

Hanoi Population density and Wards clustering

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Introduction – Problem description

- Most of the economic and social activities are taking place in the urban area of the city. In the recent years, more and more restaurants and store chains have chosen Hanoi as their next destination. Usually when investors come, there are two important questions that they want to seek answers to:
 - Where to open the first restaurant/shop?
 - Where will be the next locations after the first successful one?
- Population density by district might be a good answer to the first question while location similarity in terms of popular venues can help answer the second one.
- In this capstone project, I try to collect, analyze and visualize public data found on the internet using maps, charts and utilizing Foursquare API as well as clustering technique to help the investors make right decision.

Methodology

- First, 2nd and 3rd level Geo shapefiles for Hanoi city collected from GADM website. This data is used for displaying maps and calculating the area as well as the center (geo centroid) of the wards
- Area, population and population density collected from Hanoi committee website for creating population density map
- Utilizing Foursquare API to get most common venues to be used for clustering with searching radius is set differently, depending on ward area
- Applying Kmeans algorithm to cluster the wards

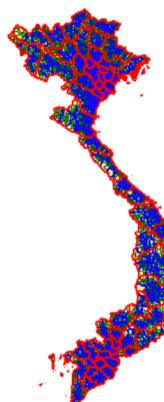
Data collection and preparation

Download GADM data (version 3.6)

Country

[Geopackage](#)
[Shapefile](#)

R (sp): [level-0](#), [level1](#), [level2](#), [level3](#)
 R (sf): [level-0](#), [level1](#), [level2](#), [level3](#)
 KMZ: [level-0](#), [level1](#), [level2](#), [level3](#)



The coordinate reference system is [longitude/latitude](#) and the [WGS84](#) datum.

ENGTYPE_2	geometry	District	Urban	Area	Avg_Population	Population_density	Wards
1	Urban District POLYGON ((105.72945 21.05656, 105.72884 21.056... Bac Tu Liem	1	45.32	333.7	7363	13	
2	Urban District POLYGON ((105.80135 21.03023, 105.80577 21.035... Ba Dinh	1	9.21	243.2	26406	14	
3	District MULTIPOLYGON (((105.46503 21.07101, 105.46525 ... Ba Vi	0	423.00	284.1	672	30	
4	Urban District POLYGON ((105.81349 21.00882, 105.81209 21.007... Cau Giay	1	12.32	280.5	22768	8	
5	District POLYGON ((105.57925 20.91554, 105.58212 20.912... Chuong My	0	237.38	332.8	1402	30	
6	Urban District POLYGON ((105.81349 21.00882, 105.80473 21.015... Dong Da	1	9.95	422.1	42422	21	
7	District POLYGON ((105.71733 21.07171, 105.70901 21.073... Dan Phuong	0	78.00	164.2	2015	15	
8	District POLYGON ((105.84167 21.08116, 105.83591 21.085... Dong Anh	0	185.62	384.7	2073	23	
9	District POLYGON ((105.96449 20.96341, 105.96065 20.963... Gia Lam	0	116.71	277.2	2375	20	

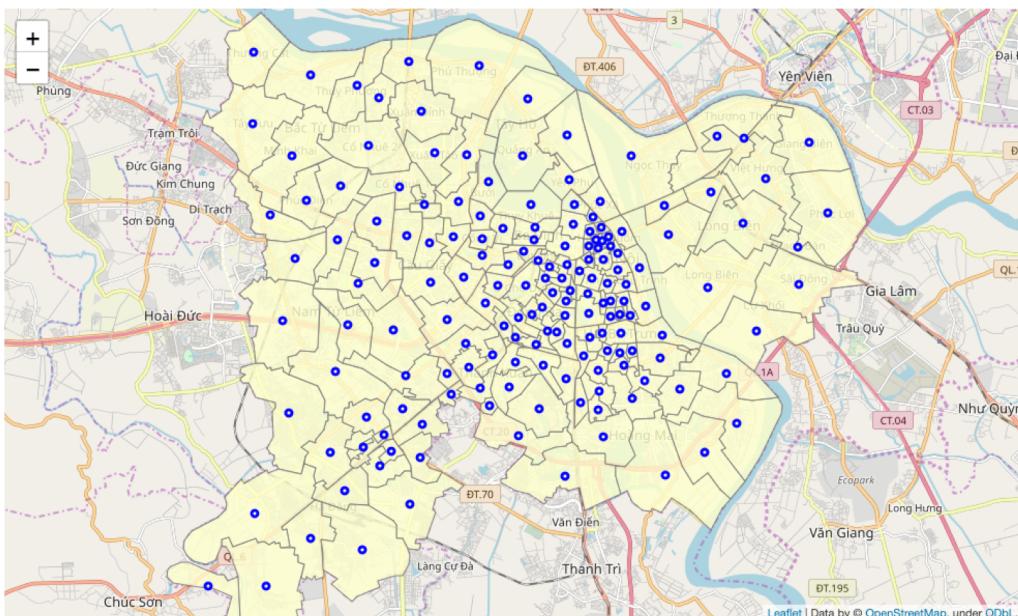
16 Diện tích, dân số, mật độ dân số và đơn vị hành chính năm 2018 phân theo đơn vị hành chính

