

Zooming in: Finding the best location for a Hospital with a Development and Research Center in New York City due to COVID-19 pandemic.

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1 Introduction

1.1 Background

COVID-19 is one of the worst pandemics the world has faced. There have been 80,155,187 confirmed cases, including 1,771,128 deaths, notified to the WHO at the end of 2020. These figures show how poorly prepared we are to face this type of problem. Many hospitals collapsed from the large number of patients arriving every hour, and some cities were hit harder than others. The neighborhoods most affected by the pandemic according to Spectrum Noticias NY1 and The New York Times were Borough Park, East Flatbush, and Williamsburg in Brooklyn, as well as Fresh Meadows, Jamaica, Elmhurst, Queens Village and Cambria Heights in Queens.

With this outlook came the idea of using the tools learned in this course to find the best location to build a Hospital that includes a development and research center in one of the most affected cities in the world during this pandemic, such as New York City in the United States of America.

1.2 Problem Statement

What is the best location to build a Hospital and a Development and Research Center (H&DRC) in NYC based on post-pandemic needs? In what borough should the authorities or private organization open the H&DRC?

2 Data Acquisition

The data to be used will be obtained from the following web address: https://geo.nyu.edu/catalog/nyu_2451_34572.

This data has a total of 5 boroughs and 306 neighborhoods from NYC. Also has the latitude and longitude coordinates of each neighborhood. I will convert addresses into their equivalent latitude and longitude values best fit to build the H&DRC. Also, I will use the Foursquare API to explore neighborhoods most affected by COVID-19 in New York City. I will use the explore function to get the most common venue categories in each neighborhood, and then use this feature to group the neighborhoods into clusters. I will use the `_k_`-means clustering algorithm to complete this task. Finally, I will use the Folium library to visualize the neighborhoods in New York City and their emerging clusters.

3 Methodology

- a. Download and explore the dataset. Transform the data into a pandas Data Frame.

- b. Using Nominatim and geocode, locate New York City on the map. Then, locate the boroughs most affected by the pandemic within New York City, which were Brooklyn and Queens. In this way, the study focused on these two Boroughs.
- c. Using the Foursquare Credentials and Version were exploring and segmented the neighborhoods inside each borough (Queens and Brooklyn) using Foursquare API.
- d. It was used the function that extracts the category of the venue and created the get request url. Useful to explore the neighborhoods inside each borough.
- e. Grouping neighborhood and by taking the mean of the frequency of occurrence of each category.
- f. Creating a data frame that display the top 5 venues for each neighborhood.
- g. Creating a new data frame that includes the cluster as well as the top 5 venues for each neighborhood.
- h. Visualizing the resulting clusters and the existing hospitals in each borough in a map.
- i. Installing `geopandas` and the `polygon` library, with the purpose of locate the area where the hospital is needed, according to the borough.
- j. This procedure (c-i) was performed in two boroughs, one for the Queens data, and the other for the Brooklyn data. In this way, both results can be compared separately, and thus, decide which of the two boroughs needs to prioritize the construction of the H&DRC.

4 Results and discussion

By using Nominatim and Geocode, all New York boroughs could be located on a map (see Figure 1).

