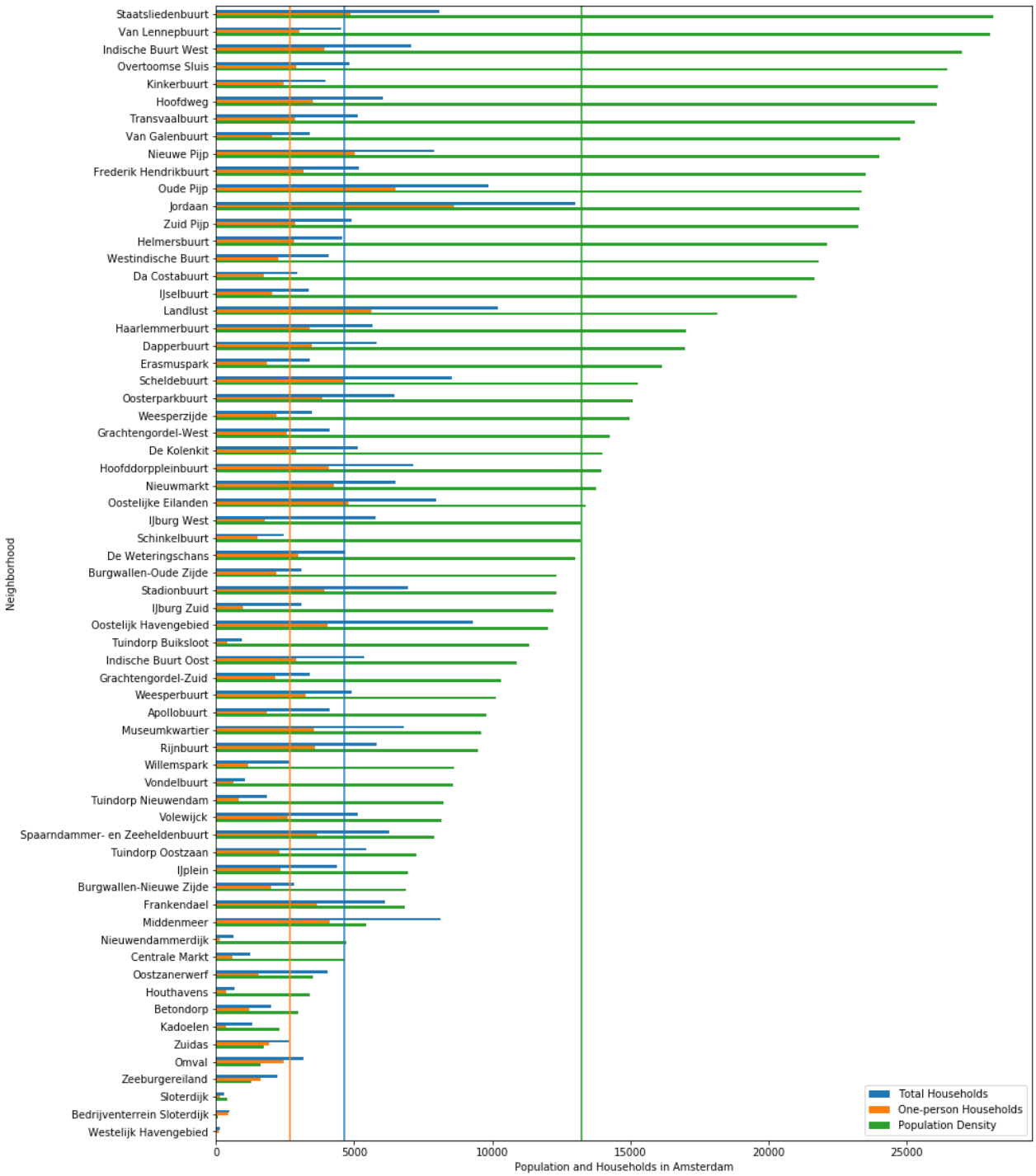
In [8]:
```
# step 1: Extract only necessary data
df_visualize = df[["Neighborhood", "Total Households", "One-person Households", "Population Density"]]
df_visualize.head()
```

Out[8]:

	Neighborhood	Total Households	One-person Households	Population Density
14	Staatsliedenbuurt	8105	4860	28139
19	Van Lennepbuurt	4535	3005	28005
31	Indische Buurt West	7060	3930	26985
21	Overtoomse Sluis	4840	2910	26482
18	Kinkerbuurt	3950	2460	26135

In [9]:
```
ax = df_visualize.plot(kind='barh', figsize=(14,20))
#ax.set_title('Population and Households in Amsterdam')
ax.set_xlabel('Population and Households in Amsterdam')
ax.set_ylabel('Neighborhood')
ax.invert_yaxis()
ax.set_yticklabels(df['Neighborhood'].values)

rects = ax.patches

# use axvline to mark the average population density
mean = df["Population Density"].mean()
ax.axvline(mean, color='#2B9B2A') #Green

# use axvline to mark the average total households
mean2 = df["Total Households"].mean()
ax.axvline(mean2, color='#1E77B4') #Blue

# use axvline to mark the average one-person households
mean3 = df["One-person Households"].mean()
ax.axvline(mean3, color='#FF7F0F') #Orange
```

Out[9]:
```
<matplotlib.lines.Line2D at 0x116e1c908>
```



3.3.1. Learnings from the Above Bar Chart

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1. One thing becomes evident is that many neighborhoods in Amsterdam has much lower population density than the average value. These neighborhoods are very unlikely to be ideal location to open the restaurant. Therefore, we should remove them to focus on the neighborhoods that are more densely populated. We will do that in the next chapter.
2. The second learning is that amongst the more densely populated neighborhoods, not all of them have above average total number of households and one-person households.We will do further analysis in chapter 3.5 to filter out the neighborhoods that do not have enough one-person households.