Area, population, population density and administrative units 2018 by district

Đơn vị hành chính (Administrative units)	Diện tích Area (Km ²)	Dân số trung bình (1000 ng) Average Population (Thous. Pers.)	Mật độ dân số (Người/km ²) Population density (Person/km ²)	Phường/Xã Precincts, communes	Thị trấn Town under district
	TỔNG SỐ - TOTAL	3358,59	7852,6	2338	563 21
Ba Đình	9,21	243,2	26406	14	-
Hoàn Kiếm	5,29	153,0	28922	18	-
Tây Hồ	24,39	166,8	6839	8	-
Long Biên	59,82	294,5	4923	14	-
Cầu Giấy	12,32	280,5	22768	8	-
Đống Đa	9,95	422,1	42422	21	-
Hai Bà Trưng	10,26	311,8	30390	20	-
Hoàng Mai	40,32	443,6	11002	14	-
Thanh Xuân	9,09	286,7	31540	11	-
Sóc Sơn	304,76	341,1	1119	25	1
Đông Anh	185,62	384,7	2073	23	1
Gia Lâm	116,71	277,2	2375	20	2
Nam Từ Liêm	32,19	240,9	7484	10	-
Thanh Trì	63,49	266,5	4198	15	1
Bắc Từ Liêm	45,32	333,7	7363	13	-
Mê Linh	142,46	228,5	1604	16	2
Hà Đông	49,64	353,2	7115	17	-
Sơn Tây	117,43	151,3	1288	15	-
Ba Vì	423,00	284,1	672	30	1

