The Battle of Neighborhoods

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1. Introduction

1.1 Background

Perth is the capital and largest city of the Australian state of Western Australian. Perth is one of the most successful diverse cities in the world, because of which, a rich variety of cuisines from different backgrounds has been adopted and developed. For example, even in a small neighborhood, you can find many different types of restaurants- Chinese, Italian, Indian, Mexican, Thai, Japanese……you name it! If you are passionate with business in food industry, like opening a restaurant, you might have to accept a reality- the competition is quite tough.

1.2 Problem

One of our clients, Mr. Romano who is an immigrant from Italy, has great passion in opening an Italian restaurant in Perth city center. But there are already so many restaurants in the city. Where is the best location to open an Italian restaurant?

1.3 Solution

In order to help Mr. Romano with the solution, we will use data science power to generate some promising neighborhoods. And then, he can choose one of them as the best location for business value. The locations we are looking for have to meet at least three criteria- as close to city center as possible, not already crowded with restaurants and without Italian restaurants in vicinity.

2. Data

2.1 Important factors and data sources

Based on the definition of the problem, factors that might impact our decision are:

- Number of the existing restaurants in the neighborhood
- Number of the existing Italian restaurants in the neighborhood
- Distance of the neighborhood from the city center

Following data sources will be needed to extract the required information:

- Centers of hexagon neighborhoods will be generated algorithmically and approximate address of centers of those areas will be obtained using 'geopy.geocoders'
- Restaurants data including number, type and location in every neighbohood will be obtained using Foursquare API
- Coordinate of Perth center will be obtained using 'geopy.geocoders'

2.2 Create neighborhood candidates

Before we create neighborhood candidates, we should first find the latitude and longitude of Perth city center, using well known address- Hay Street Mall and geopy.geocoders.

```
from geopy.geocoders import Nominatim
import requests

geolocator = Nominatim(user_agent="perth_explorer")

def get_coordinates(address, verbose=False):
    location = geolocator.geocode(address)
    lat = location.latitude
    lon = location.longitude
    return[lat, lon]

address = 'Hay Street Mall, Perth, Australia'
perth_center = get_coordinates(address)
print('Coordinate of {}: {}'.format(address, perth_center))

Coordinate of Hay Street Mall, Perth, Australia: [-31.9540732, 115.858585]
```

Figure 1

We discover that the latitude and longitude of Perth city center (Hay Street Mall) are -31.9540372 and 115.858585 (Figure 1).

Next, we will create a grid of neighbohood candidates, equally spaced, centered around city center and within ~6km from Hay Street Mall. Our neighborhoods will be defined as circular areas with a radius of 300 meters.To accurately calculate distances we need to create functions to convert between WGS84 spherical coordinate system (latitude/longitude degrees) and UTM Cartesian coordinate system (X/Y coordinates in meters). Then we'll project those coordinates back to latitude/longitude degrees to be shown on Folium map.

```python
perth_center_x, perth_center_y = lonlat_to_xy(perth_center[1], perth_center[0]) # City center in Cartesian coordinates

k = math.sqrt(3) / 2 # Vertical offset for hexagonal grid cells
x_min = perth_center_x - 6000
x_step = 600
y_min = perth_center_y - 6000 - (int(21/k)*k*600 - 12000)/2
y_step = 600 * k

latitudes = []
longitudes = []
distances_from_center = []
xs = []
ys = []
for i in range(0, int(21/k)):
    y = y_min + i * y_step
    x_offset = 300 if i%2==0 else 0
    for j in range(0, 21):
        x = x_min + j * x_step + x_offset
        distance_from_center = calc_xy_distance(perth_center_x, perth_center_y, x, y)
        if (distance_from_center <= 6001):
            lon, lat = xy_to_lonlat(x, y)
            latitudes.append(lat)
            longitudes.append(lon)
            distances_from_center.append(distance_from_center)
            xs.append(x)
            ys.append(y)

print(len(latitudes), 'candidate neighborhood centers generated.')
```
```
364 candidate neighborhood centers generated.
```

Figure 2

Figure 3

We observe that a grid of 364 candidate neighborhood centers generated (figure 2, figure 3). Then, we use the geopy.geocoders to get their approximate addresses (figure 4).