3.4. Remove Neighborhoods that have below average population density

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In [10]:
```
#First calculate the average residences of each neighborhood
average_density = int(df["Population Density"].mean())
print("Average population density of Amsterdam city proper is: ", average_density)
```

```
Average population density of Amsterdam city proper is:  13233
```

In [11]:
```
#Drop all neighborhoods that has a Total Households number below average
#result[result['Value'] ! <= 10]
df = df[df["Population Density"] > average_density]
df.head()
```

Out[11]:

	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon
14	Staatsliedenbuurt	WK036314	8105	4860	28139	52.380287	4.870951
19	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845
31	Indische Buurt West	WK036331	7060	3930	26985	52.361625	4.938813
21	Overtoomse Sluis	WK036321	4840	2910	26482	52.359468	4.860689
18	Kinkerbuurt	WK036318	3950	2460	26135	52.369167	4.866649

In [12]:
```
print("Number of neighborhoods that has higher than average population density: ", df.shape[0])
```

```
Number of neighborhoods that has higher than average population density:  29
```

3.5. Neighborhoods that Have More One-person Households

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In [13]:
```
#calculate the percentage of one-person households of every neighborhood
df["Percentage of One-person Households"] = round(df["One-person Households"] / df["Total Households"]*10000)
df.head()
```

Out[13]:

	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon	Percentage of One-person Households
14	Staatsliedenbuurt	WK036314	8105	4860	28139	52.380287	4.870951	59.96
19	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845	66.26
31	Indische Buurt West	WK036331	7060	3930	26985	52.361625	4.938813	55.67
21	Overtoomse Sluis	WK036321	4840	2910	26482	52.359468	4.860689	60.12
18	Kinkerbuurt	WK036318	3950	2460	26135	52.369167	4.866649	62.28

In [14]:
```
#sorting data frame by Percentage of One-person Households
df.sort_values(["Percentage of One-person Households"], axis=0, ascending=False, inplace=True)
df.head()
```

Out[14]:

	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon	Percentage of One-person Households
6	Jordaan	WK036306	12985	8625	23289	52.374500	4.879491	66.42
19	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845	66.26
4	Nieuwmarkt	WK036304	6485	4285	13741	52.372160	4.900096	66.08
24	Oude Pijp	WK036324	9875	6510	23353	52.355216	4.894574	65.92
25	Nieuwe Pijp	WK036325	7905	5015	23998	52.351856	4.897728	63.44

In [15]:
```
# step 1: Extract only necessary data
# oph stands for One-person Households
df_oph = df[["Neighborhood", "Percentage of One-person Households"]]
df_oph.head()
```

Out[15]:

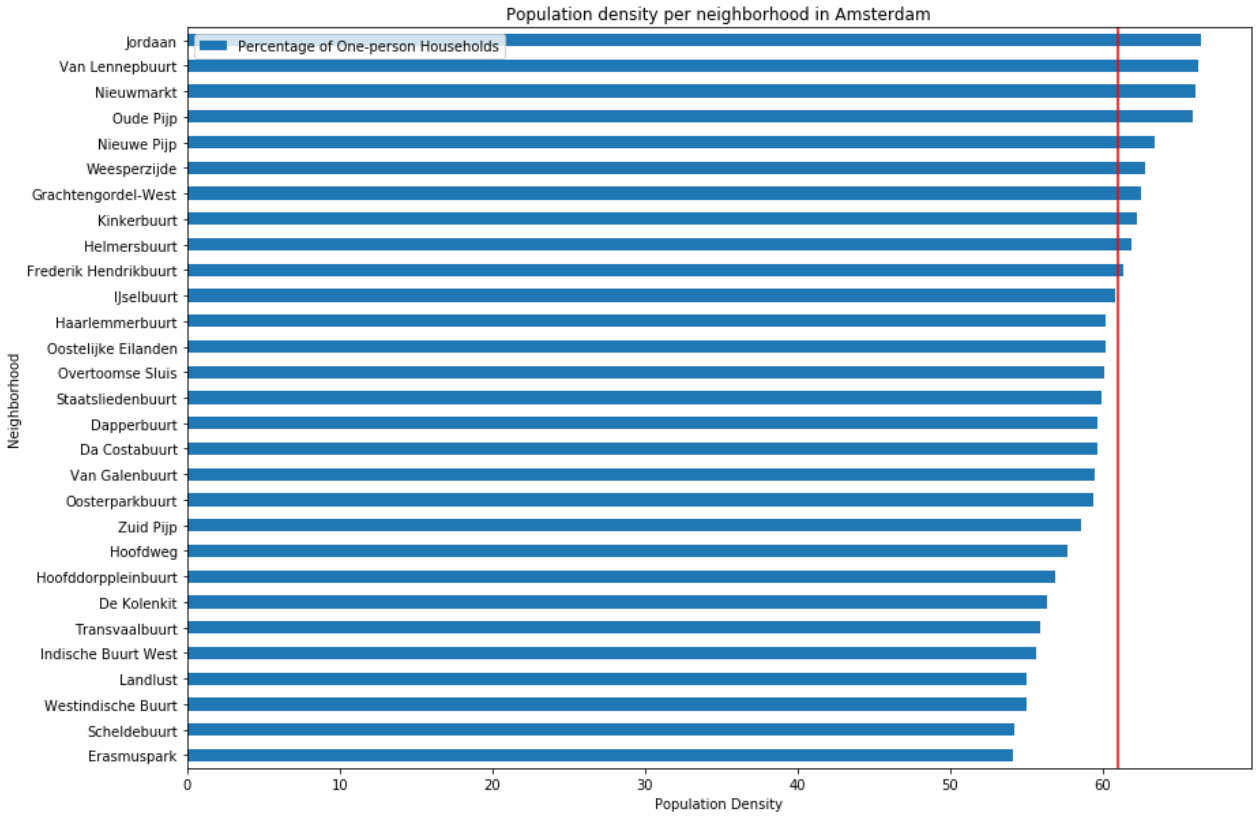
	Neighborhood	Percentage of One-person Households
6	Jordaan	66.42
19	Van Lennepbuurt	66.26
4	Nieuwmarkt	66.08
24	Oude Pijp	65.92
25	Nieuwe Pijp	63.44

In [16]:
```
# step 2: plot data
ax = df_oph.plot(kind='barh', figsize=(14,10))
ax.set_title('Population density per neighborhood in Amsterdam')
ax.set_xlabel('Population Density')
ax.set_ylabel('Neighborhood')
ax.invert_yaxis()
ax.set_yticklabels(df_oph['Neighborhood'].values)

rects = ax.patches

ax.axvline(61, color='r')
```

Out[16]: `<matplotlib.lines.Line2D at 0x1041e57f0>`



3.5.1. Learnings from the Above Bar Chart

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As mentioned after we examine the data in a bar chart (chapter 3.3.1). It seems that the percentage of one-person households (in comparison to the total number of households) seems to be rather consistent for the neighborhoods that have above average population density.

