Parking Lots Location Selection in the City of Philadelphia

IBM Applied Data Science Capstone Project Final Report

I. Abstract

This report is created for the fulfillment of IBM Applied Data Science Capstone Project. A business problem on the parking lots location selection strategy in the city of Philadelphia is explored using Python-driven data analysis method. By clustering the neighborhoods in West Philadelphia based on top 10 venues of each neighborhood from the "Foursquare" data, the ideal location to open a parking lot is found to be XXX.

II. Introduction

2.1 Backgrounds

The business problem explored in this report focuses on a common issue in big cities like New York, Toronto, and Philadelphia, that what would be the proper strategy to locate the parking lots. There are a couple of criteria for determining the neighborhood a parking lot should be built: First, in order to meet people's needs, a public parking lot should target venues where people will temporary stay during the day, and avoid communities where apartments and houses have already provided enough parking spaces. Second, for the purpose of maximizing the usage of the parking spaces, the lot must be located in neighborhoods with high densities of crowds, such as shopping centers, restaurants, bus/train stations, and airports.

2.2 Stakeholders

The stakeholders of this report will be individuals or companies who is seeking to construct or investigate a parking lot in cities like Philadelphia.

III. Data selection

This project will first acquire a list of boroughs and neighborhoods in the city of Philadelphia. This part of the data is available here: https://www.philageohistory.org/rdic-images/common/help/PhilaRegions.cfm. A complete .csv list of borough and neighborhoods in the city of Philadelphia is available in the Github repository: https://github.com/ZombieWonder/Applied-data-science-capstone-project.git.

For simplicity, we will only analyze the neighborhoods in West Philadelphia as this borough has many neighborhoods with various features to be studied such as universities, train stations, restaurants, hotels, and apartments. Since the analysis method is generalizable for other boroughs, similar study can be carried out on other boroughs if interested in the future.

The neighborhood list of West Philadelphia is shown as follows:

Table 1. List of neighborhoods in West Philadelphia.

Index	Neighborhoods	Latitude	Longitude
1	Belmont District	39.96667	-75.205
2	Black Bottom	39.9574	-75.1978
3	Carroll Park	39.973	-75.236

4	Cathedral Park	39.973	-75.236
5	Cedar Park	39.947	-75.216
6	Cobbs Creek	39.95291	-75.2359
7	Dunlap	39.961	-75.222
8	Garden Court	39.95194	-75.2186
9	Haddington	39.96139	-75.2419
10	Haverford North	39.9653	-75.2066
11	Mantua	39.964	-75.194
12	Mill Creek	39.966	-75.216
13	Overbrook	39.988	-75.25
14	Overbrook Park	39.977	-75.265
15	Overbrook Farms	39.98639	-75.2536
16	Parkside	39.97389	-75.2067
17	Powelton Village	39.95972	-75.1903
18	Saunders Park	39.959	-75.199
19	Spruce Hill	39.954	-75.21
20	Squirrel Hill	39.945	-75.213
21	University City	39.95361	-75.1986
22	Walnut Hill	39.956	-75.219
23	Woodland Terrace	39.94889	-75.2053
24	Wynnefield	39.989	-75.233
25	Wynnefield Heights	40.002	-75.209

The coordinates of each neighborhood are acquired from the Wikipedia. These coordinates will then be used to call Foursquare and get the top 10 venues of each neighborhood.

IV. Experiment method

With the neighborhood coordinates downloaded from Wikipedia (Geocoder database, as mentioned in Week 3's assignment instruction, is quite unreliable and does not return any results per call, although this part of the codes are still preserved in the Jupyter notebook.), these coordinates are called in Foursquare to get the top listed venues of each neighborhood within a radius of 500 meters. Here the top 10 listed venues are selected as features for next step clustering.

The neighborhoods in West Philadelphia will be clustered using "k means" method in "sklearn" package. Based on the results of clustering, pins representing every neighborhood will be colored differently to show its class and placed on the map of West Philadelphia. This function is realized by the "folio" package. At last, individual clusters will be examined and the results will be utilized to decide which neighborhood the parking lot will locate.

IV. Result

Figure 1 shows the location pins of all neighborhoods in West Philadelphia (a) before clustering and (b) after clustering.

