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 will 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

Vietnam

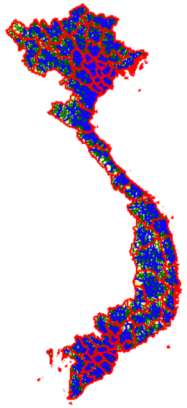
Geopackage

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.

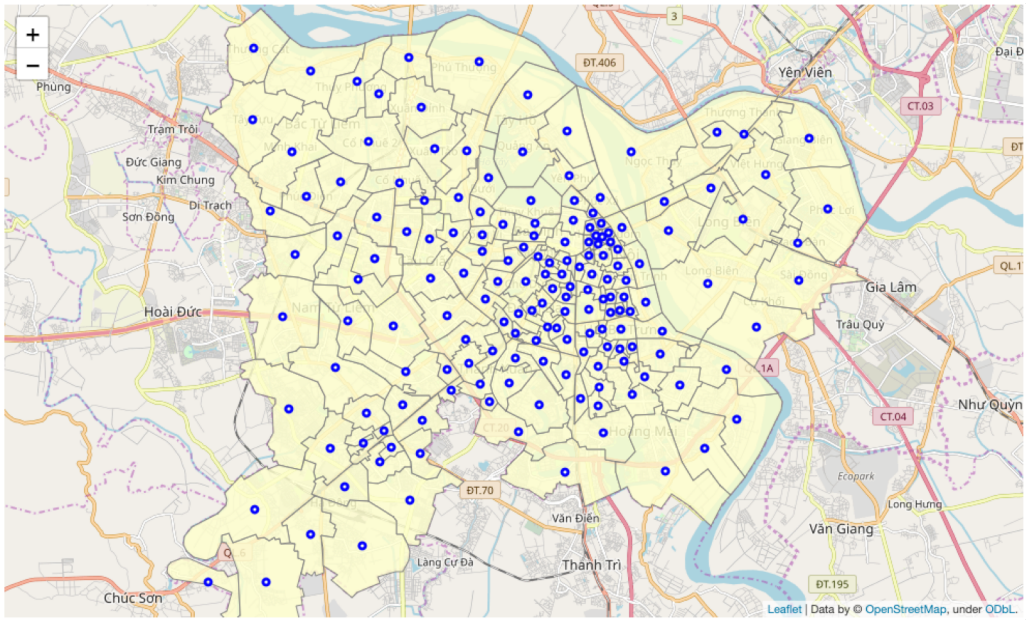
	ENGTYPE_2	geometry	District	Urban	Area	Avg_Population	Population_density	Wards
