IBM Developer
SKILLS NETWORK

Turkish Cuisine: Business Business Entry

Capstone Project - The Battle of the Neighborhoods

Applied Data Science Capstone by IBM/Coursera

Table of contents

1. Introduction
2. Data
3. Methodology
4. Analysis
5. Results and Discussion
6. Conclusion

1. Introduction

Middle Eastern cuisine has a rich historical past. Especially the geography of Turkey is a unique place where many different civilizations have lived and different cuisines created a common value. The cosmopolitan structure of middle eastern cuisine is also reflected in the city of Chicago. Almost everyone who comes from different nationalities and settles in Chicago can easily reach restaurants and markets suitable for their own cuisine and taste.

Chicago has a population of close to 10 million and is one of the most important business centers of America. It is not only a business center but also an important touristic center. Besides the city's architectural history and artifacts, the Chicago lake adds a special value to the city. In addition to these, Chicago, which has a historical background in terms of university education and academic studies, is one of the centers chosen by students to build their careers.

Chicago draws attention with a food industry exceeding 7 trillion dollars (http://www.worldbusinesschicago.com/key-industries/foodmanufacturing/). Food&Enjoy Enterprise, one of Turkey's leading restaurant chains, wants to enter this attractive market with the flavors of traditional Middle Eastern cuisine. Since the company's knowledge of the American food industry is limited, it needs smart strategies in this regard.

Food&Enjoy states that the flavors it offers are the first choice of tourists both from within the country and from abroad. They express that especially those coming from the Middle East geography are no different from the tastes of their own countries. Therefore, they would like to reach people close to this culture in Chicago.

There is a significant competition on the price axis in Chicago. For example, certain chain stores in the pizza sector sustain customer loyalty with a low price policy. Contrary to price-based competition, this entrepreneurial company states that they prefer to be in the competition based on taste. Therefore, they want to serve flavor lovers who will prefer their products for flavor.

Hence, it would be wise to consider the distrbution of the restaurants within the city. Moreover, the income and prosperity of potential customers would be equally essential to take into account. Even, the size of the population as well its density should be considered before any investment into this new venture.

In this project, I will implement a very first analysis in order to find the most optimal community areas to construct the new entrepreneurial attempt by considering the criterion mentioned juts above. Of course, they are are not enough to build a complete business. But for further research, the very basic analysis should be employed and the main focus areas should be determined and then the exact location could be chosen within the predetermined community areas.

2. Data

2.1 Data description

Necessary data will be collected in order to meet the conditions given above. Then, the data will be analyzed and the desired strategies will be developed.

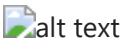
Based on criteria listed above the following data will be collected for the further analysis:

- the medien income per person in each neighborhood. This is relevant data since Food&Enjoy Enterprise would like reach real taste lovers (https://statisticalatlas.com/state/Illinois/Household-Income)
- the population and the population density of the neighborhoods are another decisive factor (https://statisticalatlas.com/state/Illinois/Population)

- the distribution of restaurants within the each neighborhood (Foresquare API)
- the coordinates of the neighborhoods. Source: Open street map (https://nominatim.openstreetmap.org/details.php?place_id=17476218)

2.2 Data Preparation

Although Chicago has 77 community areas and they are well-defined, the main focus would be on Chicago neighborhoods. This preference would be much more sensible for the first enterance since this provides us more homogeneous societies and more valuable information and guidance. There is no well-accepted neighborhoods definitions. But, from statistical point of view I would prefer to use statistical atlas of USA (https://statisticalatlas.com/United-States/Overview). Although according to the satistical atlas there are 228 neighborhoods, wikipedia defines 246 neighborhoods. It is wise to use the definitions of statistical atlas of USA since the statistics are provided by this web page.

 alt text

There are different tools for web scraping such as Beautifulsoup, Scrapy, Selenium etc. In this project I would prefer Webdriver of Selenium. Through Selenium Webdriver Chicago neighborhoods with their community areas are obtained and stored as dataframe as follows.

In [1]:
```
# install Selenium
!pip install Selenium
```

```
Requirement already satisfied: Selenium in c:\users\user\anaconda3\lib\site-packages (3.
141.0)
Requirement already satisfied: urllib3 in c:\users\user\anaconda3\lib\site-packages (fro
m Selenium) (1.26.4)
```

Now, let us find all the neighborhoods in Chicago and store them into a dataframe.

In [2]:
```
# importing webriver and pandas
from selenium import webdriver
import pandas as pd
import numpy as np
import time
# Locate chromedriver.exe and define URL
chrome_path = r'C:\Webdriver\chromedriver.exe'
driver = webdriver.Chrome(executable_path=chrome_path)
url='https://statisticalatlas.com/place/Illinois/Chicago/Overview'
driver = webdriver.Chrome(executable_path=r'C:\Webdriver\chromedriver.exe')
# Load wikipedia webpage and wait 3 seconds until all information is loaded
driver.get(url)
time.sleep(3)
# With css_selector locate the names of all neighborhoos in chicago
infos=driver.find_elements_by_css_selector('#top > div.container-fluid.container-capped
# Create a list to store the results
result=[]
# Loop over all elements in webpage and store them as text
for info in infos:
    neighborhood=info.text
    result.append(neighborhood)

# store in dataframe
df_neighborhoods_names = pd.DataFrame(result)
```

```
df_neighborhoods_names.rename(columns={0:'Neighborhood'},inplace=True)
print(df_neighborhoods_names.head())
```

```
---------------------------------------------------------------------------
NoSuchWindowException                     Traceback (most recent call last)
<ipython-input-2-162075d39256> in <module>
     13 time.sleep(3)
     14 # With css_selector locate the names of all neighborhoos in chicago
---> 15 infos=driver.find_elements_by_css_selector('#top > div.container-fluid.containe
r-capped > div > div.col-sm-12.col-md-10 > div.info-table > div:nth-child(8) > div.info-
table-contents-td.col-sm-9 > div > a')
     16 # Create a list to store the results
     17 result=[]

~\anaconda3\lib\site-packages\selenium\webdriver\remote\webdriver.py in find_elements_by
_css_selector(self, css_selector)
    612             elements = driver.find_elements_by_css_selector('.foo')
    613         """
--> 614         return self.find_elements(by=By.CSS_SELECTOR, value=css_selector)
    615
    616     def execute_script(self, script, *args):

~\anaconda3\lib\site-packages\selenium\webdriver\remote\webdriver.py in find_elements(se
lf, by, value)
   1003         # Return empty list if driver returns null
   1004         # See https://github.com/SeleniumHQ/selenium/issues/4555
-> 1005         return self.execute(Command.FIND_ELEMENTS, {
   1006             'using': by,
   1007             'value': value})['value'] or []

~\anaconda3\lib\site-packages\selenium\webdriver\remote\webdriver.py in execute(self, dr
iver_command, params)
    319         response = self.command_executor.execute(driver_command, params)
    320         if response:
--> 321             self.error_handler.check_response(response)
    322             response['value'] = self._unwrap_value(
    323                 response.get('value', None))

~\anaconda3\lib\site-packages\selenium\webdriver\remote\errorhandler.py in check_respons
e(self, response)
    240                 alert_text = value['alert'].get('text')
    241             raise exception_class(message, screen, stacktrace, alert_text)
--> 242         raise exception_class(message, screen, stacktrace)
    243
    244     def _value_or_default(self, obj, key, default):

NoSuchWindowException: Message: no such window: target window already closed
from unknown error: web view not found
  (Session info: chrome=91.0.4472.124)
```

In [3]:
```
df_neighborhoods_names.shape
```

Out[3]: (228, 1)

Every location could be located by their latitude and longitude in order to explore all locations.

In [4]:
```
# install geopy
!pip install geopy
```

```
Requirement already satisfied: geopy in c:\users\user\anaconda3\lib\site-packages (2.1.
```

```
0)
Requirement already satisfied: geographiclib<2,>=1.49 in c:\users\user\anaconda3\lib\sit
e-packages (from geopy) (1.50)
```

In [8]:

```
# importing geopy library
from geopy.geocoders import Nominatim

# calling the Nominatim tool
loc = Nominatim(user_agent="GetLoc")

# Add latitide and logitude columns
df_neighborhoods_names['Latitude']=""
df_neighborhoods_names['Longitude']=""

for row in range(0,len(df_neighborhoods_names)):
    # entering the location name
    address=df_neighborhoods_names['Neighborhood'][row]+", chicago"
    # entering the location name
    getLoc = loc.geocode(address)
    # check if returning values are not none
    if getLoc is None:
            df_neighborhoods_names['Latitude'][row] = np.nan
            df_neighborhoods_names['Longitude'][row] = np.nan
    else:
        df_neighborhoods_names['Latitude'][row] = getLoc.latitude
        df_neighborhoods_names['Longitude'][row] = getLoc.longitude
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-8-8909ce3ae5c9> in <module>
      6
      7 # Add latitide and logitude columns
----> 8 df_neighborhoods_names['Latitude']=""
      9 df_neighborhoods_names['Longitude']=""
     10

NameError: name 'df_neighborhoods_names' is not defined
```

In [1]:

```
# importing geopy library
from geopy.geocoders import Nominatim

# calling the Nominatim tool
loc = Nominatim(user_agent="GetLoc")
address="Arcadia Terrace, Chicago, Illinois, USA"
getLoc = loc.geocode(address)
print(getLoc.latitude, getLoc.longitude)
```

```
41.9098048 -87.71013317912036
```

In [6]:

```
df_neighborhoods_names.head(20)
```

Out[6]:

	Neighborhood	Latitude	Longitude
0	Albany Park	41.970329	-87.715992
1	Altgeld Gardens	41.655259	-87.609584
2	Andersonville	41.977139	-87.669273

	Neighborhood	Latitude	Longitude
3	Arcadia Terrace	41.909805	-87.710133
4	Archer Heights	41.811422	-87.726165
5	Ashburn	41.747533	-87.711163
6	Avalon Park	41.745035	-87.588658
7	Avondale	41.938921	-87.711168
8	Back of the Yards	41.807533	-87.66612
9	Belmont Central	41.939796	-87.653328
10	Belmont Gardens	41.939796	-87.653328
11	Belmont Heights	NaN	NaN
12	Belmont Terrace	41.939796	-87.653328
13	Beverly	41.718153	-87.671767
14	Beverly View	41.718153	-87.671767
15	Beverly Woods	41.683386	-87.681244
16	Big Oaks	41.539995	-88.579534
17	Bowmanville	41.972133	-87.693737
18	Brainerd	41.732812	-87.658383
19	Bridgeport	41.837938	-87.651028

As it can be seen that there are NaN values in dataframe. So, let us look at the number of NaN values.

In [7]:
```
df_neighborhoods_names[df_neighborhoods_names['Latitude'].isnull()]
```

Out[7]:

	Neighborhood	Latitude	Longitude
11	Belmont Heights	NaN	NaN
62	Fulton River District	NaN	NaN
78	Heart of Italy	NaN	NaN
86	Ida B. Wells - Darrow Homes	NaN	NaN
89	Irving Woods	NaN	NaN
92	Kelvin Park	NaN	NaN
100	Lakewood - Balmoral	NaN	NaN
114	Marycrest	NaN	NaN
151	Powder Horn Lake	NaN	NaN
174	Sheffield Neighbors	NaN	NaN
188	Tally's Corner	NaN	NaN

	Neighborhood	Latitude	Longitude
193	The Robert Taylor Homes	NaN	NaN
226	Wrightwood Neighbors	NaN	NaN

Since 13 rows have no coordinate values. It is easy to manually complete the data. By simply looking at Google.maps, the values are stored as follows.

In [8]:
```
df_neighborhoods_names['Latitude'][11]=41.9451265
df_neighborhoods_names['Longitude'][11]=-87.8143316
df_neighborhoods_names['Latitude'][62]=41.8894949
df_neighborhoods_names['Longitude'][62]=-87.6433644
df_neighborhoods_names['Latitude'][78]=41.8486142
df_neighborhoods_names['Longitude'][78]=-87.6846162
df_neighborhoods_names['Latitude'][86]=41.8285789
df_neighborhoods_names['Longitude'][86]=-87.6173674
df_neighborhoods_names['Latitude'][89]=41.9486764
df_neighborhoods_names['Longitude'][89]=-87.8300628
df_neighborhoods_names['Latitude'][92]=41.9323486
df_neighborhoods_names['Longitude'][92]=-87.7443371
df_neighborhoods_names['Latitude'][100]=41.9799008
df_neighborhoods_names['Longitude'][100]=-87.6624815
df_neighborhoods_names['Latitude'][114]=41.7376036
df_neighborhoods_names['Longitude'][114]=-87.7058723
df_neighborhoods_names['Latitude'][151]=41.6426952
df_neighborhoods_names['Longitude'][151]=-87.5303126
df_neighborhoods_names['Latitude'][174]=41.9216605
df_neighborhoods_names['Longitude'][174]=-87.6583375
df_neighborhoods_names['Latitude'][188]=41.6915904
df_neighborhoods_names['Longitude'][188]=-87.7008049
df_neighborhoods_names['Latitude'][193]=41.809198
df_neighborhoods_names['Longitude'][193]=-87.6285506
df_neighborhoods_names['Latitude'][226]=41.9285649
df_neighborhoods_names['Longitude'][226]=-87.6563505
```

Check one more time if there is null values.

In [9]:
```
df_neighborhoods_names.isnull().values.any()
```

Out[9]:
```
False
```

Now, very basic data is ready. For further use it would be stored into excel file and rename the dataframe as df_neigborhoods

In [10]:
```
df_neighborhoods_names.to_excel("chicago_neighboorhoods_coordinates.xls")
df_neighborhoods=df_neighborhoods_names
df_neighborhoods.head()
```

```
<ipython-input-10-6d9887b4ccfb>:1: FutureWarning: As the xlwt package is no longer maint
ained, the xlwt engine will be removed in a future version of pandas. This is the only e
ngine in pandas that supports writing in the xls format. Install openpyxl and write to a
n xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence thi
s warning. While this option is deprecated and will also raise a warning, it can be glob
ally set and the warning suppressed.
  df_neighborhoods_names.to_excel("chicago_neighboorhoods_coordinates.xls")
```

Out[10]:

	Neighborhood	Latitude	Longitude
0	Albany Park	41.970329	-87.715992
1	Altgeld Gardens	41.655259	-87.609584
2	Andersonville	41.977139	-87.669273
3	Arcadia Terrace	41.909805	-87.710133
4	Archer Heights	41.811422	-87.726165

Now, it will a new dataframe is defined in order to collect all necessary data into one frame.

In [11]:
```
column_names = ['Neighborhood','Latitude','Longitude','Income','Population','Population
df_distributions = pd.DataFrame(columns = column_names)
df_distributions.head()
```

Out[11]:

Neighborhood	Latitude	Longitude	Income	Population	Population Density

Put neighborhoods and their coordinates into df_distributions.

In [12]:
```
df_distributions[['Neighborhood','Latitude','Longitude']]=df_neighborhoods[['Neighborho
df_distributions.head()
```

Out[12]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
0	Albany Park	41.970329	-87.715992	NaN	NaN	NaN
1	Altgeld Gardens	41.655259	-87.609584	NaN	NaN	NaN
2	Andersonville	41.977139	-87.669273	NaN	NaN	NaN
3	Arcadia Terrace	41.909805	-87.710133	NaN	NaN	NaN
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN

Now it is time to prepare income distribution of Chicago neighborhoods. There are different income distribution such as mean, median, 95th percentile etc. Mean income distribution could be preferred. When there are highly reach people in a neighborhood, the mean value would not reflect the real situation of that society. In order to remedy this problem median income could be used. It will show that half of the society has at least that median income. Therefore, I will use median income distribution of the neighborhoods.