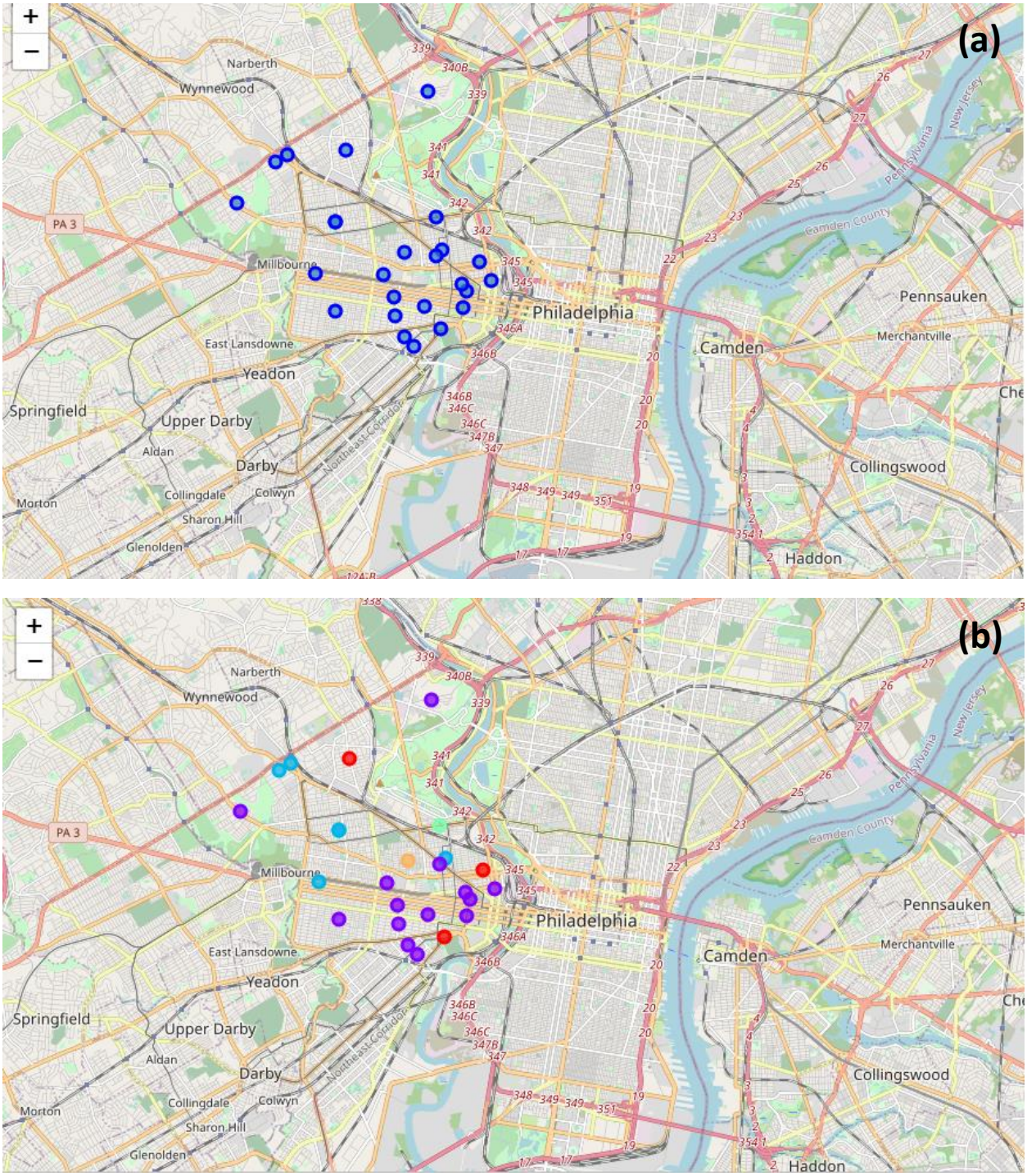

Figure 1. (a) The neighborhoods in West Philadelphia. (b) The clustered neighborhoods in West Philadelphia.

Upon examine, the top 10 venues of each cluster are displayed as follows.

Table 2. The clustering results of neighborhoods in West Philadelphia.