1	Urban District	POLYGON ((105.72945 21.05656, 105.72884 21.056...	Bac Tu Liem	1	45.32	333.7	7363	13
2	Urban District	POLYGON ((105.80135 21.03023, 105.80577 21.035...	Ba Dinh	1	9.21	243.2	26406	14
3	District	MULTIPOLYGON (((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

	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)	Đơn vị hành chính (Administrative units)	
				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

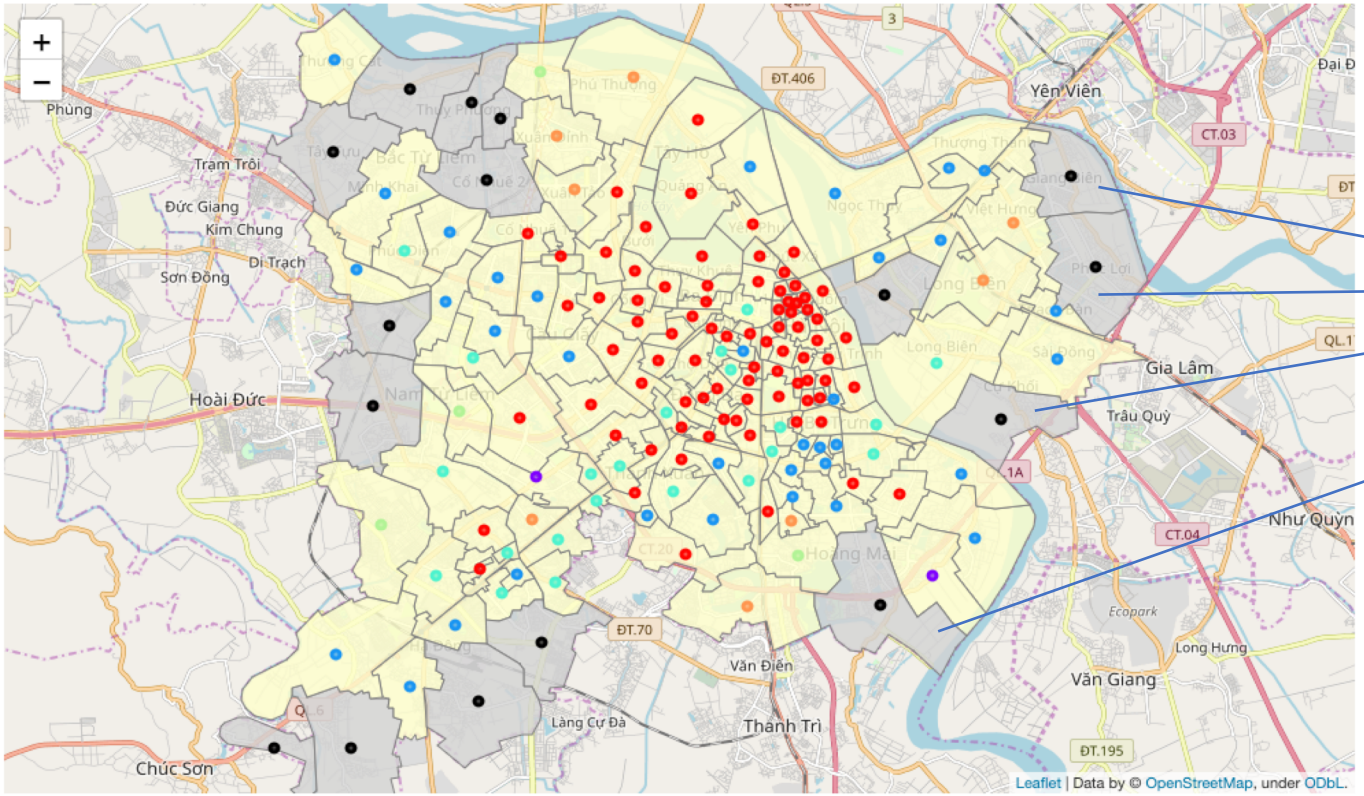
Data collection and preparation

```
# To use Foursquare API, we need a lattitude 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

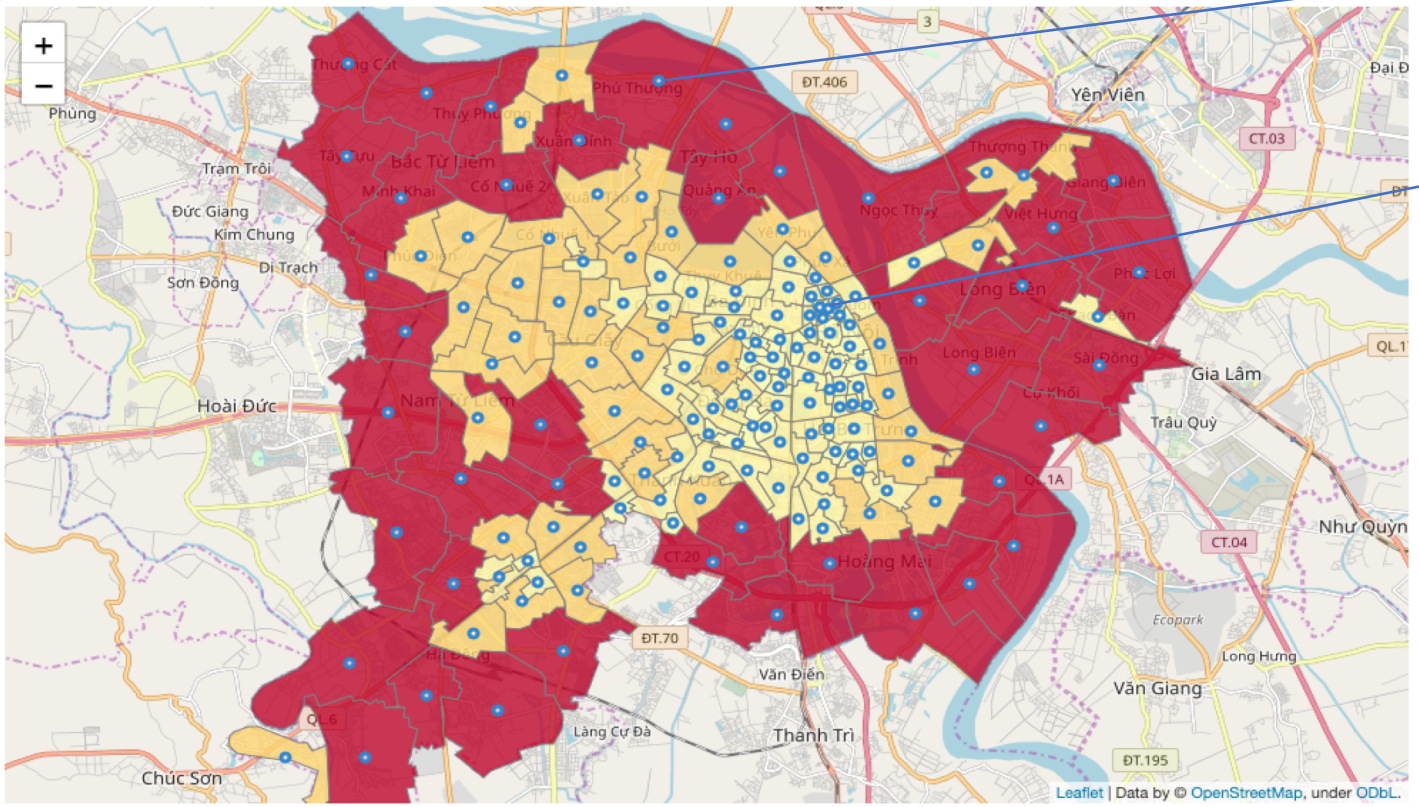
Data collection and preparation