Now, in the above bar chart, the consistency becomes quite clear.

However, we observe there are roughly 3 ranges of the percentage:

1. High: 66% ~ 67%. The first four neighborhood
2. Medium: 59% ~ 63.5%.
3. Low: 53% ~ 59%. The last 10 neighborhood

We decided to focus on the **top 10**, the neighborhoods that have **over 61 percent of one-person households** (Marked by the red line in the above bar chart).

In [17]:
```
df = df[df["Percentage of One-person Households"] > 61.0]
df.shape
```

Out[17]:
```
(10, 8)
```

3.6. View Candidate Neighborhoods on a Map

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In [19]:
```
#Install folium
!conda install -c conda-forge folium=0.5.0 --yes
import folium # map rendering library
```

```
Collecting package metadata: done
Solving environment: done

# All requested packages already installed.
```

In [20]:
```
!conda install -c conda-forge geopy --yes # uncomment this line if you haven't completed the Foursquare API l
from geopy.geocoders import Nominatim # convert an address into latitude and longitude values
```

```
Collecting package metadata: done
Solving environment: done

# All requested packages already installed.
```

In [21]:
```
address = 'Amsterdam, The Netherlands'

geolocator = Nominatim(user_agent="amsterdam")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geograpical coordinate of Amsterdam are {}, {}.'.format(latitude, longitude))
```

```
The geograpical coordinate of Amsterdam are 52.3745403, 4.89797550561798.
```

3.6.1. First Impression of the Candidate Neighborhoods

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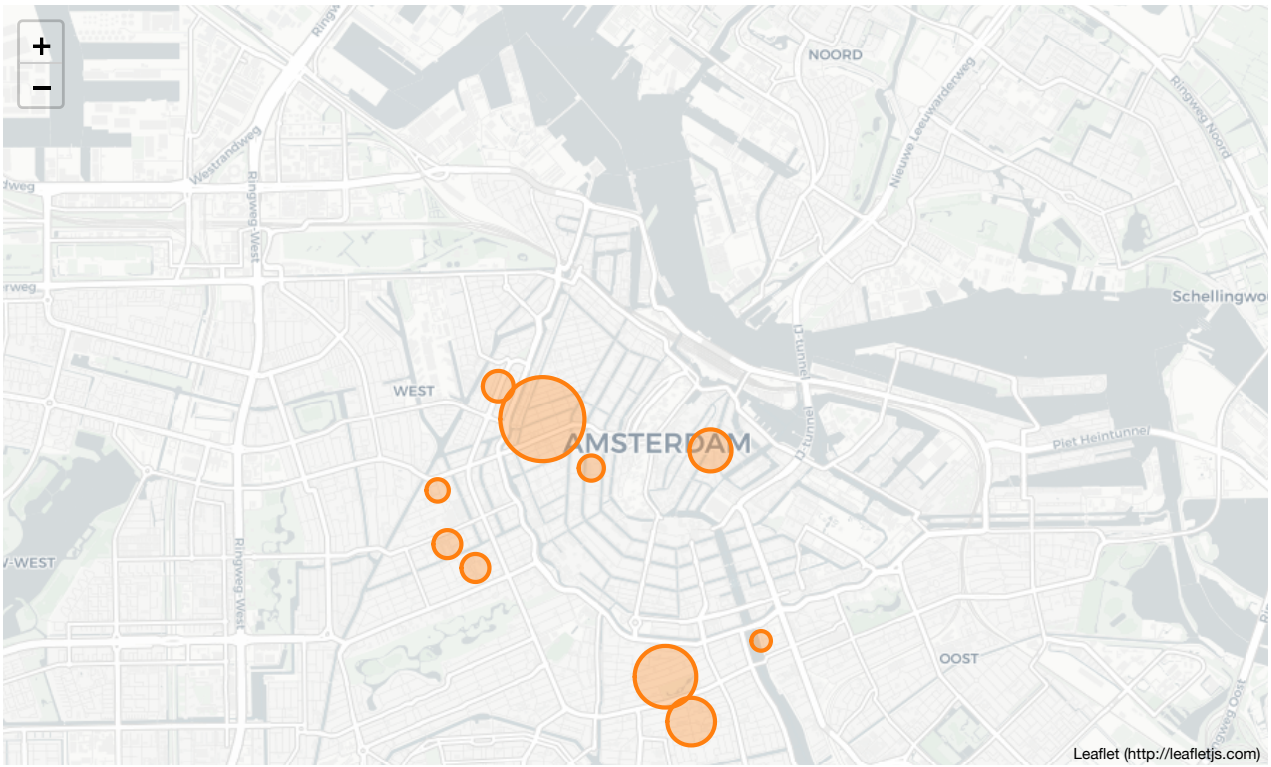
Visualize one feature (number of one-person households) to get an impression of the 10 candidate neighborhoods.

In [22]:
```
# create map of New York using latitude and longitude values
map_amsterdam = folium.Map(location=[latitude, longitude], tiles='cartodbpositron', zoom_start=13)

# add markers to map
for lat, lng, neighborhood, oph in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['One-person Households']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=oph/25,
        popup=label,
        color='#FF7F0F', # Orange
        fill=True,
        fill_color='#FF7F0F',
        fill_opacity=0.3).add_to(map_amsterdam)

map_amsterdam
```

Out[22]:



3.6.2. Visualize More Features on the Map

The above map gives us an impression of how the numbers of one-person households per neighborhood looks like.

Now let's add three features to the map:

1. **Orange circles** represent the number of one-person households.
2. **Blue circles** represent the number of households in total.
3. **Green circles** represent the population density.

As to the circles:

- The center of the orange, green, and blue circles is the center of the neighborhood. Click the center of the circles to see the name of the neighborhood.
- The radius of each circle represents the number of each feature.

In order to show a more zoomed in map view, we re-adjust the center of the map.