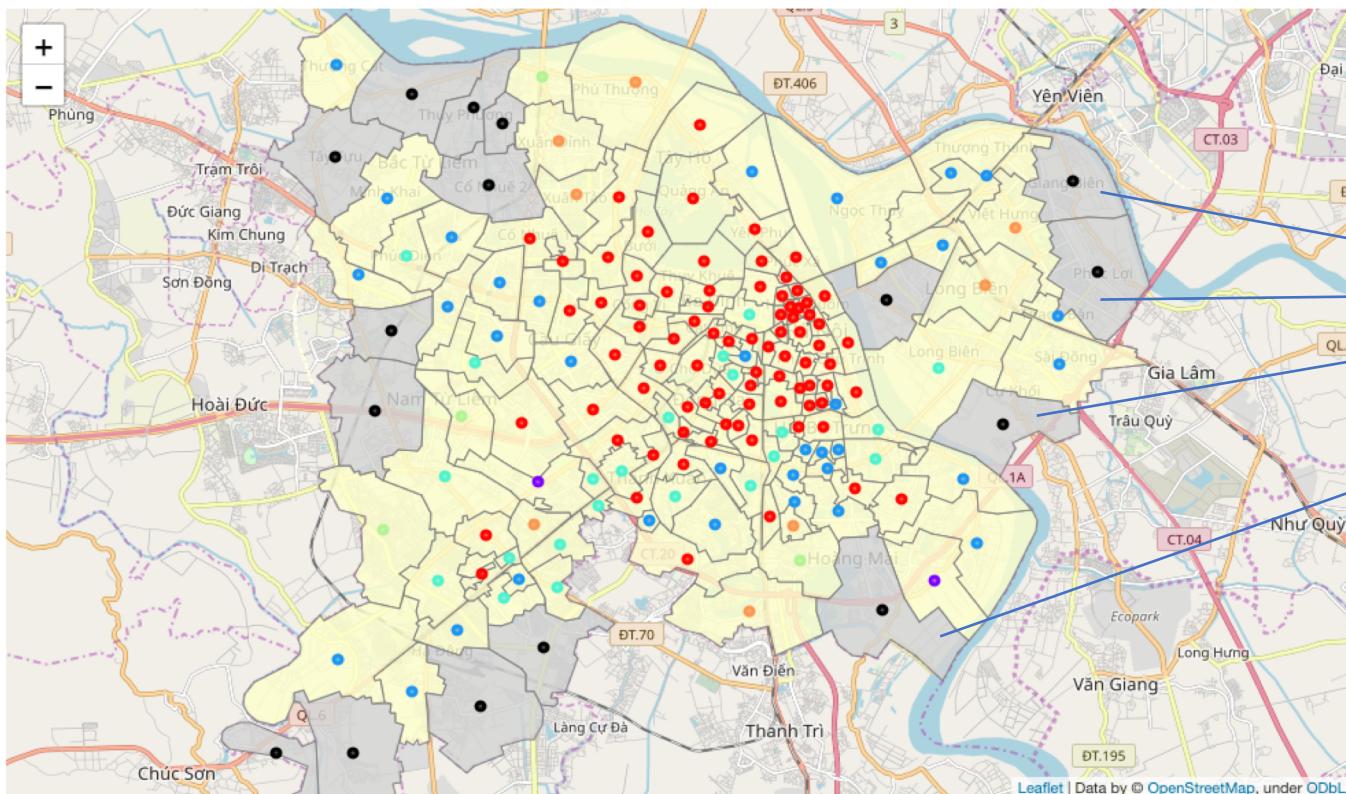
Data collection and preparation

```
# To use Foursquare API, we need a latitude and longitude for each ward  
# the centroid of each ward polygon is a good start  
uhanoi_gdf['Latitude'] = uhanoi_gdf['geometry'].centroid.y  
uhanoi_gdf['Longitude'] = uhanoi_gdf['geometry'].centroid.x
```



168 urban wards with corresponding centers calculated by python geometry.centroid.y and geometry.centroid.x