In [13]:
```
# import necessary libraries
from selenium.webdriver.common.by import By
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from selenium.webdriver.common.action_chains import ActionChains
# Define chromedriver options
chrome_options = webdriver.ChromeOptions()
chrome_options.add_argument("start-maximized")
chrome_options.add_experimental_option("excludeSwitches", ["enable-automation"])
chrome_options.add_experimental_option('useAutomationExtension', False)
```

```
# Define the path of chromedriver
driver = webdriver.Chrome(options=chrome_options, executable_path=r'C:\Webdriver\chrome
# Enter the URL, wait until the necessary part is loaded on the webpage
driver.get('https://statisticalatlas.com/place/Illinois/Chicago/Household-Income')
time.sleep(10)
element = WebDriverWait(driver, 10).until(EC.presence_of_element_located((By.CLASS_NAME
# Find all elements
test = driver.find_elements_by_xpath("//*[name()='div' and @id='data-map/neighborhood']
# Define empty list to store results
WebScrapingResult=[]
# Loop over all elements
for i in range(len(test)):
    # Take mouse hover actions
    hover = ActionChains(driver).move_to_element(test[i])
    hover.perform()
    # Find buble content when mouse hovers
    date = driver.find_elements_by_id('hover-bubble-contents')
    # Define a dictionary to store data
    row={}
    # It can return no values, so check for it
    if date[0].text != '':
        row['Neighborhood'] = date[0].text.split(': ')[0]
        if date[0].text.split(': ')[1] != "N/A":
            row['Income'] = date[0].text.split(': $')[1]
        else:
            row['Income'] = date[0].text.split(': ')[1]
        print(row)
        WebScrapingResult.append(row)
    else:
        row['Neighborhood'] = np.nan
        row['Income'] = np.nan
        print(row)
        WebScrapingResult.append(row)
```

```
{'Neighborhood': 'Trumbull Park', 'Income': '16,420'}
{'Neighborhood': 'Cragin', 'Income': '43,966'}
{'Neighborhood': 'Kenwood', 'Income': '55,493'}
{'Neighborhood': 'West De Paul', 'Income': '148,113'}
{'Neighborhood': 'Cottage Grove Heights', 'Income': '37,113'}
{'Neighborhood': 'Fernwood', 'Income': '44,425'}
{'Neighborhood': 'Schorsch Village', 'Income': '51,359'}
{'Neighborhood': 'Heart of Chicago', 'Income': '39,229'}
{'Neighborhood': 'Park West', 'Income': '70,873'}
{'Neighborhood': 'Albany Park', 'Income': '53,349'}
{'Neighborhood': 'Andersonville', 'Income': '76,489'}
{'Neighborhood': 'Marquette Park', 'Income': '35,850'}
{'Neighborhood': 'Ravenswood Manor', 'Income': '99,444'}
{'Neighborhood': 'Bowmanville', 'Income': '71,369'}
{'Neighborhood': 'Cabrini Green', 'Income': '92,284'}
{'Neighborhood': 'Canaryville', 'Income': '57,487'}
{'Neighborhood': 'Kilbourn Park', 'Income': '48,515'}
{'Neighborhood': 'Lake Meadows', 'Income': '42,313'}
{'Neighborhood': 'Irving Woods', 'Income': '78,587'}
{'Neighborhood': 'Kennedy Park', 'Income': '75,539'}
{'Neighborhood': 'Belmont Gardens', 'Income': '40,698'}
{'Neighborhood': 'Jefferson Park', 'Income': '68,102'}
{'Neighborhood': 'Lake View East', 'Income': '66,564'}
{'Neighborhood': 'Pilsen', 'Income': '37,308'}
{'Neighborhood': 'Lathrop Homes', 'Income': '107,359'}
{'Neighborhood': 'Wicker Park', 'Income': '95,586'}
{'Neighborhood': 'West Morgan Park', 'Income': '92,834'}
{'Neighborhood': 'Hermosa', 'Income': '38,672'}
```

{'Neighborhood': 'River North', 'Income': '105,209'}
{'Neighborhood': 'Goose Island', 'Income': '117,348'}
{'Neighborhood': 'Little Village', 'Income': '31,544'}
{'Neighborhood': 'Chrysler Village', 'Income': '52,936'}
{'Neighborhood': 'Tri-Taylor', 'Income': '51,693'}
{'Neighborhood': 'Ukrainian Village', 'Income': '72,887'}
{'Neighborhood': nan, 'Income': nan}
{'Neighborhood': 'Englewood', 'Income': '25,166'}
{'Neighborhood': 'Uptown', 'Income': '37,609'}
{'Neighborhood': 'Brainerd', 'Income': '46,712'}
{'Neighborhood': 'East Chatham', 'Income': '23,773'}
{'Neighborhood': 'Logan Square', 'Income': '53,980'}
{'Neighborhood': 'River West', 'Income': '113,882'}
{'Neighborhood': 'North Park', 'Income': '64,551'}
{'Neighborhood': 'Peterson Park', 'Income': '85,078'}
{'Neighborhood': 'Gage Park', 'Income': '39,905'}
{'Neighborhood': 'Portage Park', 'Income': '60,628'}
{'Neighborhood': 'Beverly View', 'Income': '70,278'}
{'Neighborhood': 'Irving Park', 'Income': '65,518'}
{'Neighborhood': 'Lake View', 'Income': '106,921'}
{'Neighborhood': 'Calumet River', 'Income': '33,923'}
{'Neighborhood': 'Heart of Italy', 'Income': '50,041'}
{'Neighborhood': 'Wrigleyville', 'Income': '98,826'}
{'Neighborhood': 'Riverdale', 'Income': '21,500'}
{'Neighborhood': 'Avalon Park', 'Income': '24,319'}
{'Neighborhood': 'Old Town Triangle', 'Income': '99,714'}
{'Neighborhood': 'West Elsdon', 'Income': '52,087'}
{'Neighborhood': 'Old Town', 'Income': '109,560'}
{'Neighborhood': 'Bridgeport', 'Income': '44,968'}
{'Neighborhood': 'Lithuanian Plaza', 'Income': '26,169'}
{'Neighborhood': 'Big Oaks', 'Income': '74,932'}
{'Neighborhood': 'North Mayfair', 'Income': '66,049'}
{'Neighborhood': 'Morgan Park', 'Income': '63,464'}
{'Neighborhood': 'The Gap', 'Income': '52,182'}
{'Neighborhood': 'Burnside', 'Income': '32,438'}
{'Neighborhood': 'Golden Gate', 'Income': '16,444'}
{'Neighborhood': 'Park Manor', 'Income': '36,532'}
{'Neighborhood': 'Illinois Medical District', 'Income': '18,146'}
{'Neighborhood': 'Fulton River District', 'Income': '130,910'}
{'Neighborhood': nan, 'Income': nan}
{'Neighborhood': 'Noble Square', 'Income': '74,032'}
{'Neighborhood': 'The Bush', 'Income': '27,031'}
{'Neighborhood': 'Rosemoor', 'Income': '45,608'}
{'Neighborhood': 'East Pilsen', 'Income': '57,297'}
{'Neighborhood': 'Pulaski Park', 'Income': '66,094'}
{'Neighborhood': 'Lincoln Square', 'Income': '80,660'}
{'Neighborhood': 'Ford City', 'Income': '53,295'}
{'Neighborhood': 'Sleepy Hollow', 'Income': '60,625'}
{'Neighborhood': 'North Kenwood', 'Income': '52,361'}
{'Neighborhood': 'Gresham', 'Income': '31,696'}
{'Neighborhood': 'Kilbourn Park', 'Income': '48,515'}
{'Neighborhood': 'Montclare', 'Income': '54,092'}
{'Neighborhood': 'Scottsdale', 'Income': '58,570'}
{'Neighborhood': 'Marynook', 'Income': '50,034'}
{'Neighborhood': 'Powder Horn Lake', 'Income': '51,250'}
{'Neighborhood': 'Galewood', 'Income': '69,277'}
{'Neighborhood': 'Wrightwood Neighbors', 'Income': '111,069'}
{'Neighborhood': "O'Hare International Airport", 'Income': 'N/A'}
{'Neighborhood': 'Wolf Lake', 'Income': '77,473'}
{'Neighborhood': 'Prairie Shores', 'Income': '39,144'}
{'Neighborhood': 'Harbour Point Estates', 'Income': '63,031'}
{'Neighborhood': 'Gladstone Park', 'Income': '63,570'}
{'Neighborhood': 'Printers Row', 'Income': '99,057'}
{'Neighborhood': 'West Chatham', 'Income': '44,321'}
{'Neighborhood': 'Princeton Park', 'Income': '45,424'}

{'Neighborhood': nan, 'Income': nan}
{'Neighborhood': 'Brynford Park', 'Income': '76,171'}
{'Neighborhood': 'McKinley Park', 'Income': '45,337'}
{'Neighborhood': 'South Shore', 'Income': '27,867'}
{'Neighborhood': 'Garfield Ridge', 'Income': '72,802'}
{'Neighborhood': 'New Eastside', 'Income': '114,760'}
{'Neighborhood': 'Belmont Central', 'Income': '49,870'}
{'Neighborhood': 'Lake Calumet', 'Income': '25,364'}
{'Neighborhood': 'Graceland West', 'Income': '101,317'}
{'Neighborhood': 'Vittum Park', 'Income': '48,630'}
{'Neighborhood': 'Edgebrook', 'Income': '112,390'}
{'Neighborhood': 'Mayfair', 'Income': '57,909'}
{'Neighborhood': 'Parkway Gardens', 'Income': '9,485'}
{'Neighborhood': 'Norwood Park West', 'Income': '77,966'}
{'Neighborhood': 'South Deering', 'Income': '37,831'}
{'Neighborhood': 'East Hyde Park', 'Income': '59,197'}
{'Neighborhood': 'Irving Park', 'Income': '65,518'}
{'Neighborhood': 'Chicago Midway Airport', 'Income': '60,500'}
{'Neighborhood': 'East Garfield Park', 'Income': '28,776'}
{'Neighborhood': 'Wildwood', 'Income': '121,479'}
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```

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```

Convert the list into data frame and save as Excel file.

In [14]:
```
df_income=pd.DataFrame(WebScrapingResult)
df_income.to_excel("chicago_neighboorhoods_income.xls")
```

```
<ipython-input-14-d3db5922c15b>:2: FutureWarning: As the xlwt package is no longer maint
ained, the xlwt engine will be removed in a future version of pandas. This is the only e
ngine in pandas that supports writing in the xls format. Install openpyxl and write to a
n xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence thi
s warning. While this option is deprecated and will also raise a warning, it can be glob
ally set and the warning suppressed.
  df_income.to_excel("chicago_neighboorhoods_income.xls")
```

The web scraping is naturally slow porcess. It is easy from the file to load necessary data when one would like not to wait such a long time.

In [4]:
```
df_income=pd.read_excel("chicago_neighboorhoods_income.xls")
df_income=df_income[['Neighborhood','Income']]
df_income.head()
```

Out[4]:

	Neighborhood	Income
0	Trumbull Park	16,420
1	Cragin	43,966
2	Kenwood	55,493
3	West De Paul	148,113
4	Cottage Grove Heights	37,113

In [16]:
```
df_income.shape
```

Out[16]: (233, 2)

I have realized that there are duplicated values. The website has some problems with the location of each neighborhoods. As it can be seen from the folloing picture, when one moves mouse over Hegewisch neighborhood, then the neighbirhood is located in two different places. That is not the only one error. Another one appears, when I explore the source code, I realized that the neighborhood is defined for mouse hover in a rectangle (second picture with light blue rectangle), which is not really correct guidance. But I would correct those later, manually.

 alt text

In [17]:

```
# Drop all duplicates
df_income.drop_duplicates(inplace=True)
df_income.shape
```

Out[17]: (214, 2)

In [18]:
```
# Check if there is any empty cell
df_income.isnull().values.any()
```

Out[18]: True

In [19]:
```
# Delete all rows with empty values
df_income = df_income.dropna()
df_income = df_income.reset_index(drop=True)
df_income.isnull().values.any()
```

Out[19]: False

In [20]:
```
# In order to integrate income distribution to main dataframe, rename columns.
df_income.rename(columns={'Neighborhood':'Neighborhood1', 'Income':'Income1'},inplace=T
```

In [21]:
```
df_income.head()
```

Out[21]:

	Neighborhood1	Income1
0	Trumbull Park	16,420
1	Cragin	43,966
2	Kenwood	55,493
3	West De Paul	148,113
4	Cottage Grove Heights	37,113

Chicago neighborhoods income distribution is obtained. It is time to merge into df_distributions dataframe (main dataframe).

In [22]:
```
new=pd.merge(df_distributions, df_income, left_on='Neighborhood', right_on='Neighborhoo
new.drop('Income', axis=1, inplace=True)
new.rename(columns={'Income1':'Income'},inplace=True)
df_distributions=new
df_distributions.head()
```

Out[22]:

	Neighborhood	Latitude	Longitude	Population	Population Density	Income
0	Albany Park	41.970329	-87.715992	NaN	NaN	53,349
1	Altgeld Gardens	41.655259	-87.609584	NaN	NaN	15,494
2	Andersonville	41.977139	-87.669273	NaN	NaN	76,489
3	Arcadia Terrace	41.909805	-87.710133	NaN	NaN	58,803

	Neighborhood	Latitude	Longitude	Population	Population Density	Income
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN

In [23]:
```
df_distributions.shape
```

Out[23]: (228, 6)

So far the income distribution over neighborhoods are completed. But there are some missing values. In the website of statistical atlas as I have mentioned above. Therefore, the mssing values would be revisited later.

Now, the population values of neighborhoods are stored in the dataframe. I will use similar approach with selenium tool.

In [121…
```
# import necessary libraries
from selenium.webdriver.common.by import By
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from selenium.webdriver.common.action_chains import ActionChains
# Define chromedriver options
chrome_options = webdriver.ChromeOptions()
chrome_options.add_argument("start-maximized")
chrome_options.add_experimental_option("excludeSwitches", ["enable-automation"])
chrome_options.add_experimental_option('useAutomationExtension', False)
# Define the path of chromedriver
driver = webdriver.Chrome(options=chrome_options, executable_path=r'C:\Webdriver\chrome
# Enter the URL, wait until the necessary part is loaded on the webpage
driver.get('https://statisticalatlas.com/place/Illinois/Chicago/Population#data-map/nei
time.sleep(10)
element = WebDriverWait(driver, 10).until(EC.presence_of_element_located((By.CLASS_NAME
# Find all elements
test = driver.find_elements_by_xpath("//*[name()='div' and @id='data-map/neighborhood']
# Define empty list to store results
WebScrapingResult=[]
# Loop over all elements
for i in range(len(test)):
    # Take mouse hover actions
    hover = ActionChains(driver).move_to_element(test[i])
    hover.perform()
    # Find buble content when mouse hovers
    date = driver.find_elements_by_id('hover-bubble-contents')
    # Define a dictionary to store data
    row={}
    # It can return no values, so check for it
    if date[0].text != '':
        row['Neighborhood'] = date[0].text.split(': ')[0]
        row['Population'] = date[0].text.split(': ')[1]
        print(row)
        WebScrapingResult.append(row)
    else:
        row['Neighborhood'] = np.nan
        row['Population'] = np.nan
        print(row)
        WebScrapingResult.append(row)
```

```
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```

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{'Neighborhood': 'Mount Greenwood', 'Population': '16,624'}
{'Neighborhood': 'Old Irving Park', 'Population': '11,555'}
{'Neighborhood': 'Altgeld Gardens', 'Population': '2,586'}
{'Neighborhood': 'LeClaire Courts', 'Population': '1,721'}
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{'Neighborhood': 'West Englewood', 'Population': '25,523'}
{'Neighborhood': 'Sheridan Park', 'Population': '6,570'}
{'Neighborhood': 'Calumet Heights', 'Population': '12,085'}
{'Neighborhood': 'West Chesterfield', 'Population': '4,128'}
{'Neighborhood': 'Edgewater Beach', 'Population': '31,397'}
{'Neighborhood': nan, 'Population': nan}
{'Neighborhood': 'East Ukrainian Village', 'Population': '7,238'}
{'Neighborhood': 'Bridgeport', 'Population': '38,031'}
{'Neighborhood': 'Near West Side', 'Population': '16,071'}
{'Neighborhood': 'Washington Heights', 'Population': '5,225'}
{'Neighborhood': 'Fernwood', 'Population': '9,985'}
{'Neighborhood': 'Winneconna Parkway', 'Population': '587'}
{'Neighborhood': 'Lincoln Park', 'Population': '14,410'}
{'Neighborhood': 'Sheffield Neighbors', 'Population': '10,992'}
{'Neighborhood': 'Parkview', 'Population': '1,463'}
{'Neighborhood': 'West Woodlawn', 'Population': '8,104'}
{'Neighborhood': 'East Side', 'Population': '23,367'}
{'Neighborhood': 'The Island', 'Population': '1,994'}
{'Neighborhood': 'Chatham', 'Population': '18,875'}
{'Neighborhood': 'Clearing (W)', 'Population': '16,761'}
{'Neighborhood': 'Edgewater Glen', 'Population': '2,194'}
{'Neighborhood': 'Dearborn Park', 'Population': '3,303'}
{'Neighborhood': 'East Side', 'Population': '23,367'}
{'Neighborhood': 'South Austin', 'Population': '56,846'}
{'Neighborhood': 'Hyde Park', 'Population': '18,430'}
{'Neighborhood': nan, 'Population': nan}
```

In [124…

```
df_population=pd.DataFrame(WebScrapingResult)
df_population.to_excel("chicago_neighboorhoods_population.xls")
```

```
<ipython-input-124-e3eaa47e5eee>:2: FutureWarning: As the xlwt package is no longer main
tained, the xlwt engine will be removed in a future version of pandas. This is the only
engine in pandas that supports writing in the xls format. Install openpyxl and write to
an xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence th
is warning. While this option is deprecated and will also raise a warning, it can be glo
bally set and the warning suppressed.
  df_population.to_excel("chicago_neighboorhoods_population.xls")
```

In [125…

```
df_population.head()
```

Out[125…

	Neighborhood	Population
0	Trumbull Park	822
1	Cragin	39,117
2	Kenwood	10,311
3	West De Paul	2,768
4	Cottage Grove Heights	2,275

In [24]:
```
# For practical purpose one can load data from a file
df_population=pd.read_excel("chicago_neighboorhoods_population.xls")
df_population=df_population[['Neighborhood','Population']]
df_population.head()
```

Out[24]:

	Neighborhood	Population
0	Trumbull Park	822
1	Cragin	39,117
2	Kenwood	10,311
3	West De Paul	2,768
4	Cottage Grove Heights	2,275

In [25]:
```
df_population.shape
```

Out[25]: (233, 2)

In [26]:
```
# Drop duplicates
df_population.drop_duplicates(inplace=True)
df_population.shape
```

Out[26]: (214, 2)

In [27]:
```
# Check any empty cell
df_population.isnull().values.any()
```

Out[27]: True

In [28]:
```
# Drop rwos with emty cells
df_population = df_population.dropna()
df_population = df_population.reset_index(drop=True)
df_population.isnull().values.any()
```

Out[28]: False

In [29]:
```
# Rename columns for merge operations.
df_population.rename(columns={'Neighborhood':'Neighborhood1', 'Population':'Population1
df_population.head()
```

Out[29]:

	Neighborhood1	Population1
0	Trumbull Park	822
1	Cragin	39,117
2	Kenwood	10,311
3	West De Paul	2,768

	Neighborhood1	Population1
4	Cottage Grove Heights	2,275

In [30]:
```
# Merge new info into main dataframe
new=pd.merge(df_distributions, df_population, left_on='Neighborhood', right_on='Neighbo
new.drop('Population', axis=1, inplace=True)
new.rename(columns={'Population1':'Population'},inplace=True)
df_distributions=new
df_distributions.head()
```

Out[30]:

	Neighborhood	Latitude	Longitude	Population Density	Income	Population
0	Albany Park	41.970329	-87.715992	NaN	53,349	57,201
1	Altgeld Gardens	41.655259	-87.609584	NaN	15,494	2,586
2	Andersonville	41.977139	-87.669273	NaN	76,489	5,979
3	Arcadia Terrace	41.909805	-87.710133	NaN	58,803	5,458
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN

In [31]:
```
df_distributions.shape
```

Out[31]:
```
(228, 6)
```

Only left to store is the population density of the neighborhoods.