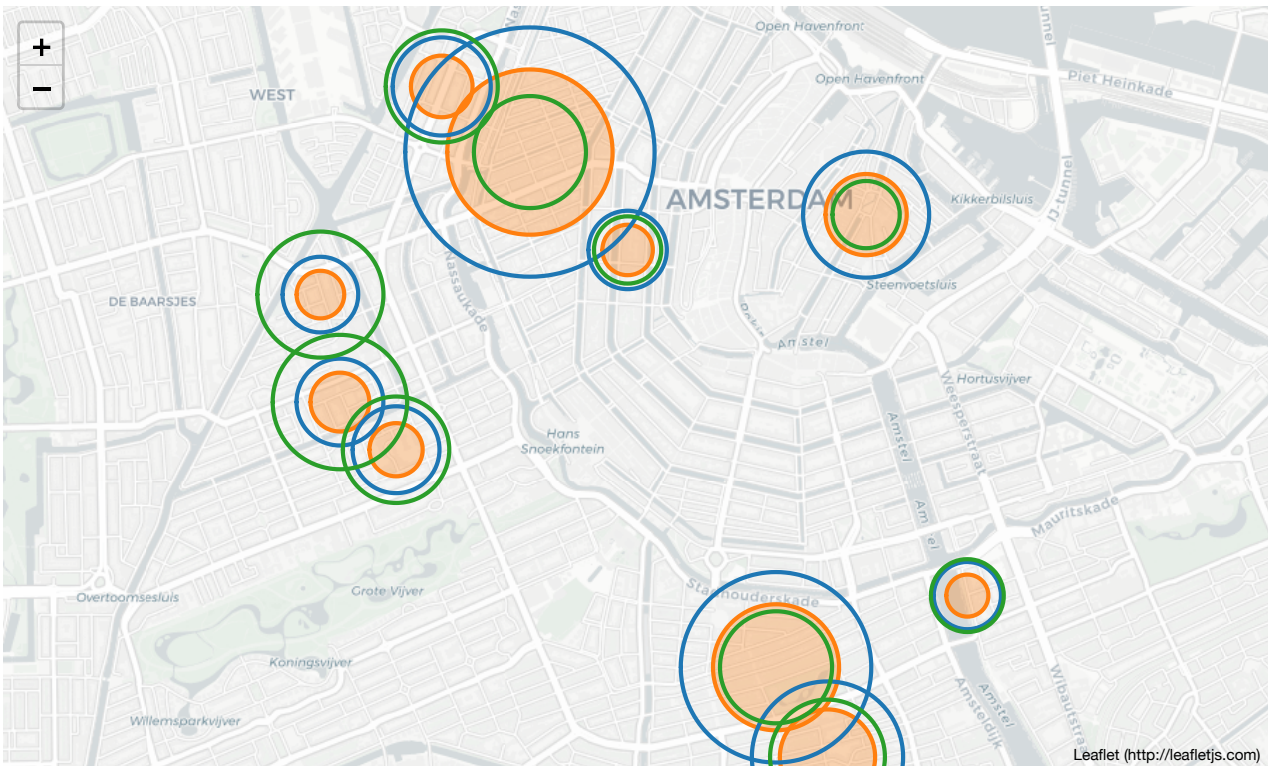
Re-adjust the center of the 10 candidate neighborhoods

In [23]:
```
center_lat = 52.364483
center_lon = 4.88949
```

Draw the Map with One-person Households, Total Households, and Population Density.

In [24]:
```
# create map of Amsterdam using latitude and longitude values
map_amsterdam = folium.Map(location=[center_lat, center_lon], tiles='cartodbpositron', zoom_start=14)

# add markers that represent one-person households to the map
for lat, lng, neighborhood, oph in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['One-person Households']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=oph/25,
        popup=label,
        color='#FF7F0F', # Orange
        fill=True,
        fill_color='#FF7F0F',
        fill_opacity=0.3
    ).add_to(map_amsterdam)

# add markers that represent total households to the map
for lat, lng, neighborhood, households in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['Total Households']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=households/25,
        popup=label,
        color='#1E77B4', # Blue
        fill=False
    ).add_to(map_amsterdam)

# add markers that represent population density to the map
for lat, lng, neighborhood, density in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['Population Density']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=density/100,
        popup=label,
        color='#2A9E2A', # Green
        fill=False
    ).add_to(map_amsterdam)

map_amsterdam
```

Out[24]:



Learnings from the above data visualization

As you can see, when we choose an ideal location to open the Chinese restaurant:

- **The bigger the green circles the better.**
- **The less difference between the size of the blue circles and the orange circles the better.**

3.7. Conclusion of Dermographic Data Analysis

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Through the above analysis, we have chosen **10** out of **65** neighborhoods in Amsterdam city proper as our candidate neighborhood to investigate further.

In the next chapter we will further analyze the **10** neighborhoods by looking into the number of restaurants and the density of Chinese restaurants to further narrow down to **3 ~ 5** neighborhoods for future analysis.

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4. Explore the Sorroundings

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As mentioned earlier, we are going to use **Foursquare API** (https://developer.foursquare.com/docs/api/endpoints) to continue our exploration of the **19** candidate neighborhoods.

Foursqaure API Endpoints that we need:

- **Search** (https://developer.foursquare.com/docs/api/venues/search): Returns a list of venues near the current location, optionally matching a search term.
- **Categories** (https://developer.foursquare.com/docs/api/venues/categories): Returns a hierarchical list of categories applied to venues. This list is also available on the categories page (https://developer.foursquare.com/docs/resources/categories).
- **Trending** (https://developer.foursquare.com/docs/api/venues/trending): Returns a list of venues near the current location with the most people currently checked in.

4.1. Define Foursquare Credentials and Version

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Get the **Client_ID** and **Client_Secret** from Foursqure MyApp (https://foursquare.com/developers/apps) to get the credentials.
Version is the date when this notebook was created.

In [25]:
```
CLIENT_ID = 'AHPVRYQIQT4LOYOT0ZEN0OJR24ERX1E5CXPFRKFQ1D44JWJH' # your Foursquare ID
CLIENT_SECRET = 'XJ1ASSSXERK2W5OLNAC00KYF4NZM2SECBZKHHE5GELUXLEG0' # your Foursquare Secret
VERSION = '20190512'
LIMIT = 50 # With a free account the max result one query returns is 50. It is very limiting.
print('Your credentails:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