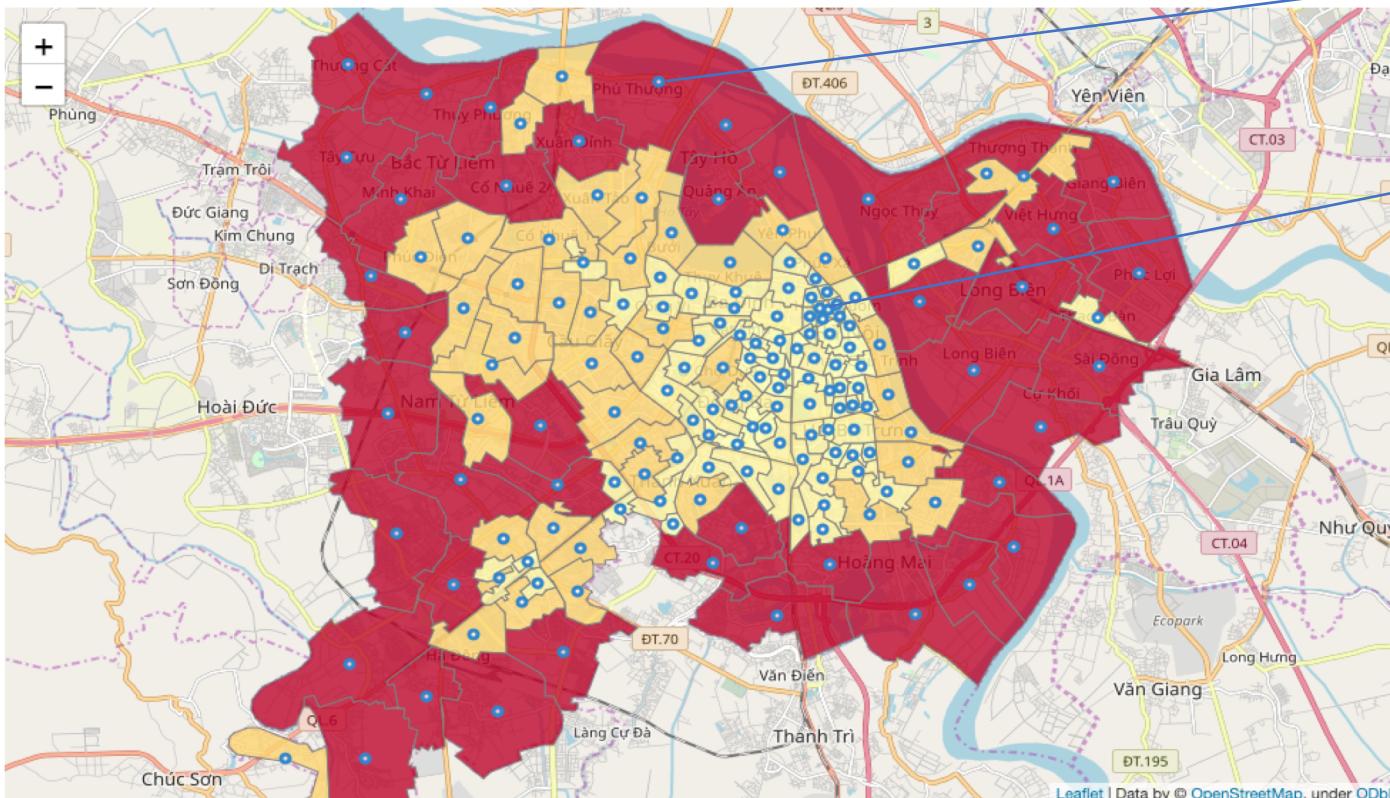
Data collection and preparation



16 “grey” wards with no nearby venues returned by Foursquare when searching radius set to 500m

Using Foursquare API with fixed searching radius is not good for all the wards with very different areas

Data collection and preparation



Largest ward
Phu Thuong: 7.47 sq. km

Smallest wards
Hang Bac, Hang Dao: 0.06 sq. km

=> Use different searching radius for each ward center

```
def getRadius(quant, area):
    if area <= quant.index[0]:
        return 300
    if area <= quant.index[1]:
        return 500
    if area <= quant.index[2]:
        return 800
    if area <= quant.index[3]:
        return 1500
    else: return 2000
```

Utilizing Foursquare API

	Ward	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Bach Dang	Vietnamese Restaurant	Coffee Shop	Café	Noodle House	Japanese Restaurant	Hotel	Sushi Restaurant	Restaurant	Tea Room	Comic Shop
1	Bach Khoa	Coffee Shop	Café	Vietnamese Restaurant	Bus Station	BBQ Joint	Fast Food Restaurant	Halal Restaurant	Bakery	Sushi Restaurant	Bubble Tea Shop
2	Bach Mai	Fast Food Restaurant	Halal Restaurant	Dessert Shop	Asian Restaurant	Vietnamese Restaurant	Café	Coffee Shop	Food	Fishing Spot	Flea Market
3	Bien Giang	Hotpot Restaurant	Vietnamese Restaurant	Zoo	Event Space	Food Truck	Food Service	Food Court	Food & Drink Shop	Food	Flower Shop
4	Bo De	Vietnamese Restaurant	Hotel	Coffee Shop	Café	Ice Cream Shop	Lounge	Vegetarian / Vegan Restaurant	Cocktail Bar	Fast Food Restaurant	Gastropub