	Address	Latitude	Longitude	X	Y	Distance from center
0	Victoria Park Drive, Burswood, Town of Victori...	-31.952881	115.893766	8.136648e+06	-1.186607e+07	5992.495307
1	Victoria Park Drive, Burswood, Town of Victori...	-31.950053	115.892572	8.137248e+06	-1.186607e+07	5840.376700
2	Placid Avenue, Burswood, Town of Victoria Park...	-31.947225	115.891379	8.137848e+06	-1.186607e+07	5747.173218
3	Belmont Park Racecourse, Placid Avenue, Burswo...	-31.944397	115.890186	8.138448e+06	-1.186607e+07	5715.767665
4	Belmont Park Racecourse, Placid Avenue, Burswo...	-31.941569	115.888993	8.139048e+06	-1.186607e+07	5747.173218
5	St John of God Mt Lawley Hospital, Thirlmere R...	-31.938742	115.887800	8.139648e+06	-1.186607e+07	5840.376700
6	St John of God Mt Lawley Hospital, Thirlmere R...	-31.935914	115.886608	8.140248e+06	-1.186607e+07	5992.495307
7	Crown Perth, Bolton Avenue, Burswood, Town of ...	-31.958006	115.892682	8.135748e+06	-1.186555e+07	5855.766389
8	Roger Mackay Drive, Burswood, Town of Victoria...	-31.955177	115.891489	8.136348e+06	-1.186555e+07	5604.462508
9	Burswood, Town of Victoria Park, Western Austr...	-31.952348	115.890296	8.136948e+06	-1.186555e+07	5408.326913

Figure 4

2.3 Use Foursquare API to get restaurant data

By using Foursquare API to get information about the restaurants in each candidate neighborhood, we discover the following data:

- Total number of restaurants: 362
- Total number of Italian restaurants: 24
- Percentage of Italian restaurants: 6.63%
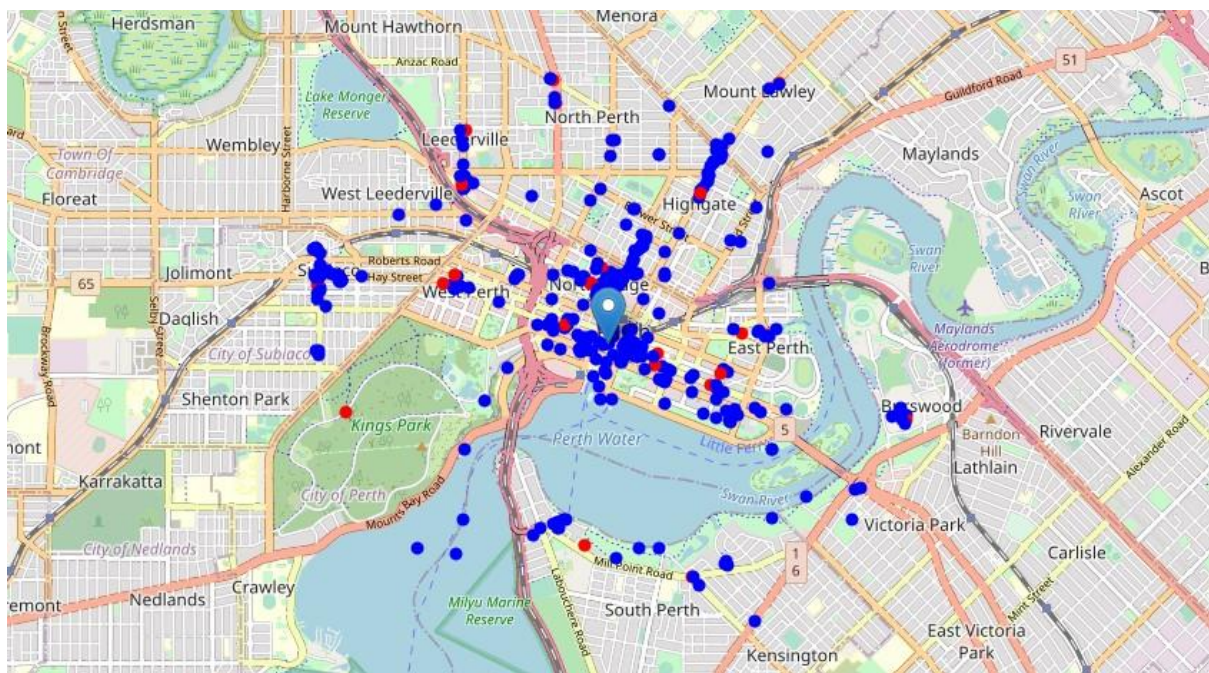- Average number of restaurants in neighborhood: 2.2747252747 (figure 5)