```
Your credentails:
CLIENT_ID: AHPVRYQIQT4LOYOT0ZEN0OJR24ERX1E5CXPFRKFQ1D44JWJH
CLIENT_SECRET:XJ1ASSSXERK2W5OLNAC00KYF4NZM2SECBZKHHE5GELUXLEG0
```

Load necessary libraries

In [26]:
```
# library to handle requests
import requests
# tranforming json file into a pandas dataframe library
from pandas.io.json import json_normalize
```

4.2. Show Chinese Restaurants in Candidate Neighborhoods on the Map

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`https://api.foursquare.com/v2/venues/` **search** `?client_id=` **CLIENT_ID**
`&client_secret=` **CLIENT_SECRET**
`&ll=` **LATITUDE , LONGITUDE**
`&v=` **VERSION**
`&categoryId=` **category (https://developer.foursquare.com/docs/resources/categories)**
`&radius=` **RADIUS**
`&limit=` **LIMIT**

Define a query to search for all the restuarants that are within 5 km from the **center of all the 10 candidate neighborhoods**.

In [27]:
```
category = '4bf58dd8d48988d145941735'# The category ID for Chinese Restaurant.
#search_query = 'Chinese Restaurant' # This won't work, because Foursquare will search 'Chinese' OR 'Restaura
search_radius = 2500
print('OK!')
```

```
OK!
```

4.2.1. Get Information from Foursquare API and convert it to a Dataframe

Define the corresponding URL

In [28]:
```
url = 'https://api.foursquare.com/v2/venues/search?client_id={}&client_secret={}&ll={},{}&v={}&categoryId={}&
url
```

Out[28]:
```
'https://api.foursquare.com/v2/venues/search?client_id=AHPVRYQIQT4LOYOT0ZEN0OJR24ERX1E5CXPFRKFQ1D44JWJH&cli
ent_secret=XJ1ASSSXERK2W5OLNAC00KYF4NZM2SECBZKHHE5GELUXLEG0&ll=52.364483,4.88949&v=20190512&categoryId=4bf5
8dd8d48988d145941735&radius=2500&limit=50'
```

Send the GET Request and examine the results

In [29]:
```
results = requests.get(url).json()
#results
```

Get relevant part of JSON and transform it into a pandas dataframe

In [30]:
```
# assign relevant part of JSON to venues
venues = results['response']['venues']

# tranform venues into a dataframe
dataframe = json_normalize(venues)
dataframe.head(2)
```

Out[30]:

	categories	hasPerk	id	location.address	location.cc	location.city	location.country	location.crossS
0	[{'id': '4bf58dd8d48988d145941735', 'name': 'C...	False	4a27080af964a520978f1fe3	Reguliersdwarsstraat 35	NL	Amsterdam	Nederland	
1	[{'id': '4bf58dd8d48988d145941735', 'name': 'C...	False	5c6c24f2ecb3ed0025efda90	Leidsestraat 95	NL	Amsterdam	Nederland	

Define information of interest and filter dataframe

In [31]:
```
# keep only columns that include venue name, and anything that is associated with location
filtered_columns = ['name', 'categories'] + [col for col in dataframe.columns if col.startswith('location.')]
dataframe_filtered = dataframe.loc[:, filtered_columns]

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

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

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

# clean column names by keeping only last term
dataframe_filtered.columns = [column.split('.')[-1] for column in dataframe_filtered.columns]

dataframe_filtered.head(2)
```

Out[31]:

	name	categories	address	cc	city	country	crossStreet	distance	formattedAddress	labeledLatLngs	lat
0	Sichuan Food	Chinese Restaurant	Reguliersdwarsstraat 35	NL	Amsterdam	Nederland	NaN	233	[Reguliersdwarsstraat 35, 1017 BK Amsterdam, N...	[{'label': 'display', 'lat': 52.36648519837077...	52.366485
1	Full Moon Garden	Chinese Restaurant	Leidsestraat 95	NL	Amsterdam	Nederland	NaN	370	[Leidsestraat 95, 1017 NZ Amsterdam, Nederland]	[{'label': 'display', 'lat': 52.36466053020717...	52.364661

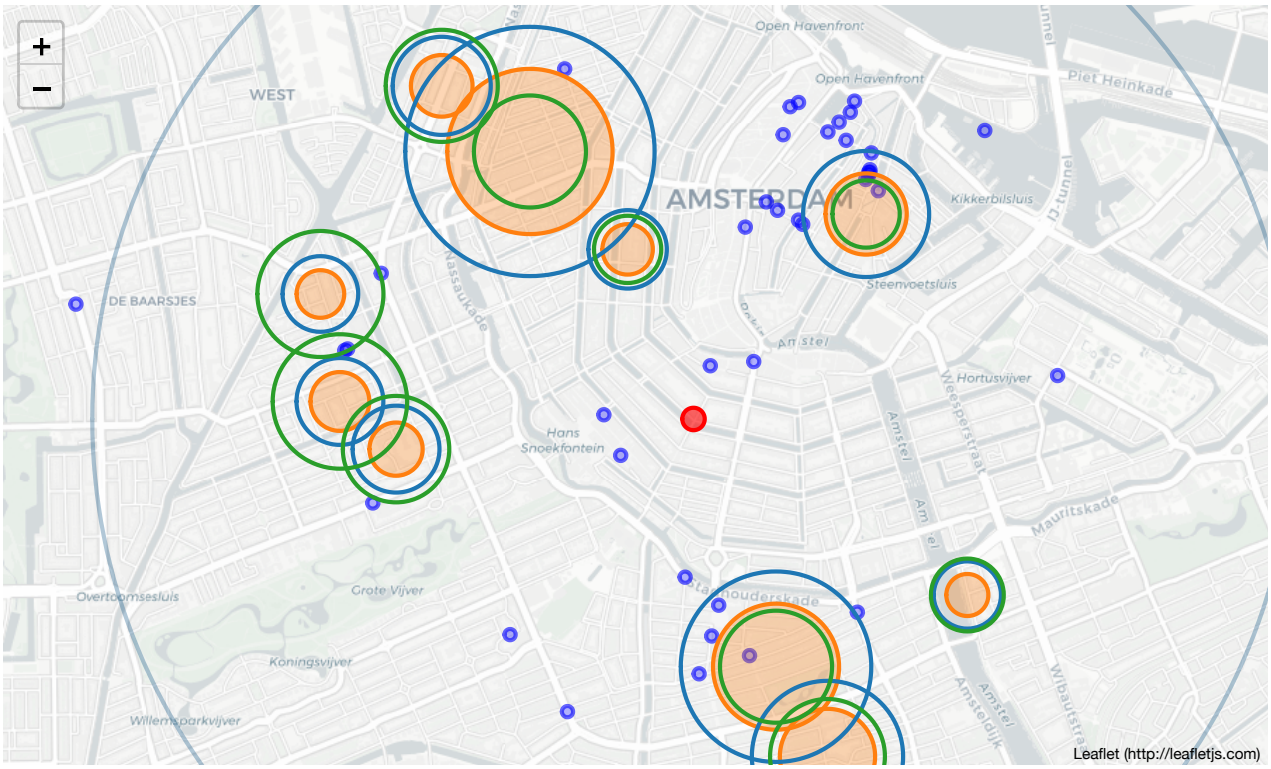
In [32]:
```
dataframe_filtered.shape
```

Out[32]:
```
(50, 16)
```

4.2.2. Visualize Chinese Restaurants in Amsterdam City Proper

In [33]:
```
# generate map centred around the 10 candidate neighborhoods
venues_map = folium.Map(location=[center_lat, center_lon], tiles='cartodbpositron', zoom_start=14)