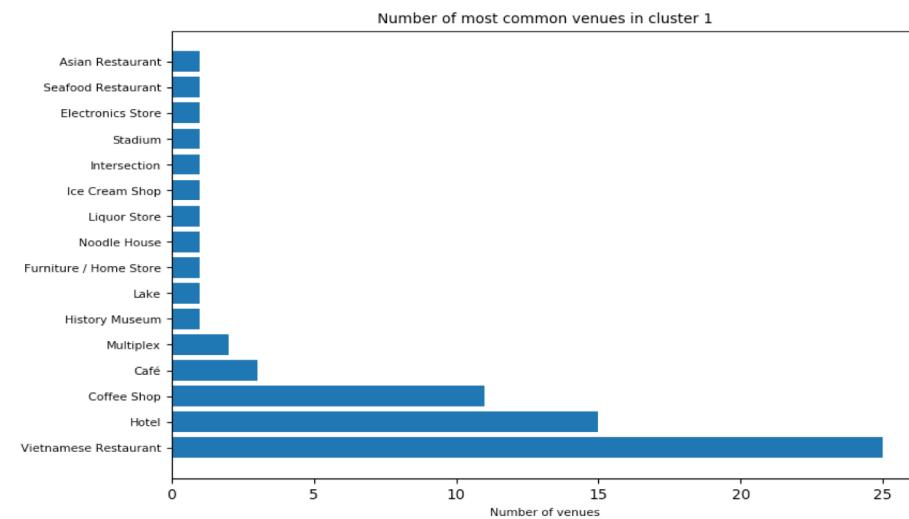
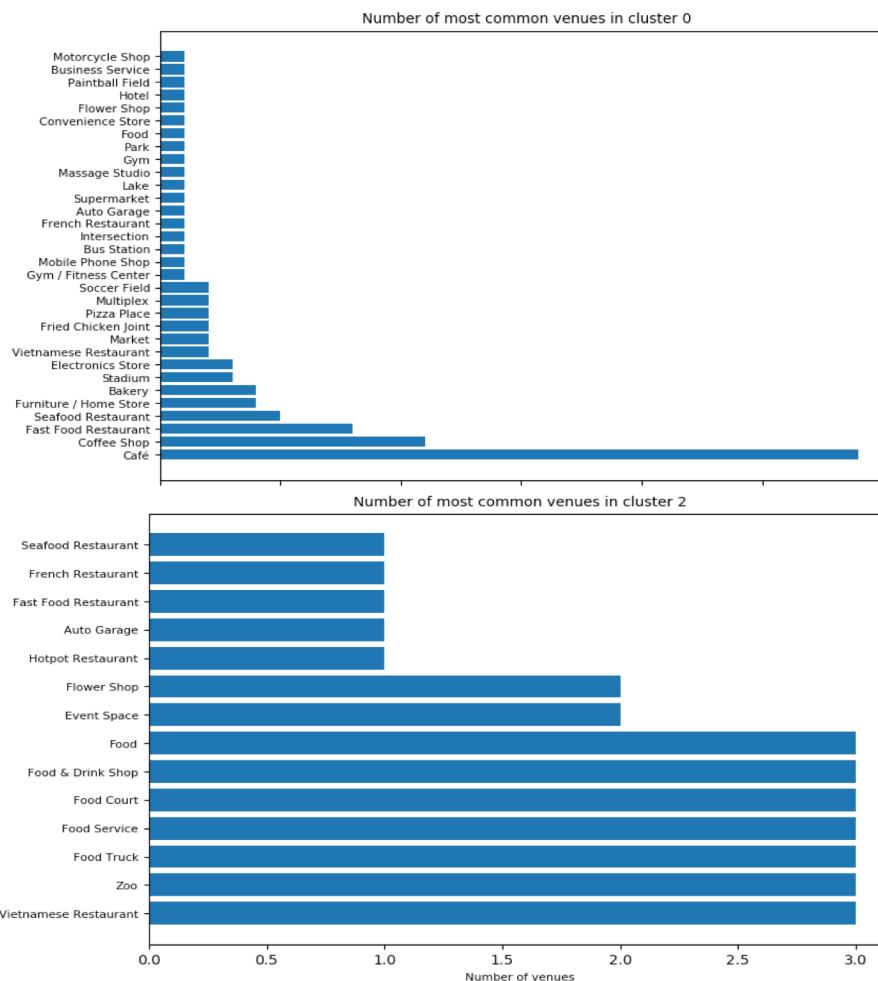
Venue Limit = 100