Cluster Labels	Neighborhood	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	Woodland Terrace	Pizza Place	Coffee Shop	Bar	Arcade	Park	Bookstore	Mexican Restaurant	College Bookstore	Farmers Market	Sandwich Place
0	Wynnefield	Pizza Place	Food	Moving Target	Salon / Barbershop	Yoga Studio	Ethiopian Restaurant	Flea Market	Fast Food Restaurant	Farmers Market	Event Space
0	Mantua	Pizza Place	Bakery	Light Rail Station	Photography Studio	Chinese Restaurant	Gym	Event Space	Food	Flea Market	Fast Food Restaurant
1	Wynnefield Heights	Pizza Place	Residential Building (Apartment / Condo)	Optical Shop	Middle Eastern Restaurant	Shopping Plaza	Rugby Pitch	Grocery Store	Discount Store	Bus Station	Donut Shop
1	Spruce Hill	Middle Eastern Restaurant	Pizza Place	Hookah Bar	Gas Station	Art Gallery	Vietnamese Restaurant	Pakistani Restaurant	Grocery Store	Ethiopian Restaurant	CafÃ©
1	Overbrook Park	Pharmacy	Fried Chicken Joint	American Restaurant	Video Store	Diner	Pizza Place	Fast Food Restaurant	Bagel Shop	Grocery Store	Event Space
1	Squirrel Hill	Light Rail Station	Pizza Place	Vietnamese Restaurant	Indian Restaurant	Park	Donut Shop	Food Truck	Yoga Studio	Moving Target	Caribbean Restaurant
1	Haverford North	Breakfast Spot	Recreation Center	Pizza Place	Intersection	Art Gallery	Mobile Phone Shop	Tram Station	Discount Store	Caribbean Restaurant	Bakery
1	University City	Sandwich Place	Food Truck	Pizza Place	Coffee Shop	Donut Shop	Salad Place	Bookstore	Mexican Restaurant	Chinese Restaurant	Indian Restaurant
1	Garden Court	Deli / Bodega	Indian Restaurant	Chinese Restaurant	Middle Eastern Restaurant	Sandwich Place	Mexican Restaurant	Diner	Flea Market	Seafood Restaurant	Caribbean Restaurant
1	Dunlap	Bar	Clothing Store	Breakfast Spot	Pizza Place	Shoe Store	Discount Store	Caribbean Restaurant	Chinese Restaurant	Food	Lounge
1	Cobbs Creek	Sandwich Place	Seafood Restaurant	Park	Spanish Restaurant	Intersection	Dessert Shop	Diner	Discount Store	Dive Bar	Donut Shop
1	Cedar Park	Ethiopian Restaurant	Indian Restaurant	Chinese Restaurant	Grocery Store	Dive Bar	Convenience Store	Deli / Bodega	Playground	Pizza Place	Dessert Shop
1	Walnut Hill	Deli / Bodega	Chinese Restaurant	Pharmacy	Convenience Store	Caribbean Restaurant	Bus Station	Pizza Place	Food & Drink Shop	Food Truck	Clothing Store
1	Black Bottom	Pizza Place	Coffee Shop	Donut Shop	Food Truck	Indian Restaurant	Sandwich Place	Gym	Performing Arts Venue	Korean Restaurant	Restaurant

1	Saunders Park	Donut Shop	Cosmetics Shop	Coffee Shop	Lounge	Tapas Restaurant	Performing Arts Venue	Office	Chinese Restaurant	Sandwich Place	CafÃ©
1	Powelton Village	Food Truck	Pizza Place	Sandwich Place	Coffee Shop	Recreation Center	Bubble Tea Shop	Burger Joint	Convenience Store	Creperie	Dessert Shop
2	Belmont District	Breakfast Spot	Seafood Restaurant	Pizza Place	Mobile Phone Shop	Light Rail Station	Caribbean Restaurant	Event Space	Yoga Studio	Flea Market	Fast Food Restaurant
2	Overbrook Farms	Intersection	Pizza Place	Deli / Bodega	Chinese Restaurant	Farmers Market	Southern / Soul Food Restaurant	Trail	Dessert Shop	Diner	Design Studio
2	Haddington	Intersection	Bakery	Dance Studio	Dessert Shop	Pizza Place	Seafood Restaurant	Sports Bar	Deli / Bodega	Gym	Hotpot Restaurant
2	Cathedral Park	Southern / Soul Food Restaurant	Light Rail Station	Deli / Bodega	Park	Intersection	Pizza Place	Asian Restaurant	Breakfast Spot	Chinese Restaurant	Food
2	Carroll Park	Southern / Soul Food Restaurant	Light Rail Station	Deli / Bodega	Park	Intersection	Pizza Place	Asian Restaurant	Breakfast Spot	Chinese Restaurant	Food
2	Overbrook	Deli / Bodega	Intersection	Pizza Place	Breakfast Spot	Southern / Soul Food Restaurant	Indian Restaurant	Train Station	Train	Trail	Gym
3	Parkside	Bar	Baseball Field	Art Gallery	Auto Garage	Sculpture Garden	Food Truck	Food & Drink Shop	Food	Flea Market	Fast Food Restaurant
4	Mill Creek	Intersection	Discount Store	Bus Stop	Convenience Store	Park	Liquor Store	Fast Food Restaurant	Food & Drink Shop	Food	Flea Market

V. Discussion

From the above figure 1 (b), a clear trend can be seem from the map that the purple cluster (1) and some of the red cluster (0) mostly occupies the southeast part of the West Philadelphia, while the blue cluster (2) is located in the northern part of the borough.