Figure 5. Italian restaurants in red and others in blue

3. Methodology

So far, we have discovered the location and type of each restaurant within 6km from Perth center. We also have identified Italian restaurants. In the next step, we will explore 'restaurant density' within the candidate area in order to find out some promising areas which are close to Perth center with low number of restaurants and no Italian restaurants in vicinity. In the final step, we will create clusters

of locations which meet the criteria- no more two restaurants in radius of 250 meters, and no Italian restaurants in radius of 400 meters.

First, we will count the number of restaurants in each area candidate, calculate the distance to nearest Italian restaurant from each area candidate center (figure 6), and create a map showing density of restaurants (figure 7).

	Address	Latitude	Longitude	X	Y	Distance from center	Restaurants in area	Distance to Italian restaurant
0	Victoria Park Drive, Burswood, Town of Victori...	-31.952881	115.893766	8.136648e+06	-1.186607e+07	5992.495307	0	1748.047741
1	Victoria Park Drive, Burswood, Town of Victori...	-31.950053	115.892572	8.137248e+06	-1.186607e+07	5840.376700	0	2330.409339
2	Placid Avenue, Burswood, Town of Victoria Park...	-31.947225	115.891379	8.137848e+06	-1.186607e+07	5747.173218	0	2609.697278
3	Belmont Park Racecourse, Placid Avenue, Burswo...	-31.944397	115.890186	8.138448e+06	-1.186607e+07	5715.767665	0	2747.771503
4	Belmont Park Racecourse, Placid Avenue, Burswo...	-31.941569	115.888993	8.139048e+06	-1.186607e+07	5747.173218	0	3001.662302
5	St John of God Mt Lawley Hospital, Thirlmere R...	-31.938742	115.887800	8.139648e+06	-1.186607e+07	5840.376700	0	2696.851827
6	St John of God Mt Lawley Hospital, Thirlmere R...	-31.935914	115.886608	8.140248e+06	-1.186607e+07	5992.495307	0	2117.203158
7	Crown Perth, Bolton Avenue, Burswood, Town of ...	-31.958006	115.892682	8.135748e+06	-1.186555e+07	5855.766389	1	780.028072
8	Roger Mackay Drive, Burswood, Town of Victoria...	-31.955177	115.891489	8.136348e+06	-1.186555e+07	5604.462508	0	1379.703075
9	Burswood, Town of Victoria Park, Western Austr...	-31.952348	115.890296	8.136948e+06	-1.186555e+07	5408.326913	0	1979.575045

figure 6 (above), figure 7 (below)

after that, we need to filter the locations that meet our criteria- no more two restaurants in radius of 250 meters, and no Italian restaurants in radius of 400 meters. We have discovered 1722 locations with no more than two restaurants nearby, 1797 locations with no Italian restaurants within 400meters and 1510 locations with both conditions met.

```python
good_res_count = np.array((df_roi_locations['Restaurants nearby']<=2))
print('Locations with no more than two restaurants nearby:', good_res_count.sum())

good_ita_distance = np.array(df_roi_locations['Distance to Italian restaurant']>=400)
print('Locations with no Italian restaurants within 400m:', good_ita_distance.sum())

good_locations = np.logical_and(good_res_count, good_ita_distance)
print('Locations with both conditions met:', good_locations.sum())

df_good_locations = df_roi_locations[good_locations]
```

```
Locations with no more than two restaurants nearby: 1722
Locations with no Italian restaurants within 400m: 1797
Locations with both conditions met: 1510
```