#-----------------

# add a grey circle to represent the search radius
folium.features.Circle(
    [center_lat, center_lon],
    radius=search_radius,
    color='#004B7F', # Navy
    opacity=0.3,
    fill = False
).add_to(venues_map)

#-----------------
# add the Chinese restaurants as blue circle markers
for lat, lng, label in zip(dataframe_filtered.lat, dataframe_filtered.lng, dataframe_filtered.name):
    folium.features.CircleMarker( # use CircleMarker, the circle size always stay the same
        [lat, lng],
        radius=4,
        color='blue',
        opacity=0.6,
        popup=label,
        fill = True,
        fill_color='blue',
        fill_opacity=0.3
    ).add_to(venues_map)

#-----------------
# add markers that represent one-person households to the map
for lat, lng, neighborhood, oph in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['One-person Households']):
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle( # use Circle, the circle size changes with the map
        [lat, lng],
        radius=oph/25,
        popup=label,
        color='#FF7F0F', # Orange
        fill=True,
        fill_color='#FF7F0F',
        fill_opacity=0.3
    ).add_to(venues_map)

#-----------------
# add markers that represent total households to the map
for lat, lng, neighborhood, households in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['Total Households'
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=households/25,
        popup=label,
        color='#1E77B4', # Blue
        fill=False
    ).add_to(venues_map)

#-----------------

# add markers that represent population density to the map
for lat, lng, neighborhood, density in zip(df['Lat'], df['Lon'], df['Neighborhood'], df['Population Density']
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.Circle(
        [lat, lng],
        radius=density/100,
        popup=label,
        color='#2A9E2A', # Green
        fill=False
    ).add_to(venues_map)

#-----------------

# add a red circle marker to represent the center of Amsterdam city proper
folium.features.CircleMarker(
    [center_lat, center_lon],
    radius=8,
    color='red',
    popup='Amsterdam City Proper',
    fill = True,
    fill_color = 'red',
    fill_opacity = 0.6
).add_to(venues_map)

#-----------------

# display map
venues_map
```

Out[33]:



Legends of the above map

1. **Orange circles**: the number of one-person households.
2. **Blue circles**: the number of households in total.
3. **Green circles**: the population density.
4. **Red circle** in the center: the center of the map.
5. **Grey circle**: the search radius.

Learnings from the above map

Our criteria to further narrow down our choice of neighborhoods are as such:

- There must be at least one existing Chinese restaurant in or near the neighborhood.
  - Because if there isn't at least one Chinese restaurant, it might mean that there isn't such demand. Opening a Chinese restaurant without understanding why there isn't any existing ones would be more risky.
- There cannot more than 10 existing Chinese restaurants.
  - The more existing Chinese restaurants means more competition.

If we apply the criteria, from the above map, we can exclude these neighborhoods:

- Too many existing Chinese restaurants
  - Nieuwmarkt
- No existing Chinese restaurant in or near the neighborhood
  - Weesperzijde
  - Frederik Hendrikbuurt
  - Grachtengordel-West
  - Nieuwe Pijp

4.3. In-depth Analysis of One Neighborhood - Oude Pijp

Let's use Oude Pijp as an example to show how we look into one particular candidate neighborhood.

4.3.1. Get the coordinates of the center of Oude Pijp

Re-index the dataframe

In [35]:
```
# Re-index the df. Otherwise we won't be able to find the coordinates of the correct neighborhood
df = df.reset_index()
df.head()
```

Out[35]:

	level_0	index	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon	Percentage of One-person Households
0	0	6	Jordaan	WK036306	12985	8625	23289	52.374500	4.879491	66.42
1	1	19	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845	66.26
2	2	4	Nieuwmarkt	WK036304	6485	4285	13741	52.372160	4.900096	66.08
3	3	24	Oude Pijp	WK036324	9875	6510	23353	52.355216	4.894574	65.92
4	4	25	Nieuwe Pijp	WK036325	7905	5015	23998	52.351856	4.897728	63.44

In [36]:
```
df.drop("index", axis=1, inplace=True)
df.drop("level_0", axis=1, inplace=True)
df.head()
```

Out[36]:

	Neighborhood	ID	Total Households	One-person Households	Population Density	Lat	Lon	Percentage of One-person Households
0	Jordaan	WK036306	12985	8625	23289	52.374500	4.879491	66.42
1	Van Lennepbuurt	WK036319	4535	3005	28005	52.365144	4.867845	66.26
2	Nieuwmarkt	WK036304	6485	4285	13741	52.372160	4.900096	66.08
3	Oude Pijp	WK036324	9875	6510	23353	52.355216	4.894574	65.92
4	Nieuwe Pijp	WK036325	7905	5015	23998	52.351856	4.897728	63.44

Extract the center of Oude Pijp from the data frame

In [37]:
```
# get the index of Oude Pijp in the dataframe
index_OP = df[df['Neighborhood']=="Oude Pijp"].index.item()

# Retrieve the lat lon location of Oude Pijp
lat_OP = df['Lat'].iloc[index_OP]
lon_OP = df['Lon'].iloc[index_OP]
lon_OP = 4.894574
print("The center of Oude Pijp is: (", lat_OP, ", ", lon_OP, ")")
```