According to table 2, there is not a very significant difference between cluster 0 and 1. If the two clusters have to be separated, cluster 0 has less restaurants, generally pizza places, while cluster 1 contains more dinning places as well as stores, stations, and galleries indicating cluster 1 locates around the business center of the West Philadelphia. On the other hand, cluster 2 mainly contains restaurants and fewer shopping centers can be found in this cluster. Cluster 3 contains more utility stores than the other clusters. And the venues in cluster 4 focus more on grocery stores for food/drinks.

As we have pre-assumed in the backgrounds, a parking lot will be more suitable in communities with high densities of population, such as shopping centers, transportation centers, and restaurants, cluster 0 and 1 should be the primary selection of where to open a parking lot.

This selection is also agreed with the actual parking lot locations found on Google map, as indicated in figure 2. Most of the parking lots are among the cluster 1 regions, probably as those areas have a tremendous need for parking places due to high population and many places of interests.

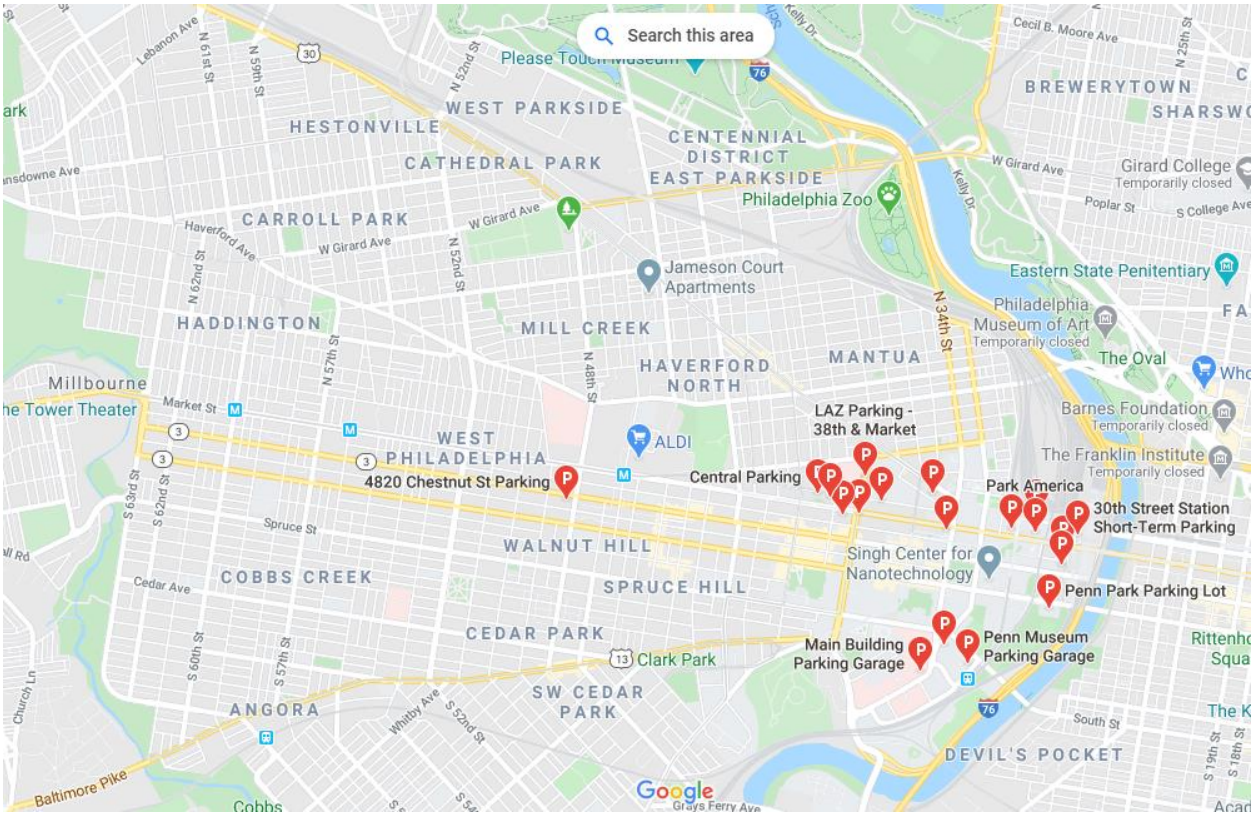

Figure 2. The parking lots found on Google map in West Philadelphia.

It is noticeable that this analysis may not complete reflect the real case scenario since the practice of locating a parking lot can be affected by other external factors such as the price of the land, the availability of the land, and the spaces for free street parking. This is probably why there is no parking lot found in figure 2 near the east of Spruce Hill.

VI. Conclusion

Through clustering the neighborhoods in West Philadelphia by “k means” method, we have found a region where a parking lot should be located to maximize the needs and space utility. The cluster 1 neighborhoods are more suitable to hold a parking lot, which is consistent to the actual parking lot distribution based on Google map.