In [128…
```
# import necessary libraries
from selenium.webdriver.common.by import By
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from selenium.webdriver.common.action_chains import ActionChains
# Define chromedriver options
chrome_options = webdriver.ChromeOptions()
chrome_options.add_argument("start-maximized")
chrome_options.add_experimental_option("excludeSwitches", ["enable-automation"])
chrome_options.add_experimental_option('useAutomationExtension', False)
# Define the path of chromedriver
driver = webdriver.Chrome(options=chrome_options, executable_path=r'C:\Webdriver\chrome
# Enter the URL, wait until the necessary part is loaded on the webpage
driver.get('https://statisticalatlas.com/place/Illinois/Chicago/Population#data-map/nei
time.sleep(10)
element = WebDriverWait(driver, 10).until(EC.presence_of_element_located((By.CLASS_NAME
# Find all elements
test = driver.find_elements_by_xpath("//*[name()='div' and @id='data-map/neighborhood']
# Define empty list to store results
WebScrapingResult=[]
# Loop over all elements
for i in range(len(test)):
    # Take mouse hover actions
    hover = ActionChains(driver).move_to_element(test[i])
    hover.perform()
    # Find buble content when mouse hovers
    date = driver.find_elements_by_id('hover-bubble-contents')
```

```
    # Define a dictionary to store data
    row={}
    # It can return no values, so check for it
    if date[0].text != '':
        row['Neighborhood'] = date[0].text.split(': ')[0]
        row['Population Density'] = (date[0].text.split(': ')[1]).split('/')[0]
        print(row)
        WebScrapingResult.append(row)
    else:
        row['Neighborhood'] = np.nan
        row['Population Density'] = np.nan
        print(row)
        WebScrapingResult.append(row)
```

```
{'Neighborhood': 'Trumbull Park', 'Population Density': '23,283'}
{'Neighborhood': 'Cragin', 'Population Density': '24,552'}
{'Neighborhood': 'Kenwood', 'Population Density': '18,993'}
{'Neighborhood': 'West De Paul', 'Population Density': '22,207'}
{'Neighborhood': 'Cottage Grove Heights', 'Population Density': '6,482'}
{'Neighborhood': 'Fernwood', 'Population Density': '9,505'}
{'Neighborhood': 'Schorsch Village', 'Population Density': '13,548'}
{'Neighborhood': 'Heart of Chicago', 'Population Density': '17,871'}
{'Neighborhood': 'Park West', 'Population Density': '28,675'}
{'Neighborhood': 'Albany Park', 'Population Density': '31,880'}
{'Neighborhood': 'Andersonville', 'Population Density': '21,264'}
{'Neighborhood': 'Marquette Park', 'Population Density': '14,504'}
{'Neighborhood': 'Ravenswood Manor', 'Population Density': '13,742'}
{'Neighborhood': 'Bowmanville', 'Population Density': '5,232'}
{'Neighborhood': 'Cabrini Green', 'Population Density': '12,348'}
{'Neighborhood': 'Canaryville', 'Population Density': '9,035'}
{'Neighborhood': 'Kilbourn Park', 'Population Density': '16,240'}
{'Neighborhood': 'Lake Meadows', 'Population Density': '10,477'}
{'Neighborhood': 'Irving Woods', 'Population Density': '8,025'}
{'Neighborhood': 'Kennedy Park', 'Population Density': '4,906'}
{'Neighborhood': 'Belmont Gardens', 'Population Density': '16,596'}
{'Neighborhood': 'Jefferson Park', 'Population Density': '11,757'}
{'Neighborhood': 'Lake View East', 'Population Density': '40,266'}
{'Neighborhood': 'Pilsen', 'Population Density': '14,411'}
{'Neighborhood': 'Lathrop Homes', 'Population Density': '13,140'}
{'Neighborhood': 'Wicker Park', 'Population Density': '21,742'}
{'Neighborhood': 'West Morgan Park', 'Population Density': '6,601'}
{'Neighborhood': 'Hermosa', 'Population Density': '20,524'}
{'Neighborhood': 'River North', 'Population Density': '24,847'}
{'Neighborhood': 'Goose Island', 'Population Density': '4,229'}
{'Neighborhood': 'Little Village', 'Population Density': '18,176'}
{'Neighborhood': 'Chrysler Village', 'Population Density': '12,699'}
{'Neighborhood': 'Tri-Taylor', 'Population Density': '13,453'}
{'Neighborhood': 'Ukrainian Village', 'Population Density': '23,691'}
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{'Neighborhood': 'Englewood', 'Population Density': '10,125'}
{'Neighborhood': 'Uptown', 'Population Density': '20,984'}
{'Neighborhood': 'Brainerd', 'Population Density': '11,265'}
{'Neighborhood': 'East Chatham', 'Population Density': '20,913'}
{'Neighborhood': 'Logan Square', 'Population Density': '25,602'}
{'Neighborhood': 'River West', 'Population Density': '7,407'}
{'Neighborhood': 'North Park', 'Population Density': '8,602'}
{'Neighborhood': 'Peterson Park', 'Population Density': '9,846'}
{'Neighborhood': 'Gage Park', 'Population Density': '19,084'}
{'Neighborhood': 'Portage Park', 'Population Density': '17,117'}
{'Neighborhood': 'Beverly View', 'Population Density': '12,025'}
{'Neighborhood': 'Irving Park', 'Population Density': '17,481'}
{'Neighborhood': 'Lake View', 'Population Density': '23,324'}
{'Neighborhood': 'Calumet River', 'Population Density': '56'}
{'Neighborhood': 'Heart of Italy', 'Population Density': '23,450'}
```

{'Neighborhood': 'Wrigleyville', 'Population Density': '24,132'}
{'Neighborhood': 'Riverdale', 'Population Density': '4,111'}
{'Neighborhood': 'Avalon Park', 'Population Density': '11,397'}
{'Neighborhood': 'Old Town Triangle', 'Population Density': '18,091'}
{'Neighborhood': 'West Elsdon', 'Population Density': '15,450'}
{'Neighborhood': 'Old Town', 'Population Density': '37,043'}
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{'Neighborhood': 'Big Oaks', 'Population Density': '10,285'}
{'Neighborhood': 'North Mayfair', 'Population Density': '9,517'}
{'Neighborhood': 'Morgan Park', 'Population Density': '6,719'}
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{'Neighborhood': 'Park Manor', 'Population Density': '11,394'}
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{'Neighborhood': 'Fulton River District', 'Population Density': '20,416'}
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```

```
{'Neighborhood': 'Mount Greenwood Heights', 'Population Density': '11,242'}
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{'Neighborhood': 'Stateway Gardens', 'Population Density': '2,294'}
{'Neighborhood': 'West Beverly', 'Population Density': '6,211'}
{'Neighborhood': 'Fifth City', 'Population Density': '10,616'}
{'Neighborhood': 'Lakewood - Balmoral', 'Population Density': '14,368'}
{'Neighborhood': 'Douglas Park', 'Population Density': '3,494'}
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{'Neighborhood': 'The Loop', 'Population Density': '9,628'}
{'Neighborhood': 'Homan Square', 'Population Density': '13,643'}
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{'Neighborhood': 'Eden Green', 'Population Density': '8,223'}
{'Neighborhood': 'Edgewater Glen', 'Population Density': '17,409'}
{'Neighborhood': nan, 'Population Density': nan}
{'Neighborhood': 'Lake Meadows', 'Population Density': '10,477'}
{'Neighborhood': 'Mount Greenwood', 'Population Density': '6,963'}
{'Neighborhood': 'Old Irving Park', 'Population Density': '11,052'}
{'Neighborhood': 'Altgeld Gardens', 'Population Density': '6,356'}
{'Neighborhood': 'LeClaire Courts', 'Population Density': '6,346'}
{'Neighborhood': 'East Beverly', 'Population Density': '7,237'}
{'Neighborhood': 'Beverly', 'Population Density': '5,162'}
{'Neighborhood': 'West Englewood', 'Population Density': '10,119'}
{'Neighborhood': 'Sheridan Park', 'Population Density': '35,638'}
{'Neighborhood': 'Calumet Heights', 'Population Density': '8,102'}
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{'Neighborhood': 'Edgewater Beach', 'Population Density': '52,920'}
{'Neighborhood': nan, 'Population Density': nan}
{'Neighborhood': 'East Ukrainian Village', 'Population Density': '28,622'}
{'Neighborhood': 'Bridgeport', 'Population Density': '13,199'}
{'Neighborhood': 'Near West Side', 'Population Density': '13,405'}
{'Neighborhood': 'Washington Heights', 'Population Density': '7,453'}
{'Neighborhood': 'Fernwood', 'Population Density': '9,505'}
{'Neighborhood': 'Winneconna Parkway', 'Population Density': '10,497'}
{'Neighborhood': 'Lincoln Park', 'Population Density': '21,322'}
{'Neighborhood': 'Sheffield Neighbors', 'Population Density': '19,865'}
{'Neighborhood': 'Parkview', 'Population Density': '9,850'}
{'Neighborhood': 'West Woodlawn', 'Population Density': '18,410'}
{'Neighborhood': 'East Side', 'Population Density': '9,764'}
{'Neighborhood': 'The Island', 'Population Density': '10,374'}
{'Neighborhood': 'Chatham', 'Population Density': '12,279'}
{'Neighborhood': 'Clearing (W)', 'Population Density': '12,544'}
{'Neighborhood': 'Edgewater Glen', 'Population Density': '17,409'}
{'Neighborhood': 'Dearborn Park', 'Population Density': '27,254'}
{'Neighborhood': 'East Side', 'Population Density': '9,764'}
{'Neighborhood': 'South Austin', 'Population Density': '17,727'}
{'Neighborhood': 'Hyde Park', 'Population Density': '17,192'}
{'Neighborhood': nan, 'Population Density': nan}
```

In [129…

```
df_population_density=pd.DataFrame(WebScrapingResult)
df_population_density.to_excel("chicago_neighboorhoods_population_density.xls")
```

```
<ipython-input-129-5f1919b2df60>:2: FutureWarning: As the xlwt package is no longer main
tained, the xlwt engine will be removed in a future version of pandas. This is the only
engine in pandas that supports writing in the xls format. Install openpyxl and write to
an xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence th
is warning. While this option is deprecated and will also raise a warning, it can be glo
bally set and the warning suppressed.
  df_population_density.to_excel("chicago_neighboorhoods_population_density.xls")
```

In [130…
```
df_population_density.head()
```

Out[130…

	Neighborhood	Population Density
0	Trumbull Park	23,283
1	Cragin	24,552
2	Kenwood	18,993
3	West De Paul	22,207
4	Cottage Grove Heights	6,482

In [32]:
```
# Easy access to population density distributions
df_population_density=pd.read_excel("chicago_neighboorhoods_population_density.xls")
df_population_density=df_population_density[['Neighborhood','Population Density']]
df_population_density.head()
```

Out[32]:

	Neighborhood	Population Density
0	Trumbull Park	23,283
1	Cragin	24,552
2	Kenwood	18,993
3	West De Paul	22,207
4	Cottage Grove Heights	6,482

In [33]:
```
df_population_density.shape
```

Out[33]: (233, 2)

In [34]:
```
# Drop duplicates
df_population_density.drop_duplicates(inplace=True)
df_population_density.shape
```

Out[34]: (214, 2)

In [35]:
```
# Check any empty cell
df_population_density.isnull().values.any()
```

Out[35]: True

In [36]:
```
# Drop rows with emoty cells
df_population_density = df_population_density.dropna()
df_population_density = df_population_density.reset_index(drop=True)
df_population_density.isnull().values.any()
```

Out[36]: False

In [37]:
```
# Prepare for merge operations
df_population_density.rename(columns={'Neighborhood':'Neighborhood1', 'Population Densi
df_population_density.head()
```

Out[37]:

	Neighborhood1	Population Density1
0	Trumbull Park	23,283
1	Cragin	24,552
2	Kenwood	18,993
3	West De Paul	22,207
4	Cottage Grove Heights	6,482

In [38]:
```
# Merge into main dataframe.
new=pd.merge(df_distributions, df_population_density, left_on='Neighborhood', right_on=
new.drop('Population Density', axis=1, inplace=True)
new.rename(columns={'Population Density1':'Population Density'},inplace=True)
df_distributions=new
df_distributions.head()
```

Out[38]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
0	Albany Park	41.970329	-87.715992	53,349	57,201	31,880
1	Altgeld Gardens	41.655259	-87.609584	15,494	2,586	6,356
2	Andersonville	41.977139	-87.669273	76,489	5,979	21,264
3	Arcadia Terrace	41.909805	-87.710133	58,803	5,458	21,551
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN

In [39]:
```
df_distributions.shape
```

Out[39]:
```
(228, 6)
```

In [40]:
```
# Now check data type of all columns
df_distributions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 228 entries, 0 to 227
Data columns (total 6 columns):
 #   Column              Non-Null Count  Dtype 
---  ------              --------------  ----- 
 0   Neighborhood        228 non-null    object
 1   Latitude            228 non-null    object
 2   Longitude           228 non-null    object
 3   Income              211 non-null    object
 4   Population          213 non-null    object
 5   Population Density  213 non-null    object
dtypes: object(6)
memory usage: 12.5+ KB
```

Hence, we have some issues with column types and the format of numeric

values.

In [41]:
```
df_distributions.head(20)
```

Out[41]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
0	Albany Park	41.970329	-87.715992	53,349	57,201	31,880
1	Altgeld Gardens	41.655259	-87.609584	15,494	2,586	6,356
2	Andersonville	41.977139	-87.669273	76,489	5,979	21,264
3	Arcadia Terrace	41.909805	-87.710133	58,803	5,458	21,551
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN
5	Ashburn	41.747533	-87.711163	67,115	14,332	9,411
6	Avalon Park	41.745035	-87.588658	24,319	3,571	11,397
7	Avondale	41.938921	-87.711168	NaN	NaN	NaN
8	Back of the Yards	41.807533	-87.66612	28,782	38,909	9,192
9	Belmont Central	41.939796	-87.653328	49,870	31,075	19,402
10	Belmont Gardens	41.939796	-87.653328	40,698	12,866	16,596
11	Belmont Heights	41.945127	-87.814332	58,311	12,887	13,210
12	Belmont Terrace	41.939796	-87.653328	72,985	2,554	10,130
13	Beverly	41.718153	-87.671767	106,744	11,844	5,162
14	Beverly View	41.718153	-87.671767	70,278	996	12,025
15	Beverly Woods	41.683386	-87.681244	95,055	1,136	8,796
16	Big Oaks	41.539995	-88.579534	74,932	4,826	10,285
17	Bowmanville	41.972133	-87.693737	71,369	3,985	5,232
18	Brainerd	41.732812	-87.658383	46,712	12,909	11,265
19	Bridgeport	41.837938	-87.651028	44,968	38,031	13,199

Income, population and density columns has numeric values with comma. Replace comma with non-space and convert into integer values.