Total: 4,507 venues in 210 unique categories

Venues was sorted into 10 most common venue for each of the 168 wards

This data is used by Kmeans to cluster the wards into different groups

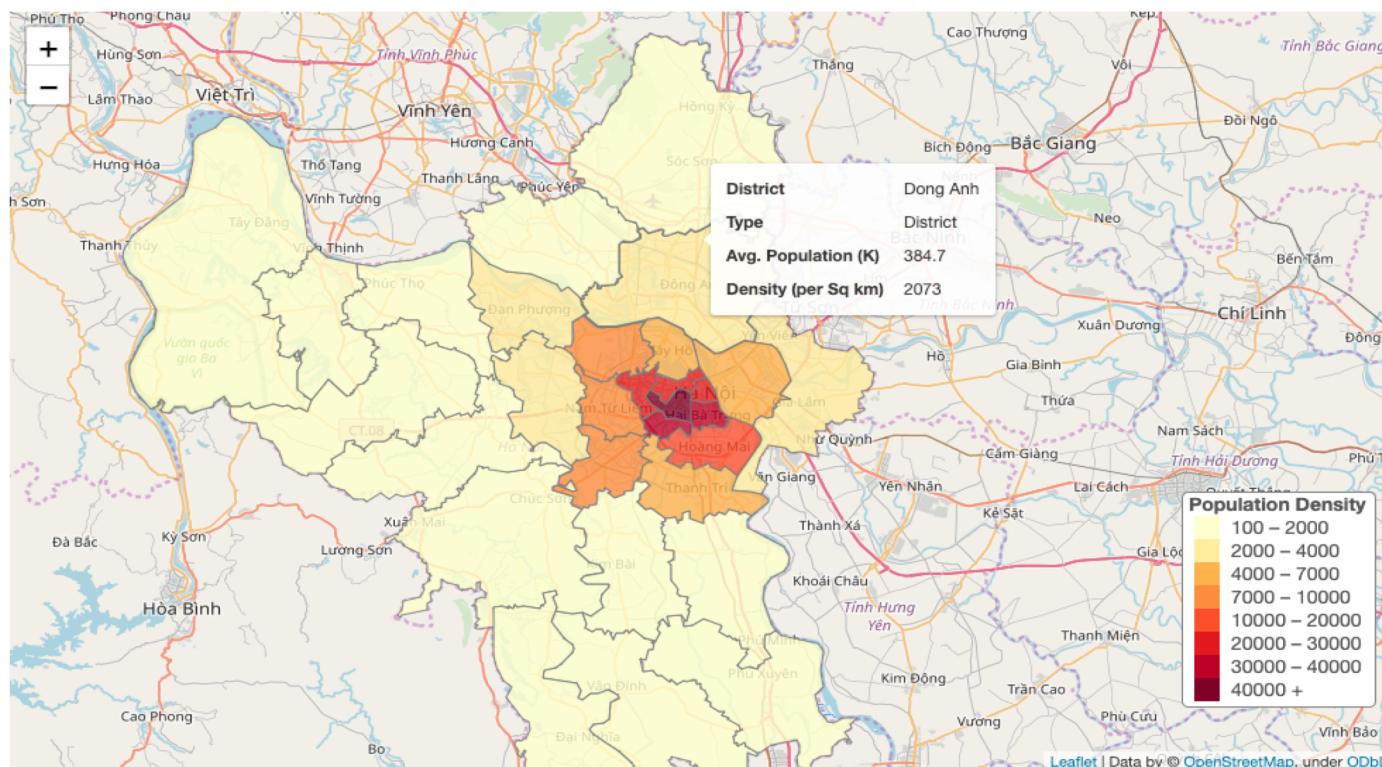
Applying Kmeans algorithm



168 wards were clustered into 3 groups:

- Cluster 0: Café, Coffee Shops, Fast Food, Stores
- Cluster 1: Restaurant, Hotel, Coffee Shops
- Cluster 2: Outing Places

Result maps – population density



Population density by district

- More than 40,000: Dong Da
- 30,000 - 40,000: Hai Ba Trung, Thanh Xuan
- 20,000 - 30,000: Ba Dinh, Hoan Kiem, Cau Giay
- 10,000 - 20,000: Hoang Mai
- 70,000 - 10,000: Bac Tu Liem, Nam Tu Liem, Ha Dong
- 4,000 - 7,000: Tay Ho, Long Bien, Thanh Tri
- Less than 4,000: the rest