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

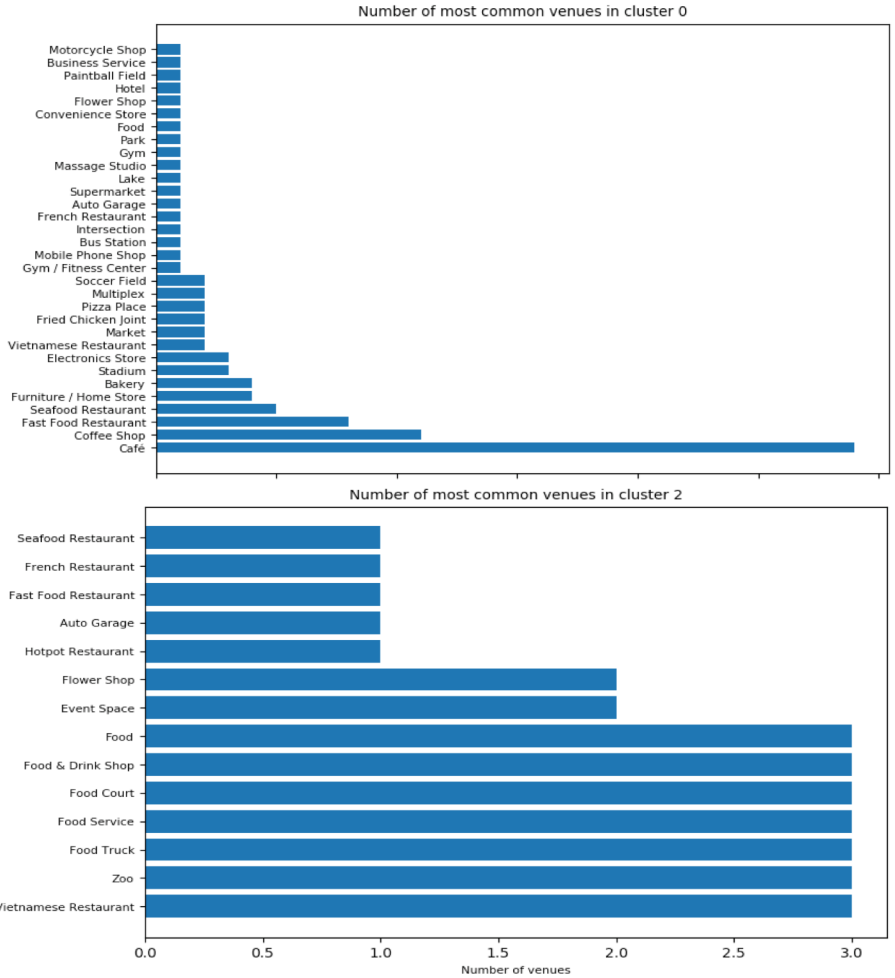
Venue Limit = 100

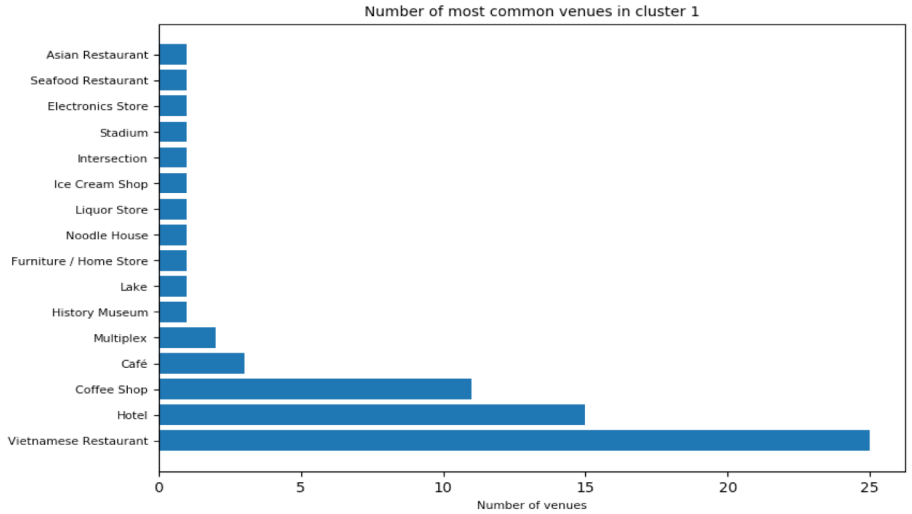
Total: 4,507 venues in 210 unique categories

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

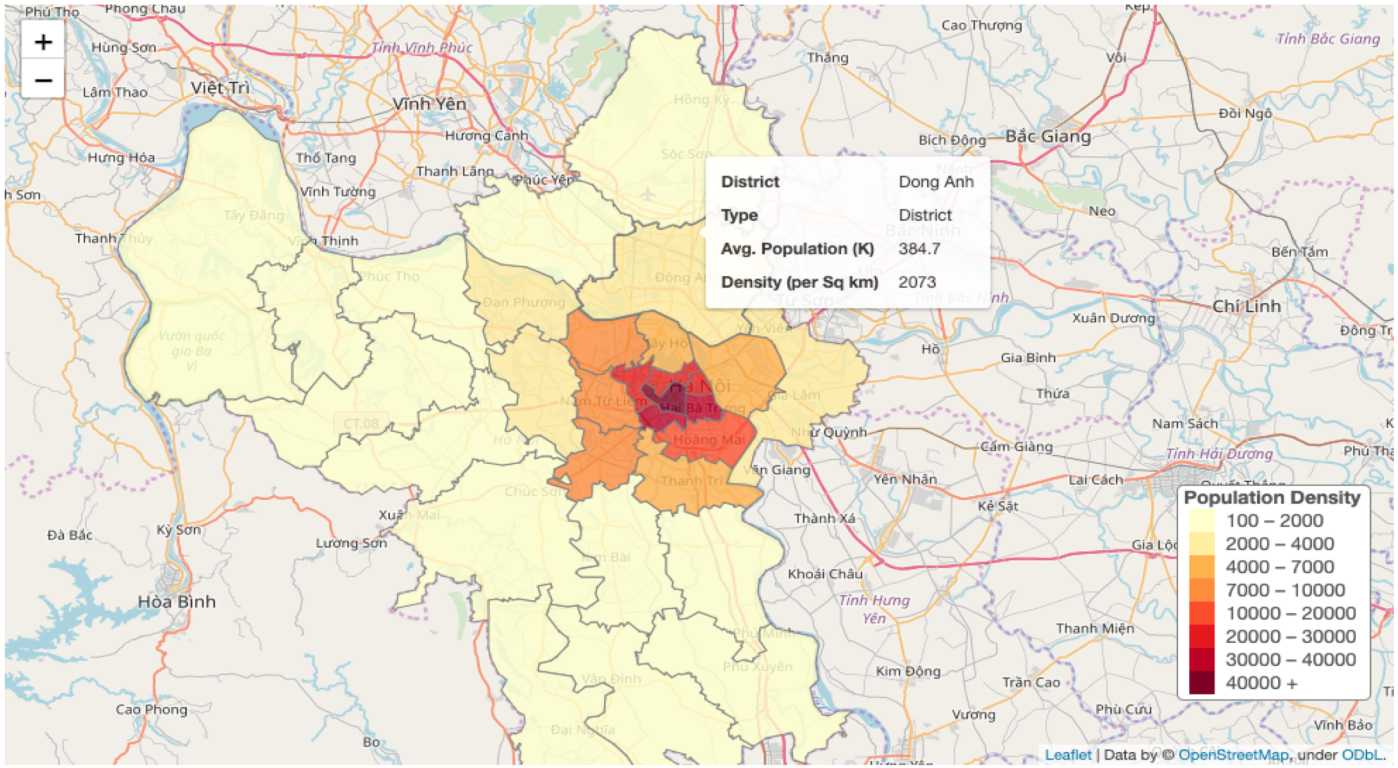




Choose to cluster into 3 clusters:

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

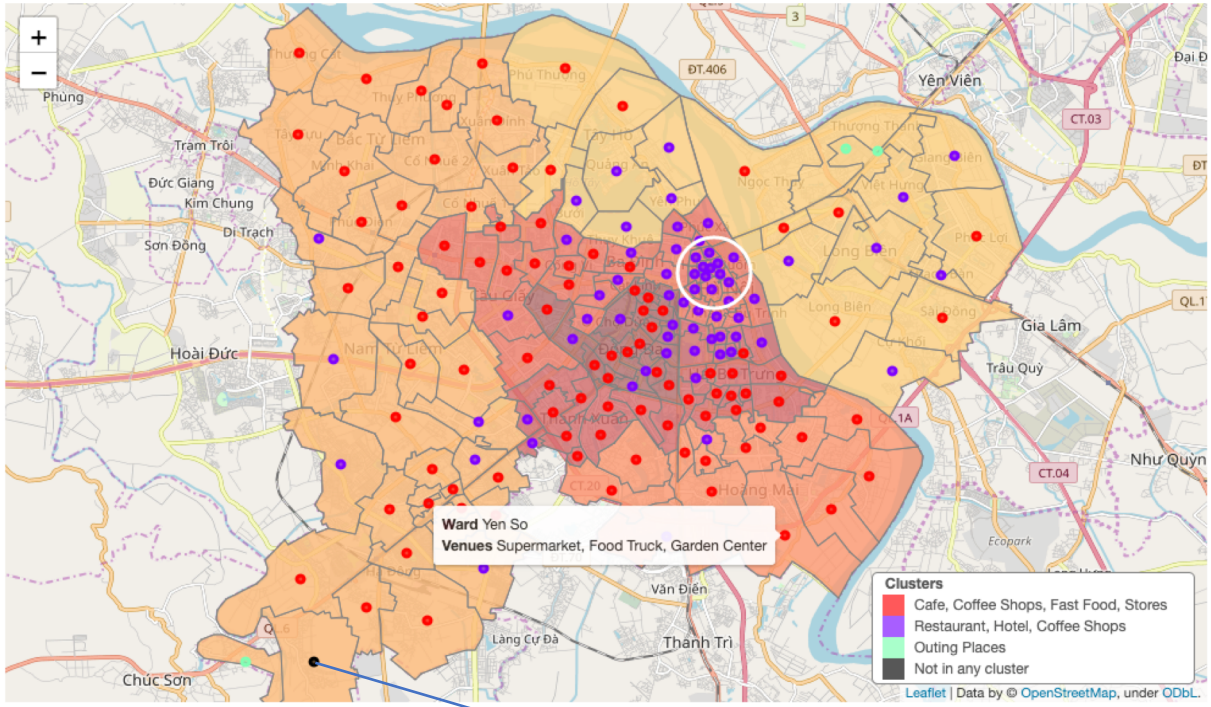
Result maps



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

Result maps



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

3 clusters:

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

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!