figure 7

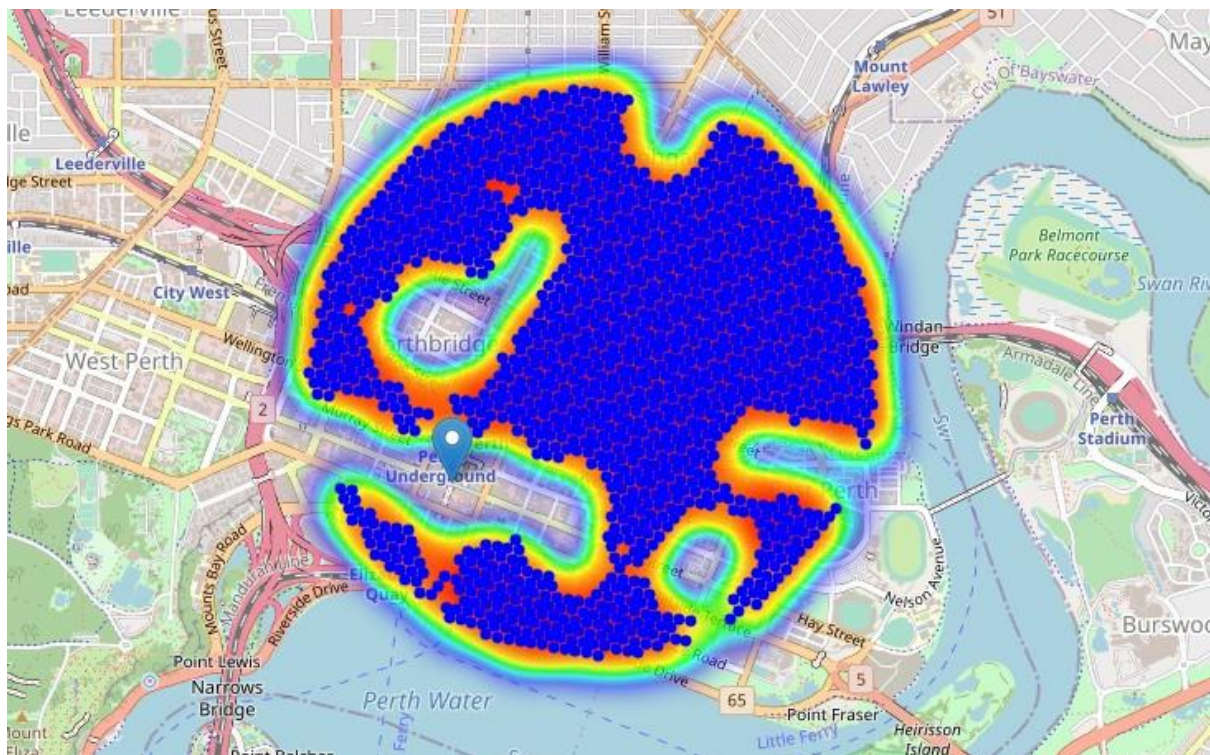The following map (figure 8) shows those potential locations.

figure 8

Next, we will cluster those locations to create centers of zones containing good locations. Those zones, their centers and addresses will be the final result of our analysis (figure 9).
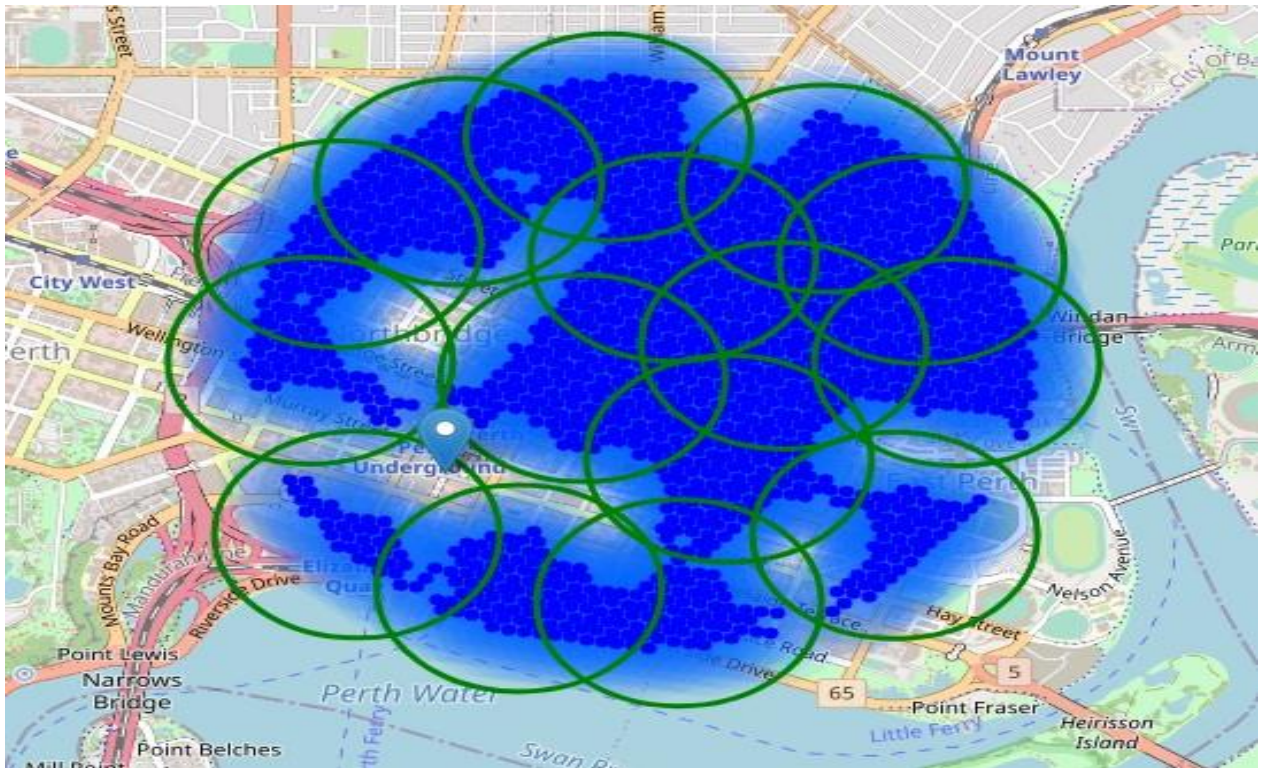