In [50]:
```
for row in range(len(df_distributions)):
    if type(df_distributions['Income'][row]) == str:
        df_distributions['Income'][row]= int(df_distributions['Income'][row].replace(",
    if type(df_distributions['Population'][row]) == str:
        df_distributions['Population'][row]= int(df_distributions['Population'][row].re
    if type(df_distributions['Population Density'][row]) == str:
        df_distributions['Population Density'][row]= int(df_distributions['Population D
```

In [51]:
```
df_distributions.head()
```

Out[51]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
0	Albany Park	41.970329	-87.715992	53349	57201	31880
1	Altgeld Gardens	41.655259	-87.609584	15494	2586	6356
2	Andersonville	41.977139	-87.669273	76489	5979	21264
3	Arcadia Terrace	41.909805	-87.710133	58803	5458	21551
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN

In [52]:
```
df_distributions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 228 entries, 0 to 227
Data columns (total 6 columns):
 #   Column              Non-Null Count  Dtype 
---  ------              --------------  ----- 
 0   Neighborhood        228 non-null    object
 1   Latitude            228 non-null    object
 2   Longitude           228 non-null    object
 3   Income              211 non-null    object
 4   Population          213 non-null    object
 5   Population Density  213 non-null    object
dtypes: object(6)
memory usage: 20.6+ KB
```

Check for null values

In [54]:
```
df_distributions[df_distributions['Income'].isnull()]
```

Out[54]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
4	Archer Heights	41.811422	-87.726165	NaN	NaN	NaN
7	Avondale	41.938921	-87.711168	NaN	NaN	NaN
52	Edgewater	41.99239	-87.664046	NaN	NaN	NaN
74	Groveland Park	41.833644	-87.610256	NaN	NaN	NaN
79	Hegewisch	41.653646	-87.546988	NaN	NaN	NaN
83	Howard Street	41.561272	-87.262869	NaN	NaN	NaN
110	Longwood Manor	41.690398	-87.67219	NaN	NaN	NaN
133	O'Hare	41.975164	-87.844242	NaN	NaN	NaN
134	O'Hare International Airport	41.977985	-87.909321	NaN	0	0
136	Old Edgebrook	41.994708	-87.767727	NaN	NaN	NaN
138	Old Norwood Park	41.988066	-87.802749	NaN	NaN	NaN
158	Ravenswood	41.965591	-87.666724	NaN	NaN	NaN
183	South Old Irving Park	41.954131	-87.733637	NaN	NaN	NaN
187	Streeterville	41.893402	-87.622001	NaN	NaN	NaN
194	The Villa	41.730232	-87.551072	NaN	NaN	NaN

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
204	Wentworth Gardens	41.825447	-87.632602	NaN	NaN	NaN
222	Winneconna Parkway	41.751872	-87.637059	NaN	587	10497

I have manually complete the null values.

In [55]:
```
df_distributions['Income'][4]=31259
df_distributions['Population'][4]=55070
df_distributions['Population Density'][4]=9349

df_distributions['Income'][7]=59410
df_distributions['Population'][7]=17995
df_distributions['Population Density'][7]=13965

df_distributions['Income'][52]=54172
df_distributions['Population'][52]=12359
df_distributions['Population Density'][52]=25770

df_distributions['Income'][74]=50300
df_distributions['Population'][74]=589
df_distributions['Population Density'][74]=8543

df_distributions['Income'][79]=49274
df_distributions['Population'][79]=13438
df_distributions['Population Density'][79]=8609

df_distributions['Income'][83]=58629
df_distributions['Population'][83]=3591
df_distributions['Population Density'][83]=15996

df_distributions['Income'][110]=55423
df_distributions['Population'][110]=7705
df_distributions['Population Density'][110]=7608

df_distributions['Income'][133]=53021
df_distributions['Population'][133]=12997
df_distributions['Population Density'][133]=3788

df_distributions['Income'][134]=0
df_distributions['Population'][134]=0
df_distributions['Population Density'][134]=0

df_distributions['Income'][136]=0
df_distributions['Population'][136]=116
df_distributions['Population Density'][136]=3429

df_distributions['Income'][138]=94502
df_distributions['Population'][138]=3148
df_distributions['Population Density'][138]=4943

df_distributions['Income'][158]=70684
df_distributions['Population'][158]=27788
df_distributions['Population Density'][158]=19566

df_distributions['Income'][183]=50943
df_distributions['Population'][183]=1347
df_distributions['Population Density'][183]=17649
```

```
df_distributions['Income'][187]=99350
df_distributions['Population'][187]=21156
df_distributions['Population Density'][187]=33871

df_distributions['Income'][194]=81328
df_distributions['Population'][194]=592
df_distributions['Population Density'][194]=6491

df_distributions['Income'][204]=11964
df_distributions['Population'][204]=772
df_distributions['Population Density'][204]=10500

df_distributions['Income'][222]=0
df_distributions['Population'][222]=587
df_distributions['Population Density'][222]=10497
```

In [56]:
```
df_distributions[df_distributions['Income'].isnull()]
```

Out[56]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density

In [61]:
```
df_distributions=df_distributions.astype({'Latitude':float,'Longitude':float,'Income':i
```

In [62]:
```
df_distributions.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 228 entries, 0 to 227
Data columns (total 6 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   Neighborhood        228 non-null    object 
 1   Latitude            228 non-null    float64
 2   Longitude           228 non-null    float64
 3   Income              228 non-null    int32  
 4   Population          228 non-null    int32  
 5   Population Density  228 non-null    int32  
dtypes: float64(2), int32(3), object(1)
memory usage: 17.9+ KB
```

For future reuse store the data into file.

In [241…
```
df_distributions.to_excel("chicago_neighboorhoods_disributions.xls")
```

```
<ipython-input-241-c7ac3128426a>:1: FutureWarning: As the xlwt package is no longer main
tained, the xlwt engine will be removed in a future version of pandas. This is the only
engine in pandas that supports writing in the xls format. Install openpyxl and write to
an xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence th
is warning. While this option is deprecated and will also raise a warning, it can be glo
bally set and the warning suppressed.
  df_distributions.to_excel("chicago_neighboorhoods_disributions.xls")
```

In [5]:
```
df_distributions=pd.read_excel("chicago_neighboorhoods_disributions.xls")
df_distributions=df_distributions[['Neighborhood','Latitude','Longitude','Income','Popu
df_distributions = df_distributions.reset_index(drop=True)
df_distributions.head()
```

Out[5]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density
0	Albany Park	41.968520	-87.738891	53349	57201	31880
1	Altgeld Gardens	41.653856	-87.602974	15494	2586	6356
2	Andersonville	41.981724	-87.672123	76489	5979	21264
3	Arcadia Terrace	41.986849	-87.698836	58803	5458	21551
4	Archer Heights	41.810804	-87.743683	31259	55070	9349

Import libraries

In [7]:

```
import requests # library to handle requests
```

Define Foursquare Credentials and Version

In [4]:

```
CLIENT_ID = '24DUTRHMELURSY1RUCOK4ATU0CC52JI41XAESPER3XH3YVAV' # your Foursquare ID
CLIENT_SECRET = 'GR2HTNIWP4CLPUVWSOQNWUNI5YV21M53S50BLP3IX1HTSNBG' # your Foursquare Se
ACCESS_TOKEN = 'DMM5D3SHSFZ02ASNGPNKDWRUPO15U2HTSIDVSFKUNEZ3JE5X' # your FourSquare Acc
VERSION = '20180604' # Foursquare API version

print('Your credentails:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

```
Your credentails:
CLIENT_ID: 24DUTRHMELURSY1RUCOK4ATU0CC52JI41XAESPER3XH3YVAV
CLIENT_SECRET:GR2HTNIWP4CLPUVWSOQNWUNI5YV21M53S50BLP3IX1HTSNBG
```

Create a function to repeat the process of exploring the venues for all the neighborhoods of Chicago

In [5]:

```
def getNearbyVenues(names, latitudes, longitudes, radius, Limit):
    #
    venues_list=[]
    for name, lat, lng, rd in zip(names, latitudes, longitudes,radius):
        #r in range(170,171):
        #name=names[r]
        #lat=latitudes[r]
        #lng=longitudes[r]
        #rd=radius[r]

        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            rd,
            Limit)

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

```
        # make sure that there are venues for each neighborhood
        count=2
        while len(results)<3 :
            # create the API request URL
            url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_se
                CLIENT_ID,
                CLIENT_SECRET,
                VERSION,
                lat,
                lng,
                rd*count,
                Limit)
            # make the GET request
            results = requests.get(url).json()["response"]['groups'][0]['items']
            count +=0.5
            print('count' +': ', count)


        print(name +': ', len(results))
        # 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_
    nearby_venues.columns = ['Borough',
                  'Neighborhood Latitude',
                  'Neighborhood Longitude',
                  'Venue',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Venue Category']

    return(nearby_venues)
```

Create a new dataframe called chicago_venues.

In [14]:

```
Area_Radius=np.sqrt(df_distributions['Population']/df_distributions['Population Density
Area_Radius.replace(np.nan, 1000, inplace=True)
chicago_venues = getNearbyVenues(names=df_distributions['Neighborhood'],
                                 latitudes=df_distributions['Latitude'],
                                 longitudes=df_distributions['Longitude'],
                                 radius = Area_Radius,
                                 Limit = 1000
                                )
```

```
Albany Park:  100
Altgeld Gardens:  23
Andersonville:  100
Arcadia Terrace:  100
Archer Heights:  100
Ashburn:  100
Avalon Park:  100
Avondale:  100
```

```
Back of the Yards:  100
Belmont Central:  100
Belmont Gardens:  100
Belmont Heights:  100
Belmont Terrace:  60
Beverly:  100
Beverly View:  21
Beverly Woods:  31
Big Oaks:  100
Bowmanville:  100
Brainerd:  100
Bridgeport:  100
Brighton Park:  100
Bronzeville:  100
Brynford Park:  4
Bucktown:  100
Budlong Woods:  100
Buena Park:  100
Burnside:  100
Cabrini Green:  93
Calumet Heights:  100
Calumet River:  100
Canaryville:  100
Chatham:  100
Chicago Lawn:  100
Chicago Midway Airport:  100
Chinatown:  100
Chrysler Village:  37
Clearing (E):  40
Clearing (W):  100
Cottage Grove Heights:  45
Cragin:  100
Dearborn Park:  100
Douglas Park:  100
Dunning:  100
East Beverly:  100
East Chatham:  100
East Garfield Park:  100
East Hyde Park:  93
East Pilsen:  100
East Side:  100
East Ukrainian Village:  100
Eden Green:  10
Edgebrook:  100
Edgewater:  100
Edgewater Beach:  100
Edgewater Glen:  100
Edison Park:  100
Englewood:  100
Fernwood:  100
Fifth City:  59
Ford City:  98
Forest Glen:  57
Fuller Park:  78
Fulton River District:  100
Gage Park:  100
Galewood:  100
Garfield Ridge:  100
Gladstone Park:  64
Gold Coast:  100
Golden Gate:  9
Goose Island:  100
Graceland West:  100
Grand Crossing:  100
Greektown:  100
```

```
Gresham:  100
Groveland Park:  47
Hanson Park:  84
Harbour Point Estates:  6
Heart of Chicago:  100
Heart of Italy:  53
Hegewisch:  80
Hermosa:  100
Hollywood Park:  100
Homan Square:  34
Howard Street:  77
Humboldt Park:  100
Hyde Park:  100
Ida B. Wells - Darrow Homes:  74
Illinois Medical District:  100
Irving Park:  100
Irving Woods:  96
Jackson Park Highlands:  50
Jefferson Park:  100
Kelvin Park:  96
Kennedy Park:  85
Kenwood:  100
Kilbourn Park:  100
Lake Calumet:  100
Lake Meadows:  97
Lake View:  100
Lake View East:  100
Lakewood - Balmoral:  100
Lathrop Homes:  100
LeClaire Courts:  32
Lincoln Park:  100
Lincoln Square:  100
Lithuanian Plaza:  23
Little Calumet River:  69
Little Village:  100
Logan Square:  100
London Towne:  9
Longwood Manor:  100
Magnolia Glen:  100
Margate Park:  100
Marquette Park:  100
Marycrest:  53
Marynook:  99
Mayfair:  100
McKinley Park:  100
Montclare:  100
Morgan Park:  100
Mount Greenwood:  100
Mount Greenwood Heights:  49
Near North:  100
Near West Side:  100
New Eastside:  100
Noble Square:  100
North Austin:  100
North Center:  100
North Kenwood:  100
North Mayfair:  100
North Park:  100
Norwood Park East:  100
Norwood Park West:  100
O'Hare:  100
O'Hare International Airport:  81
Oakland:  100
Old Edgebrook:  15
Old Irving Park:  100
```

```
Old Norwood Park:  92
Old Town:  100
Old Town Triangle:  100
Oriole Park:  100
Palmer Square:  100
Park Manor:  100
Park West:  100
Parkview:  47
Parkway Gardens:  11
Peterson Park:  83
Pill Hill:  59
Pilsen:  100
Portage Park:  100
Powder Horn Lake:  24
Prairie Shores:  100
Princeton Park:  59
Printers Row:  100
Pulaski Park:  100
Pullman:  52
Ranch Triangle:  100
Ravenswood:  100
Ravenswood Gardens:  100
Ravenswood Manor:  97
River North:  100
River West:  100
River's Edge:  3
Riverdale:  5
Rogers Park:  100
Roscoe Village:  100
Roseland:  100
Rosemoor:  100
Sauganash:  100
count:  2.5
Sauganash Woods:  7
Schorsch Forest View:  72
Schorsch Village:  100
Scottsdale:  100
Sheffield Neighbors:  100
Sheridan Park:  100
Sleepy Hollow:  24
South Austin:  100
South Chicago:  100
South Commons:  59
South Deering:  72
South East Ravenswood:  100
South Loop:  100
South Old Irving Park:  40
South Shore:  100
Stateway Gardens:  59
Stony Island Park:  77
Streeterville:  100
Tally's Corner:  55
The Bush:  81
The Gap:  88
The Island:  54
The Loop:  100
The Robert Taylor Homes:  84
The Villa:  45
Tri-Taylor:  100
count:  2.5
Trumbull Park:  11
Ukrainian Village:  100
Union Ridge:  100
University Village - Little Italy:  100
Uptown:  100
```

```
Vittum Park:  91
Washington Heights:  85
Washington Park:  100
Wentworth Gardens:  30
West Beverly:  100
West Chatham:  100
West Chesterfield:  100
West De Paul:  100
West Elsdon:  100
West Englewood:  83
West Garfield Park:  100
West Humboldt Park:  100
West Lawn:  100
West Loop Gate:  100
West Morgan Park:  98
West Pullman:  100
West Rogers Park:  100
West Town:  100
West Woodlawn:  71
Wicker Park:  100
Wildwood:  100
Winneconna Parkway:  23
Wolf Lake:  99
Woodlawn:  100
Wrightwood:  100
Wrightwood Neighbors:  100
Wrigleyville:  100
```

In [18]:
```
chicago_venues.shape
```

Out[18]:
```
(19571, 7)
```

In [16]:
```
chicago_venues.to_excel("chicago_venues.xls")
```

```
<ipython-input-16-8e7c1de48216>:1: FutureWarning: As the xlwt package is no longer maint
ained, the xlwt engine will be removed in a future version of pandas. This is the only e
ngine in pandas that supports writing in the xls format. Install openpyxl and write to a
n xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence thi
s warning. While this option is deprecated and will also raise a warning, it can be glob
ally set and the warning suppressed.
  chicago_venues.to_excel("chicago_venues.xls")
```

In [13]:
```
chicago_venues=pd.read_excel("chicago_venues.xls")
chicago_venues=chicago_venues[['Neighborhood','Neighborhood Latitude','Neighborhood Lon
chicago_venues = chicago_venues.reset_index(drop=True)
chicago_venues.head()
```

Out[13]:

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Albany Park	41.96852	-87.738891	Shibam City Restaurant	41.968175	-87.740268	Middle Eastern Restaurant
1	Albany Park	41.96852	-87.738891	Gompers Park	41.975472	-87.734078	Park
2	Albany Park	41.96852	-87.738891	Starbucks	41.968911	-87.728817	Coffee Shop

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
3	Albany Park	41.96852	-87.738891	Lawrence Fish Market	41.968280	-87.726250	Seafood Restaurant
4	Albany Park	41.96852	-87.738891	Old Irving Brewing Co.	41.960726	-87.739303	Brewery

In [14]:
```
chicago_venues.isnull().values.any()
```

Out[14]: False

By neighborhood now it is time to check the number of returned values.

In [15]:
```
chicago_venues.groupby('Neighborhood').count()
```

Out[15]:

Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Albany Park	100	100	100	100	100	100
Altgeld Gardens	23	23	23	23	23	23
Andersonville	100	100	100	100	100	100
Arcadia Terrace	100	100	100	100	100	100
Archer Heights	100	100	100	100	100	100
...	...	...	...	...	...	...
Wolf Lake	99	99	99	99	99	99
Woodlawn	100	100	100	100	100	100
Wrightwood	100	100	100	100	100	100
Wrightwood Neighbors	100	100	100	100	100	100
Wrigleyville	100	100	100	100	100	100

228 rows × 6 columns

Search for Turkish cuisine and similar to cuisine.