```
The center of Oude Pijp is: ( 52.355216 ,  4.894574 )
```

4.3.2. All Asian and Chinese Restaurants within Reachable Distance

We want to extend our query to restaurants that serve all sorts of Asian food. And observe how many Chinese restaurants in comparison of all Asian restaurants.

The reachable distance means that people live within this distance are more likely to walk to dine in a restaurant or get takeout food. For this project, we define the reachable distance as **500 meters (about 0.3 mile)**.

Search For Asian Restaurants

Search for all Asian restaurants using Foursquare API and store the information in a dataframe: **df_ar**

** Due to the limitation of Foursquare API, the limit is 50. But somehow, folium map does not show up if the limit is 50. Therefore, I have to adjust the limit to 45. There are definitely more Asian restaurants in the area.*

In [38]:
```
# Define the corresponding URL for Foursquare API
search_radius = 500
LIMIT = 45
category = '4bf58dd8d48988d142941735'# The category ID for category: Asian Restaurants.
url = 'https://api.foursquare.com/v2/venues/search?client_id={}&client_secret={}&ll={},{}&v={}&categoryId={}&
url
```

Out[38]:
```
'https://api.foursquare.com/v2/venues/search?client_id=AHPVRYQIQT4LOYOT0ZEN0OJR24ERX1E5CXPFRKFQ1D44JWJH&cli
ent_secret=XJ1ASSSXERK2W5OLNAC00KYF4NZM2SECBZKHHE5GELUXLEG0&ll=52.355216,4.894574&v=20190512&categoryId=4bf
58dd8d48988d142941735&radius=500&limit=45'
```

In [39]:
```
# Send the GET Request
results = requests.get(url).json()

# Get relevant part of JSON and transform it into a pandas dataframe
restaurants = results['response']['venues'] # assign relevant part of JSON to venues

# tranform venues into a dataframe
df_ar_temp = json_normalize(restaurants)
df_ar_temp.head(2)

# ----------Define information of interest and filter dataframe------------

# keep only columns that include venue name, and anything that is associated with location
filtered_columns = ['name','categories'] + [col for col in df_ar_temp.columns if col.startswith('location.')]
df_ar = df_ar_temp.loc[:, filtered_columns]

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

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

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

# clean column names by keeping only last term
df_ar.columns = [column.split('.')[-1] for column in df_ar.columns]

df_ar.head(2)
```

Out[39]:

	name	categories	address	cc	city	country	crossStreet	distance	formattedAddress	labeledLatLngs	lat	ln
0	Sapporo Ramen Sora	Ramen Restaurant	Ceintuurbaan 49 H	NL	Amsterdam	Nederland	NaN	492	[Ceintuurbaan 49 H, Amsterdam, Nederland]	[{'label': 'display', 'lat': 52.3525348486028,...	52.352535	4.88880
1	Sushi Op De Markt	Sushi Restaurant	Albert Cuypstraat 172	NL	Amsterdam	Nederland	NaN	60	[Albert Cuypstraat 172, 1072 CN Amsterdam, Ned...	[{'label': 'display', 'lat': 52.3557292653159,...	52.355729	4.89430

In [40]:
```
print("There are at least", df_ar.shape[0], "Asian restaurants in Oude Pijp.")
```

```
There are at least 45 Asian restaurants in Oude Pijp.
```

Search For All Chinese Restaurants

Search for all Chinese restaurants using Foursquare API and store the information in a dataframe: **df_cr**

In [41]:
```
# Define the corresponding URL for Foursquare API
search_radius = 500
LIMIT = 45
category = '4bf58dd8d48988d145941735'# The category ID for category: Chinese Restaurants.
url = 'https://api.foursquare.com/v2/venues/search?client_id={}&client_secret={}&ll={},{}&v={}&categoryId={}&
url
```

Out[41]:
```
'https://api.foursquare.com/v2/venues/search?client_id=AHPVRYQIQT4LOYOT0ZEN0OJR24ERX1E5CXPFRKFQ1D44JWJH&cli
ent_secret=XJ1ASSSXERK2W5OLNAC00KYF4NZM2SECBZKHHE5GELUXLEG0&ll=52.355216,4.894574&v=20190512&categoryId=4bf
58dd8d48988d145941735&radius=500&limit=45'
```

In [42]:
```
# Send the GET Request
results = requests.get(url).json()

# Get relevant part of JSON and transform it into a pandas dataframe
restaurants = results['response']['venues'] # assign relevant part of JSON to venues

# tranform venues into a dataframe
df_cr_temp = json_normalize(restaurants)
df_cr_temp.head(2)

# ----------Define information of interest and filter dataframe------------

# keep only columns that include venue name, and anything that is associated with location
filtered_columns = ['name','categories'] + [col for col in df_cr_temp.columns if col.startswith('location.')]
df_cr = df_cr_temp.loc[:, filtered_columns]

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

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

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

# clean column names by keeping only last term
df_cr.columns = [column.split('.')[-1] for column in df_cr.columns]

df_cr.head(2)
```

Out[42]:

	name	categories	address	cc	city	country	distance	formattedAddress	labeledLatLngs	lat	lng	neighborho
0	Nam Kee	Chinese Restaurant	Marie Heinekenplein 4	NL	Amsterdam	Nederland	353	[Marie Heinekenplein 4, 1072 MH Amsterdam, Ned...	[{'label': 'display', 'lat': 52.35753532093774...	52.357535	4.891028	Na
1	DIM SUM NOW	Dim Sum Restaurant	Ferdinand Bolstraat 36	NL	Amsterdam	Nederland	297	[Ferdinand Bolstraat 36, Amsterdam, Nederland]	[{'label': 'display', 'lat': 52.35636390084206...	52.356364	4.890616	Na

In [664]:
```
print("There are", df_cr.shape[0], "Chinese restaurants in Oude Pijp.")
```

```
There are 10 Chinese restaurants in Oude Pijp.
```

Try to get the Most Popular Venues

We can retrieve the most popular venues via Foursquare "Get Trending Venues" (https://developer.foursquare.com/docs/api/venues/trending). This information gives us an impression what are the places people like the most.

In [706]:
```
# Define the corresponding URL for Foursquare API
search_radius = 500
LIMIT = 45
url = 'https://api.foursquare.com/v2/venues/trending?client_id={}&client_secret={}&ll={},{}&v={}&radius={}&li