figure 9

Finaly, let's get the addresses of the centers of those zones, which can be presented to the client (figure 10) and the map shows those zones (figure 11).


```
============================================================
Addresses of centers of areas recommended for further analysis
============================================================


Traffic Police, Bronte Street, East Perth, Perth, City of Perth, Western Australia, 6004 => 2.9km from Hay Streeet Mall
238, Brisbane Street, Perth, City Of Vincent, Western Australia, 6003 => 2.6km from Hay Streeet Mall
Tully Road, East Perth, Perth, City of Perth, Western Australia, 6004 => 3.4km from Hay Streeet Mall
The Emperors Crown Backpackers, 85, Stirling Street, Perth, City Of Vincent, City of Perth, Western Australia, 6000 => 1.2km from Hay Stre
eet Mall
Governors Avenue, Perth, City of Perth, Western Australia, 6000 => 1.1km from Hay Streeet Mall
Wright Street, Highgate, City Of Vincent, Western Australia, 6050 => 3.5km from Hay Streeet Mall
Northbridge Tunnel (West Bound), Aberdeen Street, Perth, City of Perth, Western Australia, 6003 => 2.1km from Hay Streeet Mall
Youth With A Mission, Gladstone Street, Perth, City Of Vincent, Western Australia, 6004 => 2.4km from Hay Streeet Mall
William Street after Glendower Street, William Street, Perth, City Of Vincent, Western Australia, 6006 => 3.1km from Hay Streeet Mall
Wittenoom Street, East Perth, Perth, City of Perth, Western Australia, 6004 => 1.8km from Hay Streeet Mall
Street lamp, Geoffrey Bolton Way, Perth, City of Perth, Western Australia, 6000 => 0.8km from Hay Streeet Mall
Old Milligan Street, Perth CityLink, Perth, City of Perth, Western Australia, 6000 => 1.3km from Hay Streeet Mall
Stirling Street, Perth, City Of Vincent, Western Australia, 6003 => 2.4km from Hay Streeet Mall
Greyhound Coaches, Midland PSP, East Perth, City Of Vincent, Western Australia, 6004 => 3.6km from Hay Streeet Mall
Hill Street, Perth, City of Perth, Western Australia, 6004 => 1.9km from Hay Streeet Mall
```