In [16]:
```
chicago_venues[chicago_venues['Venue Category'].str.contains('Turkish Restaurant', rege
               chicago_venues['Venue Category'].str.contains('Middle Eastern Restaurant'
               chicago_venues['Venue Category'].str.contains('Mediterranean Restaurant',
               chicago_venues['Venue Category'].str.contains('Falafel Restaurant', regex
               chicago_venues['Venue Category'].str.contains('Greek Restaurant', regex=F
```

Out[16]:
```
Neighborhood             238
Neighborhood Latitude    238
Neighborhood Longitude   238
```

```
Venue                  238
Venue Latitude         238
Venue Longitude        238
Venue Category         238
dtype: int64
```

In [17]:
```
chicago_venues[(chicago_venues['Venue Category'].str.contains('Restaurant', regex=False
```

Out[17]:
```
Neighborhood             4789
Neighborhood Latitude    4789
Neighborhood Longitude   4789
Venue                    4789
Venue Latitude           4789
Venue Longitude          4789
Venue Category           4789
dtype: int64
```

In [18]:
```
chicago_turkish_like=chicago_venues[chicago_venues['Venue Category'].str.contains('Turk
              chicago_venues['Venue Category'].str.contains('Middle Eastern Restaurant'
              chicago_venues['Venue Category'].str.contains('Mediterranean Restaurant',
              chicago_venues['Venue Category'].str.contains('Falafel Restaurant', regex
              chicago_venues['Venue Category'].str.contains('Greek Restaurant', regex=F
chicago_turkish_like.drop(['Neighborhood Latitude', 'Neighborhood Longitude', 'Venue' ,
chicago_turkish_like.rename(columns = {'Venue Category':'Number of Middle Eastern Resta
chicago_turkish_like.head()
```

Out[18]:

Neighborhood	Number of Middle Eastern Restaurant
Albany Park	2
Andersonville	3
Arcadia Terrace	6
Archer Heights	1
Ashburn	2

In [19]:
```
chicago_restaurant=chicago_venues[(chicago_venues['Venue Category'].str.contains('Resta
chicago_restaurant.drop(['Neighborhood Latitude', 'Neighborhood Longitude', 'Venue' , '
chicago_restaurant.rename(columns = {'Venue Category':'Number of Restaurant'}, inplace=
chicago_restaurant.head()
```

Out[19]:

Neighborhood	Number of Restaurant
Albany Park	31
Altgeld Gardens	3
Andersonville	28
Arcadia Terrace	50
Archer Heights	32

In [20]:
```
# join above dataframe to the main df
df_main = df_distributions.join(chicago_turkish_like, on='Neighborhood')
df_main = df_main.join(chicago_restaurant, on='Neighborhood')
df_main.head()
```

Out[20]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Number of Restaurant
0	Albany Park	41.968520	-87.738891	53349	57201	31880	2.0	31.0
1	Altgeld Gardens	41.653856	-87.602974	15494	2586	6356	NaN	3.0
2	Andersonville	41.981724	-87.672123	76489	5979	21264	3.0	28.0
3	Arcadia Terrace	41.986849	-87.698836	58803	5458	21551	6.0	50.0
4	Archer Heights	41.810804	-87.743683	31259	55070	9349	1.0	32.0

In [21]:
```
df_main.isnull().values.any()
```

Out[21]: True

In [22]:
```
df_main = df_main.fillna(0)
df_main.head()
```

Out[22]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Number of Restaurant
0	Albany Park	41.968520	-87.738891	53349	57201	31880	2.0	31.0
1	Altgeld Gardens	41.653856	-87.602974	15494	2586	6356	0.0	3.0
2	Andersonville	41.981724	-87.672123	76489	5979	21264	3.0	28.0
3	Arcadia Terrace	41.986849	-87.698836	58803	5458	21551	6.0	50.0
4	Archer Heights	41.810804	-87.743683	31259	55070	9349	1.0	32.0

In [24]:
```
df_main.to_excel("df_main.xls")
```

```
<ipython-input-24-5b8744c2a67f>:1: FutureWarning: As the xlwt package is no longer maint
ained, the xlwt engine will be removed in a future version of pandas. This is the only e
ngine in pandas that supports writing in the xls format. Install openpyxl and write to a
n xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence thi
s warning. While this option is deprecated and will also raise a warning, it can be glob
ally set and the warning suppressed.
  df_main.to_excel("df_main.xls")
```

In [2]:
```
df_main=pd.read_excel("df_main.xls")
df_main=df_main[['Neighborhood','Latitude','Longitude','Income','Population','Populatio
```

```
df_main = df_main.reset_index(drop=True)
df_main.head()
```

Out[2]:

	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Number of Restaurant
0	Albany Park	41.968520	-87.738891	53349	57201	31880	2	31
1	Altgeld Gardens	41.653856	-87.602974	15494	2586	6356	0	3
2	Andersonville	41.981724	-87.672123	76489	5979	21264	3	28
3	Arcadia Terrace	41.986849	-87.698836	58803	5458	21551	6	50
4	Archer Heights	41.810804	-87.743683	31259	55070	9349	1	32

3. Methodology and Analysis

The available data are from 228 neighborhoods, and considering the size of the city of Chicago, it is necessary to exclude some neighborhoods according to the criteria described earlier. Namely, if there is no previous interest in the products to be offered in the region, if the income level of the region is low and if there is not enough interest in restaurants in general; then there is no need to focus on those regions at the very first place. For the remaining core data we will conduct a more detailed analysis.

3.1 Exploratory Data Analysis

Before any data exploration let us look at the general view of the main data. Chicago has nearly 60K of medien income all over the neighborhoods. Per neighborhood there are 21 restaurants.Unfortunately, we have a restriction on the exploration of venues since we are using the free version of Foursquare API. Despite this fact we have a good representation of the city.

In [27]:

```
df_main.describe()
```

Out[27]:

	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Number of Restaurant
count	228.000000	228.000000	228.000000	228.000000	228.000000	228.000000	228.000000
mean	41.853101	-87.686424	59757.078947	11844.938596	14286.956140	1.043860	21.004386
std	0.104018	0.069679	29365.199523	14825.908953	10139.444792	1.394706	10.080512
min	41.646716	-87.922474	0.000000	0.000000	0.000000	0.000000	0.000000
25%	41.765886	-87.737090	38240.500000	2184.750000	8208.000000	0.000000	13.000000
50%	41.869273	-87.678742	54797.500000	6215.500000	11888.000000	1.000000	23.000000
75%	41.946914	-87.635948	76171.000000	14432.750000	18152.000000	2.000000	28.000000
max	42.020779	-87.531578	157519.000000	84998.000000	68753.000000	9.000000	50.000000

Folium is a great tool for visualization.

In [7]:
```
!pip install folium
```

```
Requirement already satisfied: folium in c:\users\user\anaconda3\lib\site-packages (0.1
2.1)
Requirement already satisfied: numpy in c:\users\user\anaconda3\lib\site-packages (from
folium) (1.20.1)
Requirement already satisfied: requests in c:\users\user\anaconda3\lib\site-packages (fr
om folium) (2.25.1)
Requirement already satisfied: jinja2>=2.9 in c:\users\user\anaconda3\lib\site-packages
(from folium) (2.11.3)
Requirement already satisfied: branca>=0.3.0 in c:\users\user\anaconda3\lib\site-package
s (from folium) (0.4.2)
Requirement already satisfied: MarkupSafe>=0.23 in c:\users\user\anaconda3\lib\site-pack
ages (from jinja2>=2.9->folium) (1.1.1)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\user\anaconda3\lib\site-pa
ckages (from requests->folium) (2020.12.5)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\user\anaconda3\lib\site
-packages (from requests->folium) (1.26.4)
Requirement already satisfied: idna<3,>=2.5 in c:\users\user\anaconda3\lib\site-packages
(from requests->folium) (2.10)
Requirement already satisfied: chardet<5,>=3.0.2 in c:\users\user\anaconda3\lib\site-pac
kages (from requests->folium) (4.0.0)
```

In [54]:
```
import folium # map rendering library
```

In [58]:
```
# importing geopy library
from geopy.geocoders import Nominatim
```

Get the coordinate of Chicago.

In [60]:
```
address = 'Chicago'
geolocator = Nominatim(user_agent="chicago_explorer")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geograpical coordinate of Stuttgart are {}, {}.'.format(latitude, longitude)
```

```
The geograpical coordinate of Stuttgart are 41.8755616, -87.6244212.
```

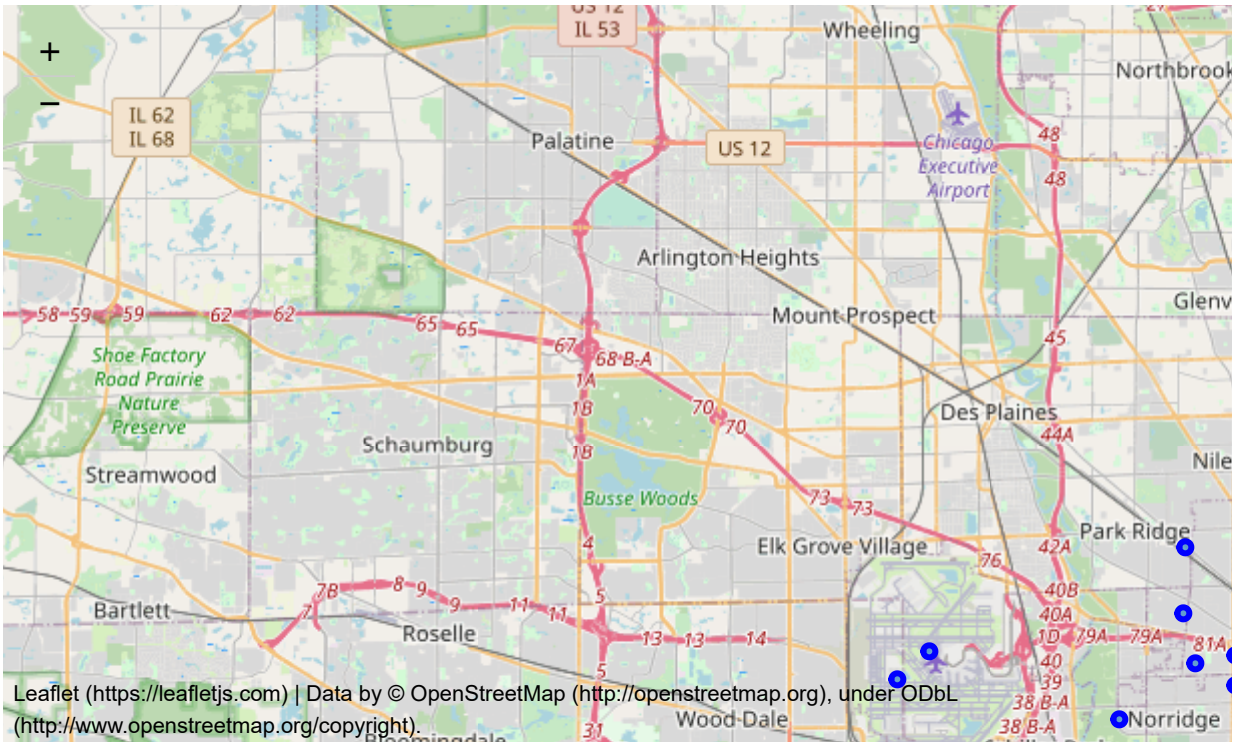
In [61]:
```
# create map of Chicago using latitude and longitude values
map_chicago = folium.Map(location=[latitude, longitude], zoom_start=11)

# add markers to map
for  neighborhood, lat, lng in zip(df_main['Neighborhood'], df_main['Latitude'], df_mai
    label = '{}'.format(neighborhood)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=3,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
```

```
        parse_html=False).add_to(map_chicago)

map_chicago
```

Out[61]:



If the distribution of restaurants per neighborhood is analyzed, then it can be seen that more than 60% of all regions have at least 20 restaurants. Moreover, 20% of them has more than 30 restaurants.

In [30]:

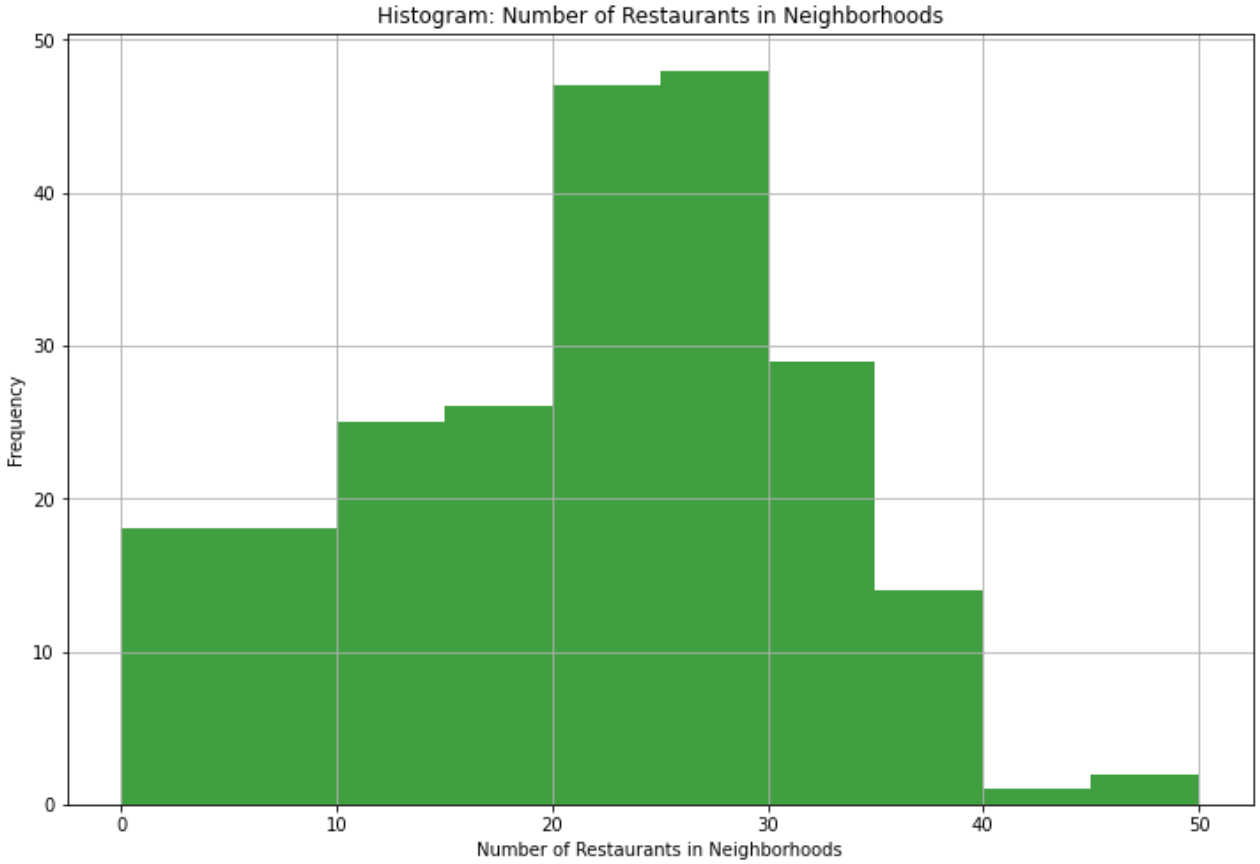
```
%pylab inline
import numpy as np
import matplotlib.pyplot as plt

# Fixing random state for reproducibility
plt.figure(figsize=[12,8])
x = (df_main['Number of Restaurant']).values
#df_main['Number of Middle Eastern Restaurant']/
# the histogram of the data
plt.hist(x, facecolor='g', alpha=0.75)


plt.xlabel('Number of Restaurants in Neighborhoods')
plt.ylabel('Frequency')
plt.title('Histogram: Number of Restaurants in Neighborhoods')


plt.grid(True)
plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```



Number of restaurants reflects the interest in eating outside. But, we should focus on high income neighborhoods. Because, Food&Enjoy would like to reach real taste seekers. From the histogram, we could say it is fair to focus on the neighborhoods with median salary of at least 70K.

In [32]:

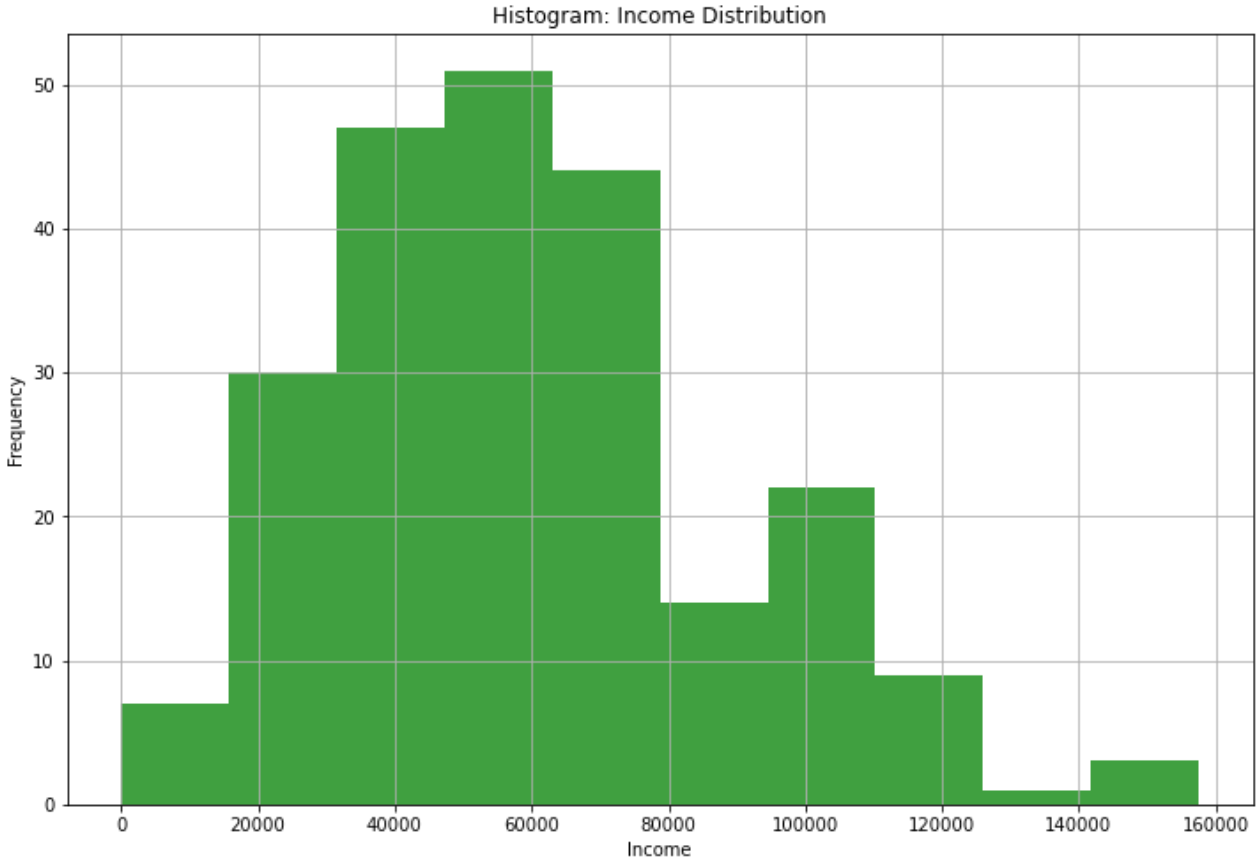
```
%pylab inline
import numpy as np
import matplotlib.pyplot as plt

# Fixing random state for reproducibility
plt.figure(figsize=[12,8])
x = (df_main['Income']).values
#df_main['Number of Middle Eastern Restaurant']/
# the histogram of the data
plt.hist(x, facecolor='g', alpha=0.75)


plt.xlabel('Income')
plt.ylabel('Frequency')
plt.title('Histogram: Income Distribution')


plt.grid(True)
plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```



Another factor the prospective customers in neighborhoods. If there is not enough, then it would be wise to exclude those regions. It could be seen that there are a lot neighborhoods with less than 5 thousands.