# --------Send the GET Request--------
results = requests.get(url).json()
results
```

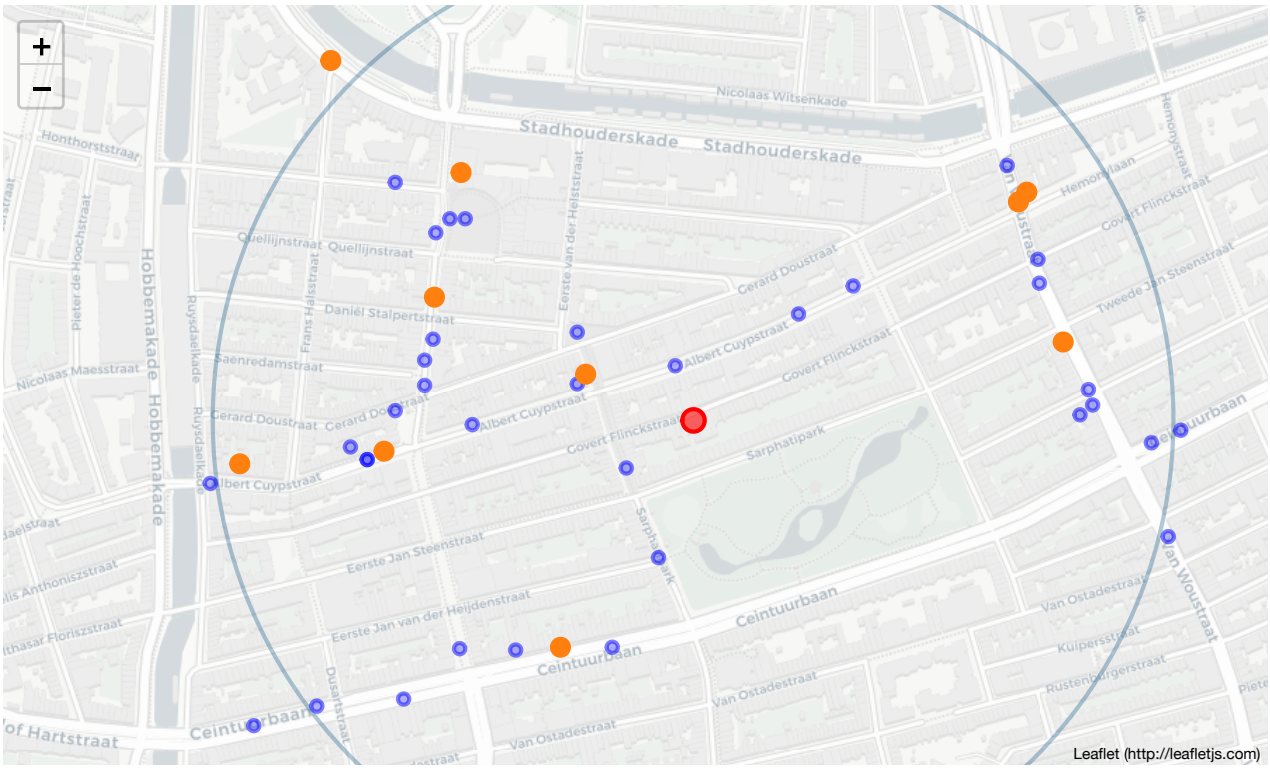
Out[706]:
```
{'meta': {'code': 200, 'requestId': '5cfecfde4c1f6753b1f4c321'},
 'response': {'venues': []}}
```

UNFORTUNATELY, the trending venue return us 0 result.

Draw all the Asian and Chinese restaurants on the map

In [723]:
```
# generate map centred around the 10 candidate neighborhoods
map_OP = folium.Map(location=[lat_OP, lon_OP], tiles='cartodbpositron', zoom_start=16)

# add a grey circle to represent the search radius
folium.features.Circle(
    [lat_OP, lon_OP],
    radius=search_radius,
    color='#004B7F', # Navy
    opacity=0.3,
    fill = False
).add_to(map_OP)

# add a red circle to represent the center of Amsterdam city proper
folium.features.CircleMarker(
    [lat_OP, lon_OP],
    radius=8,
    color='red',
    popup='Oude Pijp',
    fill = True,
    fill_color = 'red',
    fill_opacity = 0.6
).add_to(map_OP)

# add Asian restaurants as light blue dots
for lat, lng, label in zip(df_ar.lat, df_ar.lng, df_ar.name):
    folium.features.CircleMarker( # use CircleMarker, the circle size always stay the same
        [lat, lng],
        radius=4,
        color='blue', # light blue
        opacity=0.5,
        popup=label,
        fill = True,
        fill_color='blue',
        fill_opacity=0.3
    ).add_to(map_OP)

# add Chinese restaurants as orange dots
for lat, lng, label in zip(df_cr.lat, df_cr.lng, df_cr.name):
    folium.features.CircleMarker( # use CircleMarker, the circle size always stay the same
        [lat, lng],
        radius=6,
        color='#FF7F0F', # Orange
        popup=label,
        fill = True,
        fill_color='#FF7F0F',
        fill_opacity=1
    ).add_to(map_OP)

# display map
map_OP
```

Out[723]:



Learnings of the map above

1. According to Foursquare there are 10 Chinese Restaurants within the range of 500 meters in the neighborhood Oude Pijp.
2. As to Asian restaurants. Due to the 45 limit, we can only show 45 Asian restaurants here. The actual number could be higher.
3. From the map we learn that in the North and Southeast of Oude Pijp seems to be a void of all restaurants. If we open a Chinese restaurant there, we will likely have enough customers.

4.3.3. Repeat the In-depth Analysis

We can see the value of the in-depth analysis. Later on, we will repeat this analysis to all other remaining candidate neighborhoods. We will compare more categories of venues. Such as, Chinese restaurants and all other restaurants, café, snack bars, etc.

---

5. Conclusion and Future Work

The limitation of this project

Only focus on residential information

This project is limited by the lack of crucial information. So far we have been focused quite a lot on residences information and one-person households. However, customers can also come from nearby business venues. We are unable to validate any assumption or answer any questions, because the information of business venues in Amsterdam is not as available as dermographic information.

Rent of a venue is not taken into consideration

Due to lack of information, we are unable to include rental price as part of the analysis. The rent is a large part of costs for a restaurant. In order to be able to predict the potential profit, it is crucial to include potential rental price.

Lack of understanding of how popular existing Chinese restaurants are

For a free Foursquare account, information that helps us understand how popular a venu is is not accessible. Information such as:

- **Likes**: how many people like a place
- **Rating**: star rating of a place

Next Step

- Continue to do more in-depth analysis as mentioned in 4.3.3..
- Include rental price of each neighborhood in future analysis.