figure 10

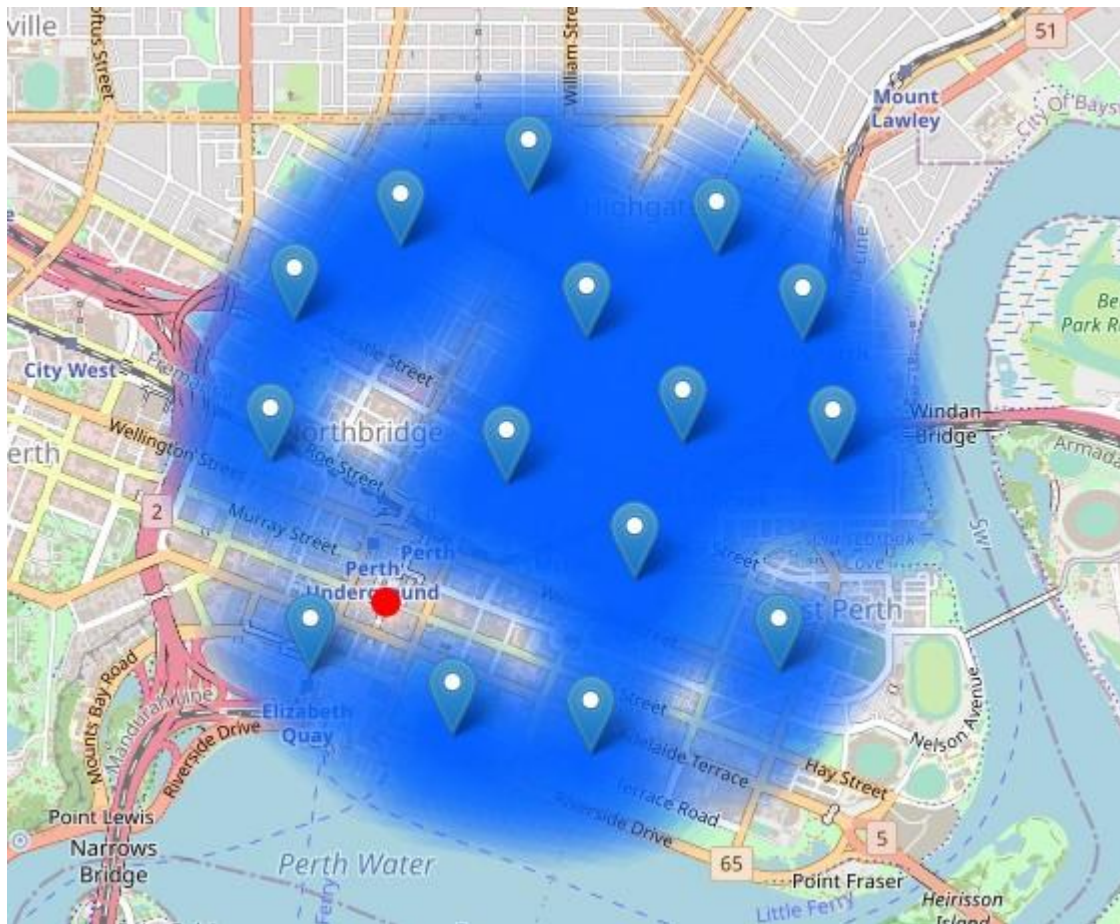figure 11

4. Results and Discussion

Our analysis shows that although there is a great number of restaurants in Perth. There are pockets of low restaurant density fairly close to city center. Highest concentration of restaurants was detected west from Hay Street Mall, so we focused our attention to areas north and east.

After focusing our attention on this more narrow area of interest we first created a dense grid of location candidates (spaced 100m appart). And then, we filter the locations that meet our criteria- no more two restaurants in radius of 250 meters, and no Italian restaurants in radius of 400 meters. We have discovered 1722 locations with no more than two restaurants nearby, 1797 locations with no Italian restaurants within 400meters and 1510 locations with

both conditions met. Next, we cluster those locations to create centers of zones containing good locations. Those zones, their centers and addresses will be the final result of our analysis. Finaly, we get the addresses of the centers of those zones, which can be presented to the client. Result of all this is 15 zones containing largest number of potential new restaurant locations based on number of and distance to existing venues. Recommended zones should be considered only as a starting point for more detailed analysis because other factors need to be taken into account.

5. Conclusion

Purpose of this project was to discover neighborhoods close to Perth center (Hay Street Mall) with low number of restaurants (particularly Italian restaurants) in order to help our client in narrowing down the search for optimal location for a new Italian restaurant.

We first use 'geopy.geocoders' to generate centers of hexagon neighborhoods and approximate address of centers of those areas. And then use Foursquare API to obtain restaurants data including number, type and location in every neighbohood. Result of all this is 15 zones containing largest number of potential new restaurant locations based on number of and distance to existing venues.

Final decision on optimal restaurant location will be made by our client based on specific characteristics of neighborhoods and locations in every recommended zone, taking into consideration additional factors like levels of noise, real estate availability, prices, social and economic dynamics etc.