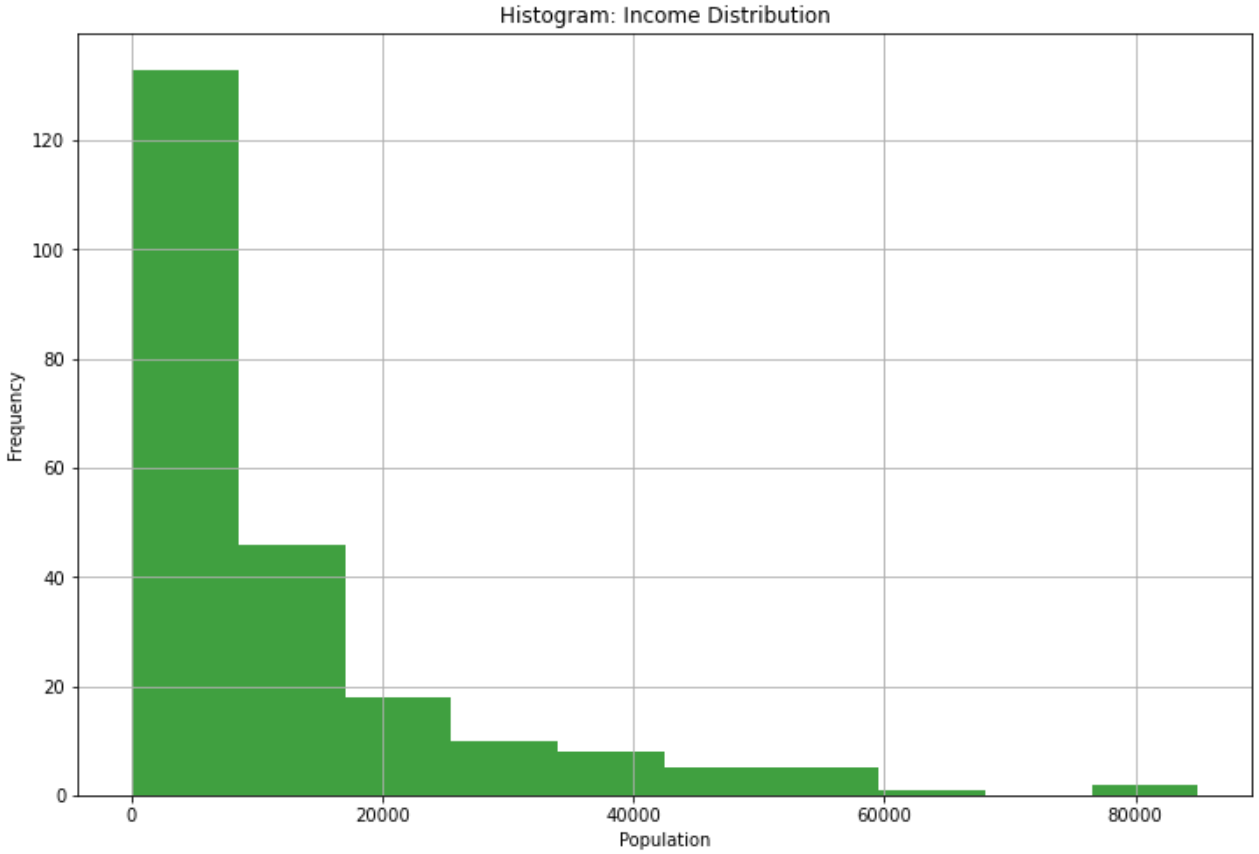
In [33]:
```
%pylab inline
import numpy as np
import matplotlib.pyplot as plt

# Fixing random state for reproducibility
plt.figure(figsize=[12,8])
x = (df_main['Population']).values
#df_main['Number of Middle Eastern Restaurant']/
# the histogram of the data
plt.hist(x, facecolor='g', alpha=0.75)


plt.xlabel('Population')
plt.ylabel('Frequency')
plt.title('Histogram: Population Distribution')


plt.grid(True)
plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```



Reduction of Data Set

Chicago has many neighborhoods and, as we are focusing on the best places for the new investment, some of them are not suitable to invest at the very first place. For the very first elimination it is wise to determine a limit for the median income. It is widely accepted that for a good living one should have at least 70K as an annual salary. Food&Enjoy's would like to reach tasty food seekers and, therefore, this limit for salary is quite applicable. After applying this restriction we have 77 neighborhoods with high income distributions.

In [274…
```
df_core=df_main[df_main["Income"]>70000]
```

In [275…
```
df_core.shape
```

Out[275… (77, 8)

High income constraints are not enough to make sure there are enough potential consumers in neighborhoods. At his point, we need to check total populations. Of course, any place could attract the people from other neighborhoods. But, the location gives signal whether the restaurant serves to rich people or low income residents. Arbitrarily, we prefer to focus on neighborhoods with at least 5 thousands residents. Now, we have 34 potential places to make the investment.

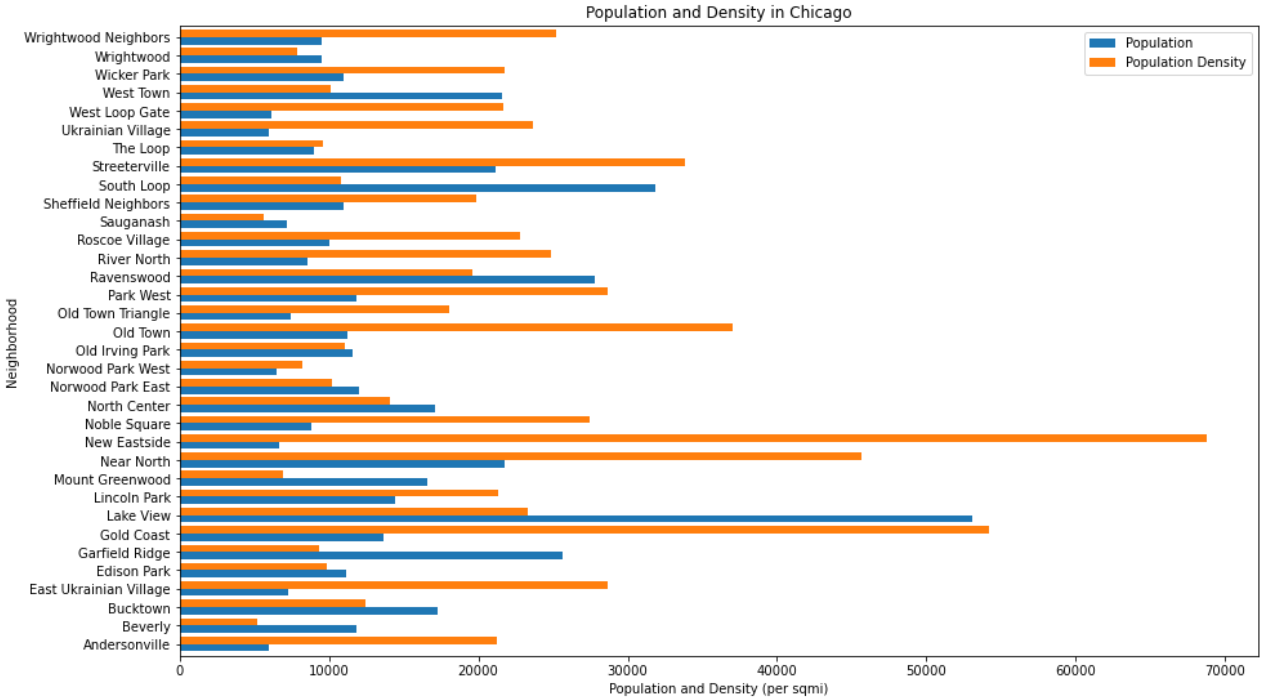
In [276…
```
df_core=df_core[df_core["Population"]>5000]
```

In [277…
```
df_core.shape
```

Out[277… (34, 8)

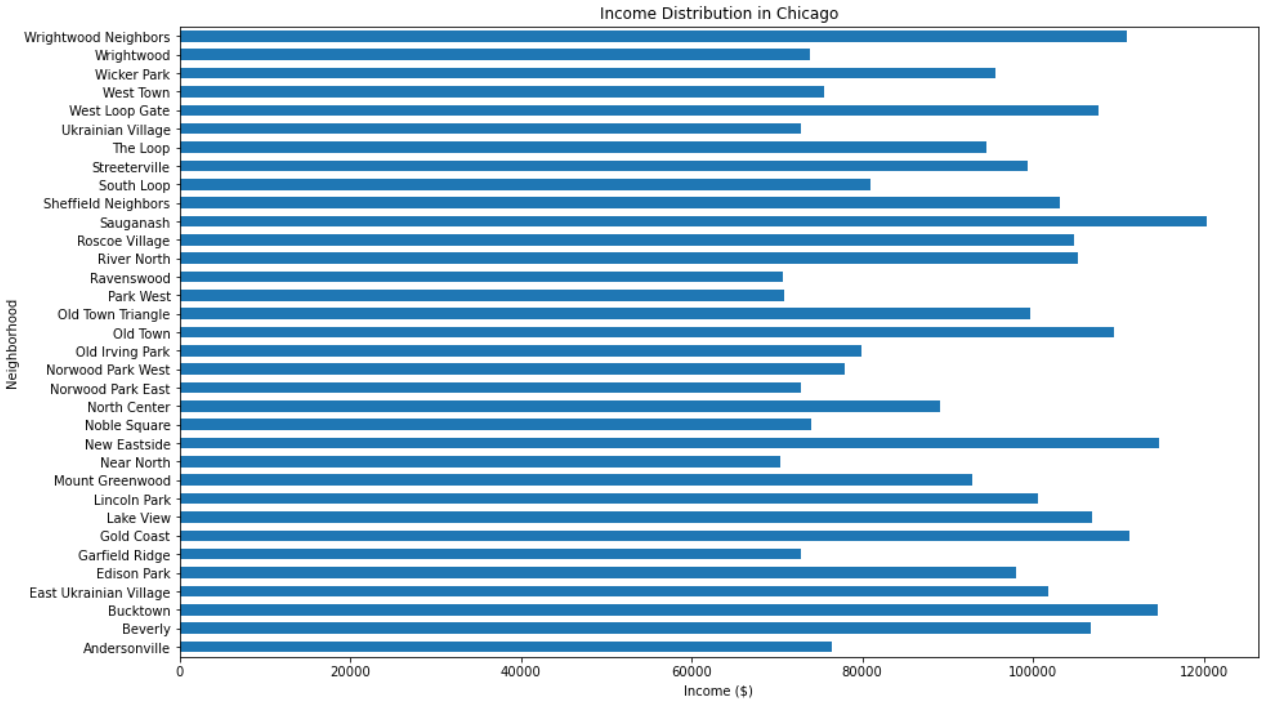
It is time to get more insights about those 34 regions. Let us look at the populations and densities in 34 neighborhoods

In [19]:
```
import matplotlib.pyplot as plt
# Plot the bar chart
df_core[['Neighborhood', 'Population', 'Population Density']].plot(kind='barh', figsize
# Label the data
plt.xlabel('Population and Density (per sqmi)') # add to x-label to the plot
plt.ylabel('Neighborhood') # add y-label to the plot
plt.title('Population and Density in Chicago') # add title to the plot
plt.yticks (np.arange(34), df_core['Neighborhood'])
plt.show()
```



Another important factor is the income distributions. 14 neighborhoods have more than 100K annual median salary. These regions could be one for the investment.

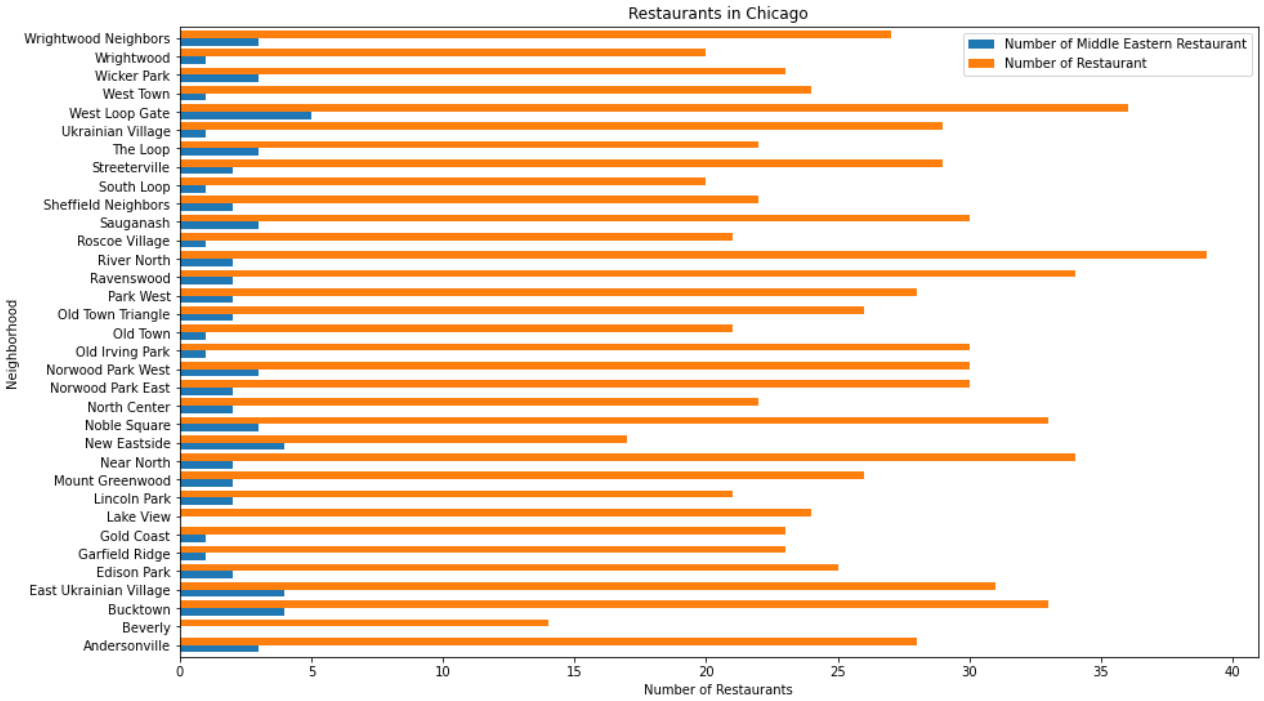
In [24]:
```
import matplotlib.pyplot as plt
# Plot the bar chart
df_core[['Neighborhood', 'Income']].plot(kind='barh', figsize=(15, 9), width=0.6, legen
# Label the data
plt.xlabel('Income ($)') # add to x-label to the plot
plt.ylabel('Neighborhood') # add y-label to the plot
plt.title('Income Distribution in Chicago') # add title to the plot
plt.yticks (np.arange(34), df_core['Neighborhood'])
plt.show()
```



For te competition measure it is a good idea to visualize the number of restaurants. Moreover, the measure for the familiarity to Middle Eastern foods could be obtained from the number of restaurants similar to Middle Eastern cuisine. For example West Loop Gate has a lot restaurants and some of them serve Middle Eastern foods.

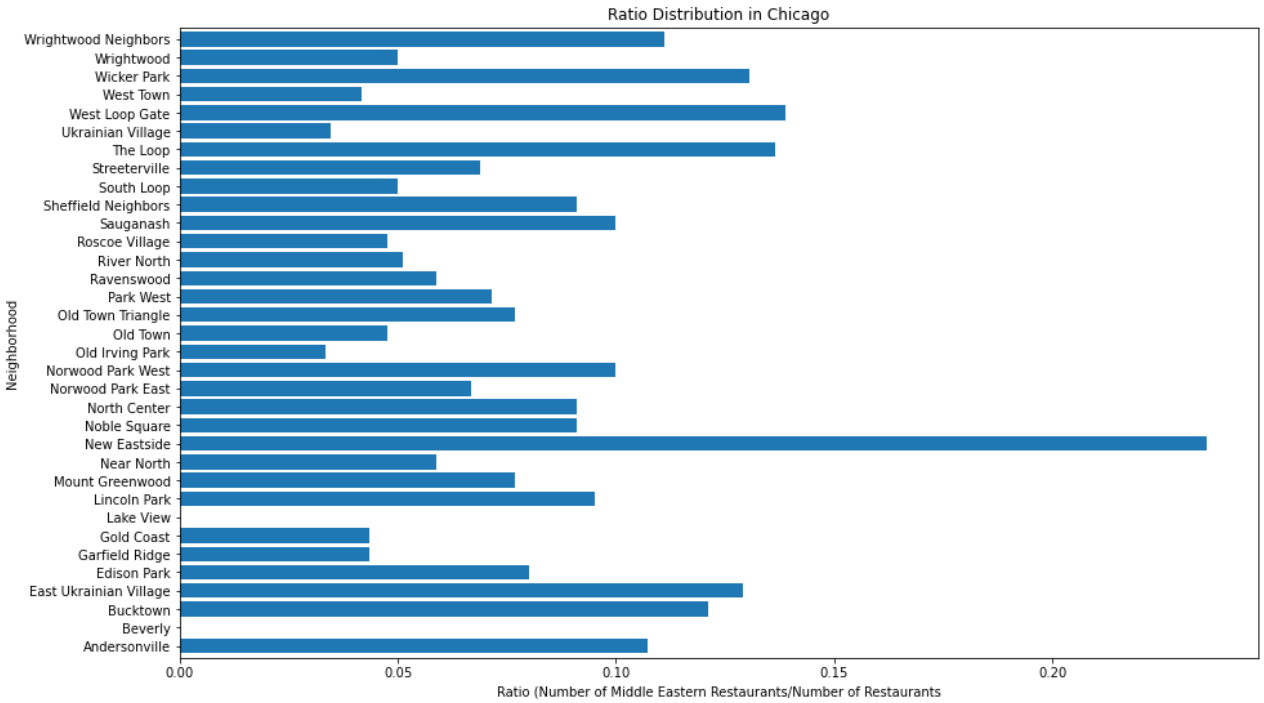
In [35]:

```
import matplotlib.pyplot as plt
# Plot the bar chart
df_core[['Neighborhood', 'Number of Middle Eastern Restaurant', 'Number of Restaurant']
# Label the data
plt.xlabel('Number of Restaurants') # add to x-label to the plot
plt.ylabel('Neighborhood') # add y-label to the plot
plt.title('Restaurants in Chicago') # add title to the plot
plt.yticks (np.arange(34), df_core['Neighborhood'])
plt.show()
```



But for the familiarity it is better to use the proportion of Middle Eastern type resaturants among all restaurants. More than 20% of the restaurants in New Eastside are of type interested.

In [37]:
```
import matplotlib.pyplot as plt
# Plot the bar chart
dfs=pd.DataFrame(df_core['Number of Middle Eastern Restaurant']/df_core['Number of Rest
dfs.plot(kind='barh', figsize=(15, 9), width=0.8,legend=None)
# Label the data
plt.xlabel('Ratio (Number of Middle Eastern Restaurants/Number of Restaurants') # add t
plt.ylabel('Neighborhood') # add y-label to the plot
plt.title('Ratio Distribution in Chicago') # add title to the plot
plt.yticks (np.arange(34), df_core['Neighborhood'])
plt.show()
```



3.2 Cluster Analysis

Cluster analysis would provide us better strategies. Before the procedure it is needed to manipulate the dataframe. Firstly, the income values are really high and would decrease the effects of other factors. So the income is divided by 1000 to reduce the large number effect.

In [278…
```
df_core['Income'] = df_core['Income'] / 1000
df_core.head()
```

Out[278…

	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Number of Restaurant
2	Andersonville	41.981724	-87.672123	76.489	5979	21264	3	28
13	Beverly	41.716645	-87.688542	106.744	11844	5162	0	14
23	Bucktown	41.979512	-87.702463	114.647	17313	12444	4	33
49	East Ukrainian Village	41.899629	-87.676646	101.865	7238	28622	4	31
55	Edison Park	42.007178	-87.823215	98.098	11115	9899	2	25

Not all of the information in dataframe is relevant to cluster analysis. Since we focus on neighborhood with higher income, the competition within neighborhoods and neighborhoods' familirty with middle eastern foods; new dataframe would include the income distribution, number of restaurants and the proportion of Middle Eastern restaurants for each neighborhood. Income values are adjusted, but we could not directly use the distribution of restaurants. This is simply because of that there could be more restaurants corresponding to higher population. Therefore, it is scaled by population and expressed as number of restaurants per 1000 residents. Similarly, we use the familiarty measure as percentage value instead of proportion.

In [279…
```
df_clusters=df_core.drop(['Neighborhood','Latitude', 'Longitude', 'Population Density']
df_clusters['Income'] = df_core['Income']
df_clusters['Number of Restaurants per 1000 People'] = df_core['Number of Restaurant']/
df_clusters['Familiarity'] = df_core['Number of Middle Eastern Restaurant']/df_core['Nu
df_clusters = df_clusters.drop(['Population', 'Number of Restaurant', 'Number of Middle
df_clusters.head()
```

Out[279…

	Income	Number of Restaurants per 1000 People	Familiarity
2	76.489	4.683057	10.714286
13	106.744	1.182033	0.000000
23	114.647	1.906082	12.121212
49	101.865	4.282951	12.903226
55	98.098	2.249213	8.000000

In [280…
```
df_clusters.replace([np.inf, -np.inf], np.nan, inplace=True) #check for infinte values
```

In [281…
```
df_clusters = df_clusters.fillna(0) # fill non-numeric values with zero
```

Now, we must perform normalization as all values have different intervals.

In [282…
```
from sklearn.preprocessing import StandardScaler
df_clusters = StandardScaler().fit_transform(df_clusters)
df_clusters
```

Out[282…
```
array([[-1.03874286e+00,  1.62549792e+00,  6.35567139e-01],
       [ 8.80887087e-01, -9.55891780e-01, -1.76642854e+00],
       [ 1.38231943e+00, -4.22032947e-01,  9.50980713e-01],
       [ 5.71322569e-01,  1.33048991e+00,  1.12629744e+00],
       [ 3.32312620e-01, -1.69034443e-01,  2.70615661e-02],
       [-1.27267694e+00, -1.16646535e+00, -7.91705657e-01],
       [ 1.17230538e+00, -5.84053655e-01, -7.91705657e-01],
       [ 8.92117446e-01, -1.49381506e+00, -1.76642854e+00],
       [ 4.92583161e-01, -7.52915139e-01,  3.68678730e-01],
       [ 3.07911129e-03, -6.74255524e-01, -4.19188226e-02],
       [-1.42076540e+00, -6.77161648e-01, -4.47685815e-01],
       [ 1.38948909e+00,  4.73064926e-02,  3.50854236e+00],
       [-1.19463546e+00,  9.19427891e-01,  2.71628399e-01],
       [-2.34471526e-01, -8.80545740e-01,  2.71628399e-01],
       [-1.27128108e+00,  1.21977689e-02, -2.71853452e-01],
       [-9.45029641e-01,  1.59614263e+00,  4.75434093e-01],
       [-8.17435001e-01,  8.68656165e-02, -1.01914100e+00],
       [ 1.05955765e+00, -4.53415487e-01, -6.98874906e-01],
       [ 4.34845159e-01,  7.34430590e-01, -4.19188226e-02],
       [-1.39506881e+00, -8.05154036e-02, -1.65098088e-01],
       [-1.40706055e+00, -9.25280561e-01, -4.47685815e-01],
       [ 7.83493864e-01,  1.54447585e+00, -6.16755396e-01],
       [ 7.56782107e-01, -2.86449347e-01, -6.98874906e-01],
       [ 1.74422884e+00,  1.24304477e+00,  4.75434093e-01],
       [ 6.51584736e-01, -3.51711786e-01,  2.71628399e-01],
       [-7.56334236e-01, -1.36450810e+00, -6.45497224e-01],
       [ 4.11749959e-01, -8.16731858e-01, -2.20316380e-01],
       [ 1.03137165e-01, -3.04762921e-02,  1.29065687e+00],
       [-1.26728383e+00,  1.73392578e+00, -9.93372461e-01],
       [ 9.36848535e-01,  2.51900012e+00,  1.34726956e+00],
       [-1.10193742e+00, -1.00719695e+00, -8.32319111e-01],
       [ 1.72930355e-01, -2.88553534e-01,  1.15774011e+00],
       [-1.20415272e+00, -2.81680404e-01, -6.45497224e-01],
       [ 1.15530122e+00,  2.69885663e-01,  7.24529942e-01]])
```

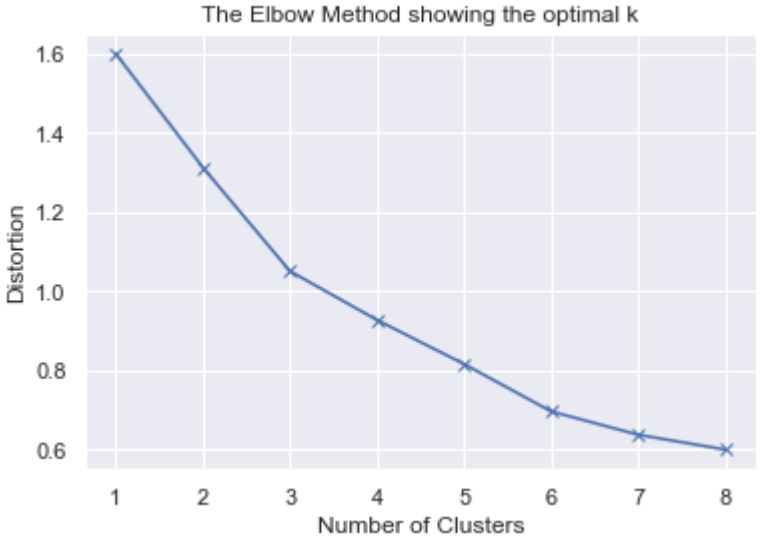
The Elbow method is now employed in order to determine the number of clusters. From the result it can be seen that we have 3 clusters.

In [293…
```
from sklearn.cluster import KMeans
from sklearn import metrics
from scipy.spatial.distance import cdist
import numpy as np


distortions = []
K = range(1,9)
for k in K:
    kmeanModel = KMeans(n_clusters=k).fit(df_clusters)
    kmeanModel.fit(df_clusters)
    distortions.append(sum(np.min(cdist(df_clusters, kmeanModel.cluster_centers_, 'eucl
```

```
# Plot the elbow
plt.plot(K, distortions, 'bx-')
plt.xlabel('Number of Clusters')
plt.ylabel('Distortion')
plt.title('The Elbow Method showing the optimal k')
plt.show()
```

```
C:\Users\User\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:881: UserWarning: K
Means is known to have a memory leak on Windows with MKL, when there are less chunks tha
n available threads. You can avoid it by setting the environment variable OMP_NUM_THREAD
S=1.
  warnings.warn(
C:\Users\User\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:881: UserWarning: K
Means is known to have a memory leak on Windows with MKL, when there are less chunks tha
n available threads. You can avoid it by setting the environment variable OMP_NUM_THREAD
S=1.
  warnings.warn(
```



In [284…

```
# import k-means from clustering stage
from sklearn.cluster import KMeans
# set number of clusters
kclusters = 3

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

# check cluster labels generated for each row in the dataframe
kmeans.labels_[0:34]
```

Out[284…

```
array([1, 2, 0, 0, 2, 1, 2, 2, 2, 2, 1, 0, 1, 2, 1, 1, 1, 2, 0, 1, 1, 0,
       2, 0, 2, 1, 2, 0, 1, 0, 1, 0, 1, 0])
```

In [285…

```
df_core.insert(0, 'Cluster Labels', kmeans.labels_) #insert the cluster values for nieg
df_core = df_core.reset_index() # reset the indices
del df_core['index']
df_core.head()
```

Out[285…

Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Numb Restaura

	Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Numb Restaura
0	1	Andersonville	41.981724	-87.672123	76.489	5979	21264	3	
1	2	Beverly	41.716645	-87.688542	106.744	11844	5162	0	
2	0	Bucktown	41.979512	-87.702463	114.647	17313	12444	4	
3	0	East Ukrainian Village	41.899629	-87.676646	101.865	7238	28622	4	
4	2	Edison Park	42.007178	-87.823215	98.098	11115	9899	2	

In [287…

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

Now, it has been created clusters and neighborhoods are labelled with them. It is time to create a map with these clusters. The following map is illustrating the clusters, where the radius of each marker is proportional to a number of restaurants per 1000 residents in each neighborhood. It can be easily realised that yellow cluster has less restaurants than others.

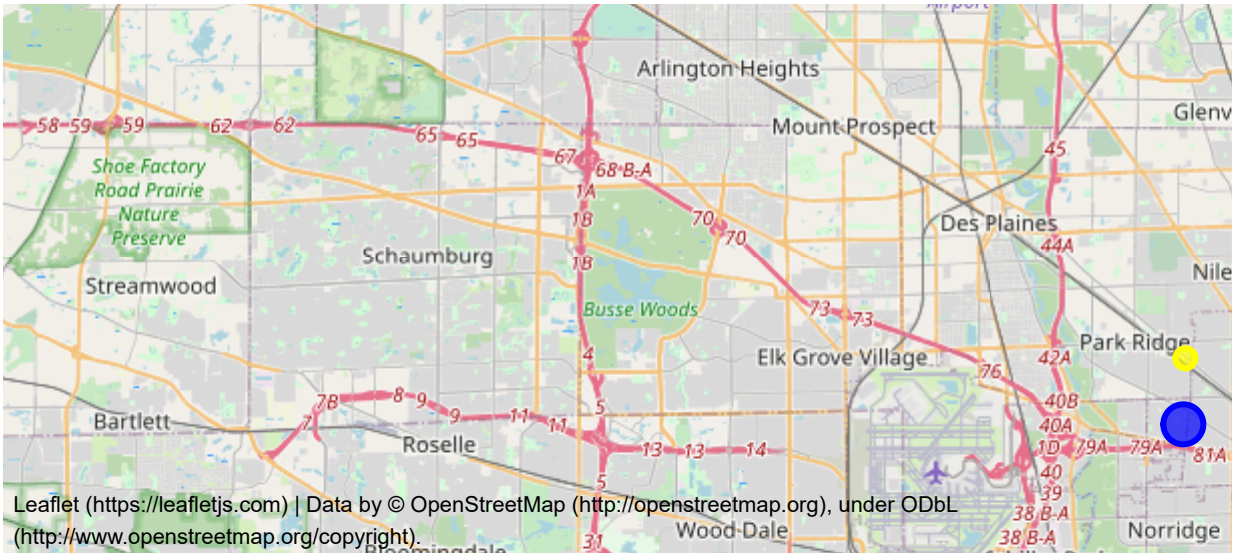
In [288…

```
# create map
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=11)
colours = ['red',  'blue', 'yellow']
# 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, ngbh, pop, cluster, nRest in zip(df_core['Latitude'], df_core['Longitude'
    label = folium.Popup(str(ngbh) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=nRest*2/pop*1000+1,
        popup=label,
        #color=rainbow[cluster-1],
        color=colours[cluster],
        fill=True,
        #fill_color=rainbow[cluster-1],
        fill_color=colours[cluster],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

Out[288…



The map could be recreated by using income distribution of neighborhoods. As it can seen that red cluster has more income than others. But yellow cluster has more income than blue cluster contrary to previus map.