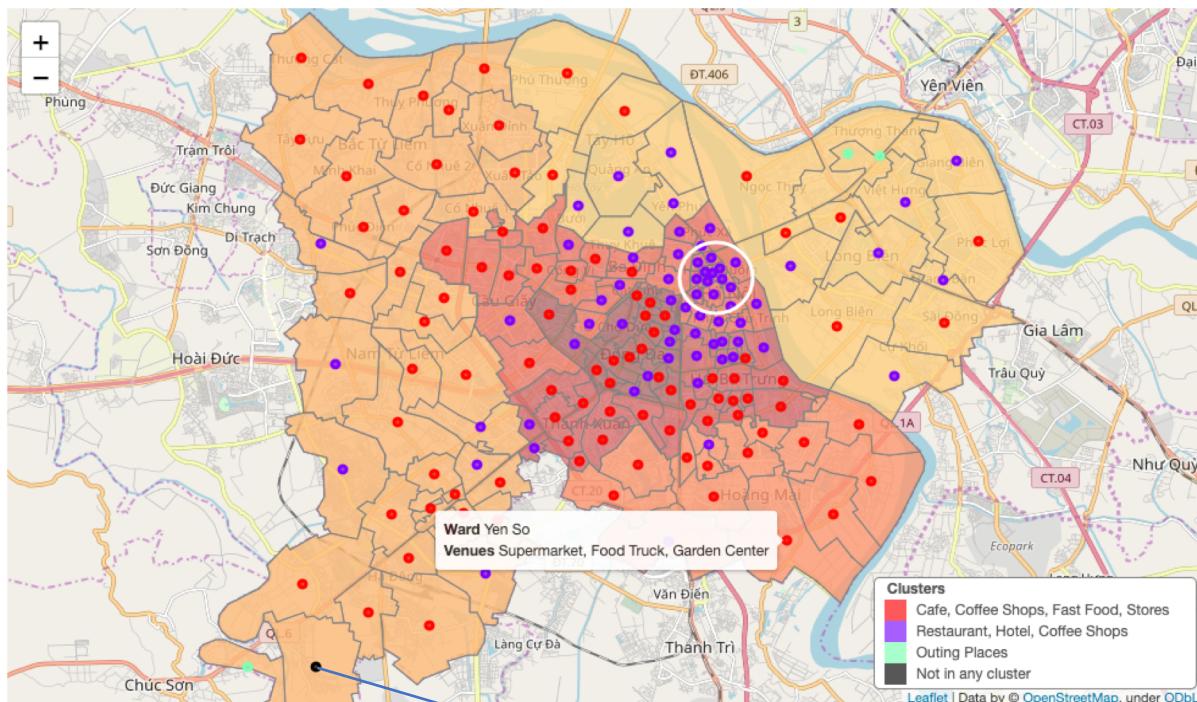
Results

- The map shows that more than half of the districts in Hanoi have fairly low population density of less than 2,000 people per square kilometer.
- There's only one suburban district - Thanh Tri - that has the density comparable to those of some urban districts.

Results

- The districts can be categorized into different groups based on population density as follows:
 - More than 40,000: Dong Da
 - 30,000 - 40,000: Hai Ba Trung, Thanh Xuan
 - 20,000 - 30,000: Ba Dinh, Hoan Kiem, Cau Giay
 - 10,000 - 20,000: Hoang Mai
 - 70,000 - 10,000: Bac Tu Liem, Nam Tu Liem, Ha Dong
 - 4,000 - 7,000: Tay Ho, Long Bien, Thanh Tri
 - Less than 4,000: the rest
- When an investor comes, depending on the business, he can consider to choose the districts in each of the group above.

Result maps – Wards clustering



3 clusters:

- Cluster 0 (red): Café, Coffee Shops, Fast Food, Stores
- Cluster 1 (purple): Restaurant, Hotel, Coffee Shops
- Cluster 2 (green): Outing Places

Not in any cluster
Foursquare return no data
even with radius = 2km

Results

- The map clearly shows two dominant clusters - purple and red and a small cluster - green
- The purples are places with high-end restaurants, hotels and coffee shops while the red ones have many Fast food and Café.
- Most of the purples are in small wards in the center of Hanoi (close to the old quarter - the white circle in the map) where the population is much denser, where many visitors come and stay and where there are many office buildings and shopping streets located.
- The red ones are located further to the west and south from the center, to the direction that the city has been expanded during the last few years.
- The third cluster (light greens) includes wards at the edge of the urban area. Those wards are less densely populated, close to the rivers and suitable for outdoor events.
- There is one ward shown at the bottom left of the map - Dong Mai - with the center colored in black as Foursquare returned no common venue for it, even with the searching radius set to 2km. This shows that choosing appropriate value of searching radius is very important for the analysis.

Discussion

- Population statistics is not updated (since 2018) though population of districts in Hanoi change rapidly
- Foursquare updates database continuously, the clusters and maps will change regularly => need method to automatically choose number of cluster, assign appropriate labels and create maps
- Elbow was unclear with the dataset => further investigate BIC and SSE methods

Thank you!