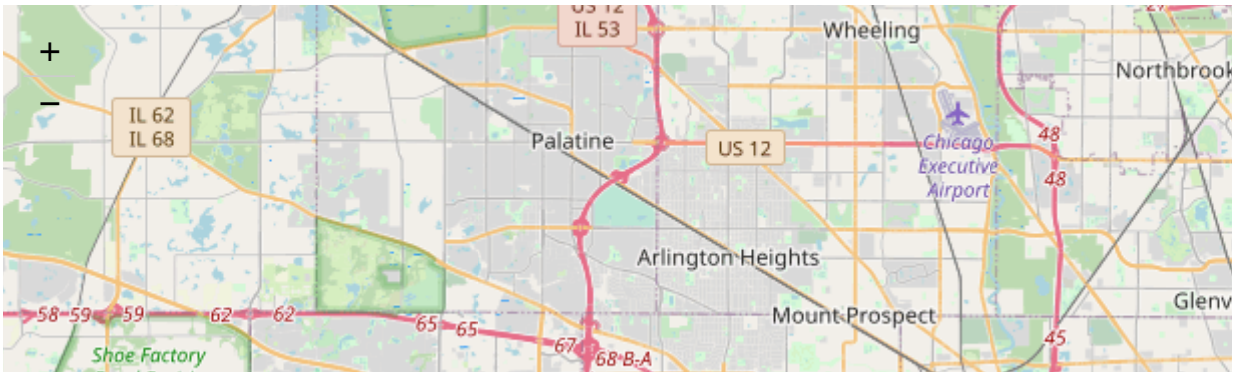
In [289…

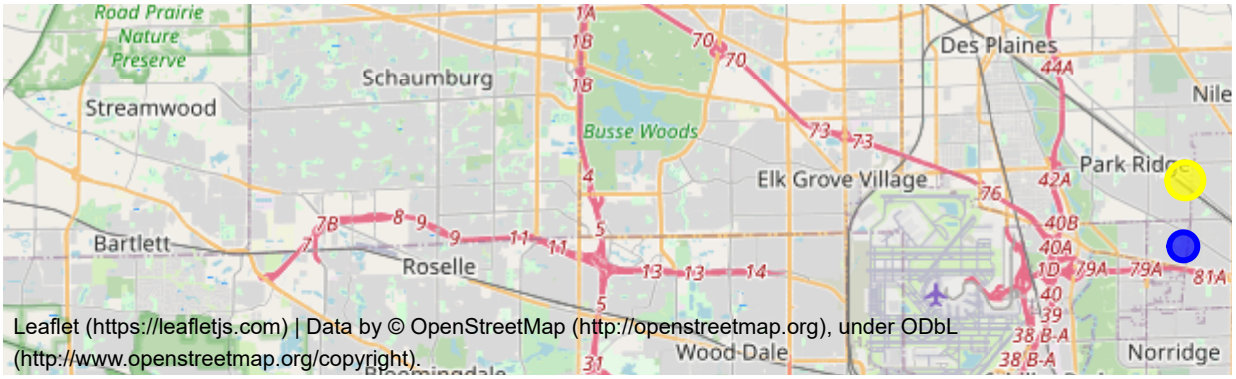
```
# create map
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=11)
colours = ['red',  'blue','yellow']
# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i + x + (i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

# add markers to the map
markers_colors = []
for lat, lon, ngbh, pop, cluster, income in zip(df_core['Latitude'], df_core['Longitude
    label = folium.Popup(str(ngbh) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=income/10-1,
        popup=label,
        #color=rainbow[cluster-1],
        color=colours[cluster],
        fill=True,
        #fill_color=rainbow[cluster-1],
        fill_color=colours[cluster],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

Out[289…



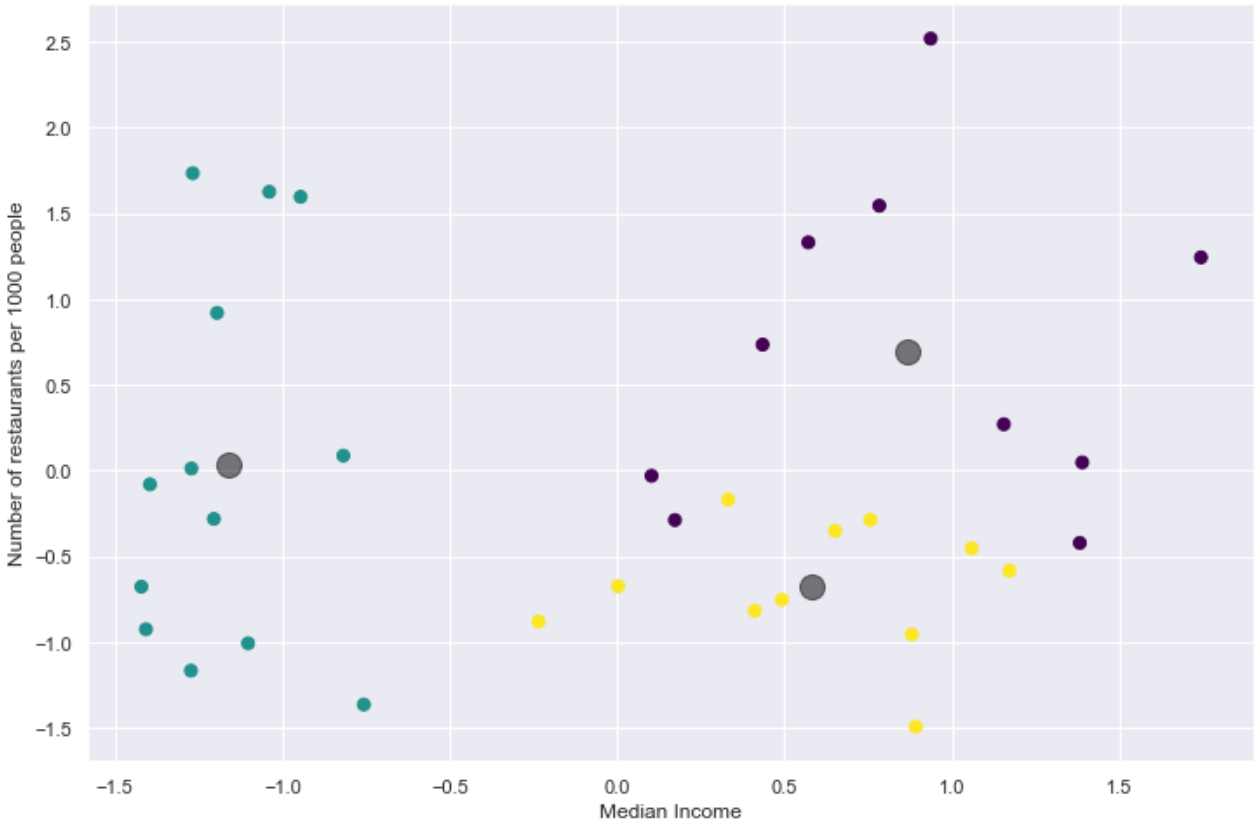


Although the map visualization is a good representation of the data, it is difficult to understand the relationships between three factors that we use to classify the neighborhoods. At his point it is better use scatter plots in order to get more insights. The grey circle marker is representing the centroid of each cluster. As a reminder the axis are normlaized and does not represent the real values.

In [294…

```
import matplotlib.pyplot as plt
y_kmeans = kmeans.predict(df_clusters)
plt.figure(figsize=[12,8])
plt.scatter(df_clusters[:, 0], df_clusters[:, 1], c=y_kmeans, s=50, cmap='viridis')

centers = kmeans.cluster_centers_
plt.scatter(centers[:, 0], centers[:, 1], c='black', s=200, alpha=0.5);
plt.xlabel('Median Income')
plt.ylabel('Number of restaurants per 1000 people')
plt.show()
```



The plot above indicates that the turquoise cluster on the left side has lower income than others

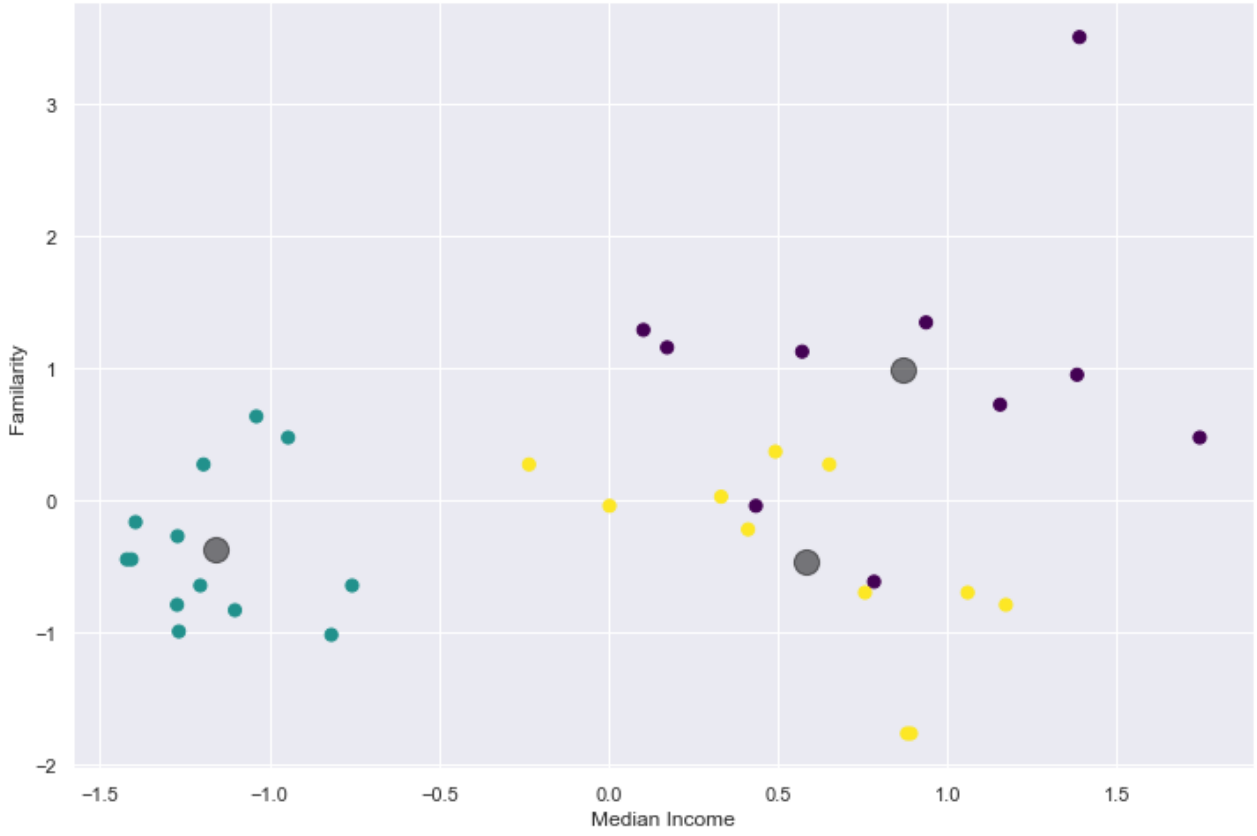
and there are more competition just above zero level of x-axis. Yellow cluster has more income than the turquoise cluster. But the competition is relatively lower than others. The high income and competition could be seen in the purple cluster.

The plot below conveys a little more information about the neighborhoods familiarity with Middle Eastern cuisine. Some neighborhoods in the turquoise have those type of restaurants. Similarly, few neighborhoods in yellow cluster has also experience with this type of foods. But most of the purple cluster have tasted more, relatively. New Eastside (at the top of familiarity measure) has the most familiarity with this cuisine.

In [295…

```
y_kmeans = kmeans.predict(df_clusters)
plt.figure(figsize=[12,8])
plt.scatter(df_clusters[:, 0], df_clusters[:, 2], c=y_kmeans, s=50, cmap='viridis')

centers = kmeans.cluster_centers_
plt.scatter(centers[:, 0], centers[:, 2], c='black', s=200, alpha=0.5);
plt.xlabel('Median Income')
plt.ylabel('Familarity')
plt.show()
```



In [221…

```
df_core[(df_core['Cluster Labels'] == 0)] # purple cluster
```

Out[221…

	Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Nu Restau
23	0	Bucktown	41.979512	-87.702463	114.647	17313	12444	4	

	Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Nur Restau
49	0	East Ukrainian Village	41.899629	-87.676646	101.865	7238	28622	4	
124	0	New Eastside	41.886604	-87.623659	114.760	6686	68753	4	
140	0	Old Town Triangle	41.915279	-87.642837	99.714	7483	18091	2	
161	0	River North	41.891607	-87.643057	105.209	8528	24847	2	
169	0	Sauganash	41.987970	-87.743066	120.351	7204	5637	3	
192	0	The Loop	41.882136	-87.629127	94.486	9027	9628	3	
214	0	West Loop Gate	41.880685	-87.645702	107.626	6107	21644	5	
220	0	Wicker Park	41.908865	-87.686177	95.586	11020	21742	3	
226	0	Wrightwood Neighbors	41.928982	-87.660545	111.069	9492	25227	3	

In [223…

```
df_core[(df_core['Cluster Labels'] == 1)] # turquoise cluster
```

Out[223…

	Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Nur Restau
2	1	Andersonville	41.981724	-87.672123	76.489	5979	21264	3	
65	1	Garfield Ridge	41.803332	-87.787256	72.802	25657	9367	1	
122	1	Near North	41.898952	-87.646386	70.468	21794	45636	2	
125	1	Noble Square	41.899770	-87.667449	74.032	8858	27458	3	
131	1	Norwood Park East	41.991071	-87.801077	72.824	12024	10177	2	
132	1	Norwood Park West	41.990206	-87.823849	77.966	6461	8233	3	
137	1	Old Irving Park	41.954618	-87.746242	79.977	11555	11052	1	
144	1	Park West	41.929186	-87.648481	70.873	11818	28675	2	
158	1	Ravenswood	41.968772	-87.702892	70.684	27788	19566	2	
182	1	South Loop	41.861421	-87.645011	80.940	31855	10765	1	
197	1	Ukrainian Village	41.899467	-87.686417	72.887	6004	23691	1	
218	1	West Town	41.892528	-87.671572	75.493	21574	10092	1	
225	1	Wrightwood	41.746408	-87.701315	73.882	9540	7838	1	

In [224…

```
df_core[(df_core['Cluster Labels'] == 2)] # yellow cluster
```

Out[224…

	Cluster Labels	Neighborhood	Latitude	Longitude	Income	Population	Population Density	Number of Middle Eastern Restaurant	Nur Restau
13	2	Beverly	41.716645	-87.688542	106.744	11844	5162	0	
55	2	Edison Park	42.007178	-87.823215	98.098	11115	9899	2	
67	2	Gold Coast	41.903015	-87.635797	111.337	13639	54227	1	
98	2	Lake View	41.946996	-87.669568	106.921	53042	23324	0	
103	2	Lincoln Park	41.921898	-87.668973	100.624	14410	21322	2	
120	2	Mount Greenwood	41.696868	-87.735257	92.909	16624	6963	2	
127	2	North Center	41.946887	-87.702608	89.165	17131	14101	2	
139	2	Old Town	41.907628	-87.637067	109.560	11269	37043	1	
166	2	Roscoe Village	41.943193	-87.693575	104.788	10048	22773	1	
174	2	Sheffield Neighbors	41.921299	-87.667658	103.130	10992	19865	2	
187	2	Streeterville	41.894653	-87.621749	99.350	21156	33871	2	

4. Results and discussion

This research, for the best place to enter the Chicago food industry with new restaurant investment by Food&Enjoy Corporations, provide many useful insights to construct concrete strategies. Chicago metropolitan area is big and has 228 neighborhoods. The area and the population of neighborhoods are challenging to analyze. The effort to to collect data results in many problems because the website for the statistics has no well defined area boundaries for neighborhoods. Therefore, it was required to manually data correction to built the dataframe. The tool of Selenium is a great way of getting dynamic data from interactive maps. Unfortunately, it is very sensitive to any intervention during the webscraping process.

Another problem has appeared when the necessary information from Foursquare API is searched. Since we are using freen version, we are limited to 100 venues per neighborhood. For small regions it can be enough, but for larger ones we are stucked with the limitation. Therefore, the search provide us with a limited number of venues and we could say the results could be improved with more information.

Food&Enjoy Entrepreneurship state that they would like to reach customers who give more value to the taste of foods rather than prices. For the new entrance they prefer nieghborhoods having more acquaintances to Middle Eastern foods. Besides these factors, they would like to be careful about the high competition. With respect to very intial constraints, we have decide to reduce the data set

so that all neighborhoods with income of less than 70K and with population of less than 5 thousands are excluded. Low population is prone to outliers and the residents with lower income would most probably not like to prefer Food&Enjoy's foods.

During the valuable research we have focused on 44 neighborhoods after the reduction. Consequently, three clusters were well defined according the prosperity of neighborhoods, the level of competition and the measure of familiarity to Middle Eastern flavors. It has been found that the turquoise cluster, above given, is not suitable since it has relatively lower income and three neighborhoods are familiar with the desired foods. The other two clusters, yellow and purple clusters, have both higher income levels. Purple cluster prefers more Middle Eastern foods than yellow cluster. But, there are at least three neighborhoods in yellow cluster with Middle Eastern restaurants.

In terms of competition, purple cluster is more competitive than yellow cluster. This indicates there are still rooms for new restaurants in yellow cluster. Although purple cluster scares the new investments, the region has been already familiar with the Food&Enjoy's flavors.

5. Conclusion

In conclusion, our data science analysis indicates that Food&Enjoy could invest either in yellow or purple cluster. It is advised to prefer neighborhoods with the Cook County, very center and attraction place of Chicago Metropolitan Area. As a reminder the room for new entrance is lower for purple cluster than yellow one. Unfortunately, the analysis is here very limited due the lack of information. Therefore, it would be wise to perform more research in these two candidate clusters.