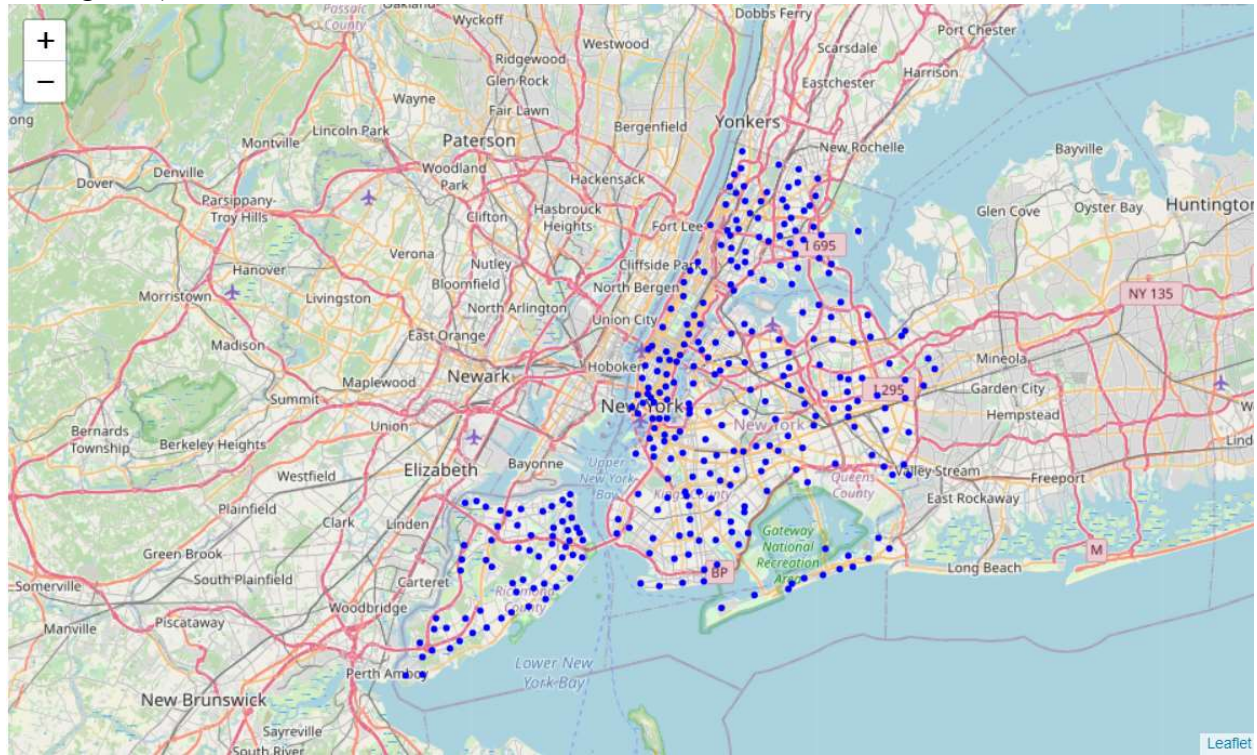


Figure 1. Locating New York City on the map

After observing that the city was effectively represented, we proceeded to the location of the boroughs most affected by the pandemic, corresponding to Queens and Brooklyn (see Figure 2). This to have a more accurate approach in subsequent analyzes within each neighborhood.



Figure 2. Boroughs most affected by COVID-19 in the New York City, Queens (Green) and Brooklyn (Red).

4.1 Borough Queens

Creating the url request and cataloging the venues for Queens using the Foursquare tool, a total of 81 neighborhoods were detected, indicating their coordinates (latitude and longitude). Also, were found 2089 venues, displayed according to the type of venue, giving their coordinates, and category (270 unique categories). Table 1 shows this information.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Astoria	40.768509	-73.915654	Favela Grill	40.767348	-73.917897	Brazilian Restaurant
1	Astoria	40.768509	-73.915654	Orange Blossom	40.769856	-73.917012	Gourmet Shop
2	Astoria	40.768509	-73.915654	Titan Foods Inc.	40.769198	-73.919253	Gourmet Shop
3	Astoria	40.768509	-73.915654	CrossFit Queens	40.769404	-73.918977	Gym
4	Astoria	40.768509	-73.915654	Simply Fit Astoria	40.769114	-73.912403	Gym
5	Astoria	40.768509	-73.915654	Off The Hook	40.767200	-73.918104	Seafood Restaurant
6	Astoria	40.768509	-73.915654	Al-sham Sweets and Pastries	40.768077	-73.911561	Middle Eastern Restaurant
7	Astoria	40.768509	-73.915654	Sitan Muay Thai	40.766108	-73.913224	Martial Arts School
8	Astoria	40.768509	-73.915654	Noisette	40.768544	-73.911248	Dessert Shop
9	Astoria	40.768509	-73.915654	The Gully	40.766719	-73.912410	Indian Restaurant

Table 1. Data frame that keeps the venues in all the neighborhood in Queens.

Foursquare provided the frequency of occurrence for each category. This is valuable information from which you can infer cause of patterns, need for places or services, among others. An important point that I call attention to the Queen neighborhoods where COVID-19 cases were alarming corresponding to Fresh Meadows, Jamaica, Elmhurst, Queens Village and Cambria Height. Most of these neighborhoods have a wide variety of restaurants, shops, and general places where people meet. Despite distancing measures and wearing a mask to avoid spreading the virus, it was difficult to prevent it at least at the beginning. So, it is possible that many people self-medicate going to the pharmacy, and much more if there were no hospitals nearby. In this way we see the need for the area to have an additional hospital, not only for exceptional situations such as the pandemic, but also for general illnesses.

----Fresh Meadows----			----Glen Oaks----		
	venue	freq		venue	freq
0	Bus Station	0.21	0	Pharmacy	0.17
1	Pharmacy	0.14	1	Bank	0.06
2	Chinese Restaurant	0.14	2	Grocery Store	0.06
3	Food Truck	0.07	3	Park	0.06
4	Vegetarian / Vegan Restaurant	0.07	4	Gift Shop	0.06

----Jamaica Hills----			----Oakland Gardens----		
	venue	freq		venue	freq
0	Pharmacy	0.09	0	Korean Restaurant	0.14
1	Grocery Store	0.09	1	Yoga Studio	0.09
2	Fast Food Restaurant	0.09	2	Pharmacy	0.09
3	Indian Restaurant	0.09	3	Chinese Restaurant	0.09
4	Donut Shop	0.09	4	Bagel Shop	0.05

----Queens Village----			----Cambria Heights----		
	venue	freq		venue	freq
0	Bank	0.11	0	Cosmetics Shop	0.14
1	Bus Stop	0.11	1	Caribbean Restaurant	0.14
2	Donut Shop	0.06	2	Jewelry Store	0.07
3	Grocery Store	0.06	3	Moving Target	0.07
4	Pedestrian Plaza	0.06	4	Flower Shop	0.07

Figure 3. How often people in Queens go to the pharmacy in the neighborhoods most affected by COVID-19.

By creating a cluster of venues in Queens, we can verify in Table 2 the information shown in the previous paragraph. Cluster 1 includes many places where people meet, these being places with a high probability of contagion, few places to attend to in case of illness (hospitals) and several places to self-medicate (pharmacies).

In cluster 0 there is one pharmacy, in cluster 1 there are 11 pharmacies, and in clusters 2, 3 and 4 there are none. In this way, we could hypothesize that, due to the absence of hospitals in this area, people turn to self-medication, even when it is not the pandemic.

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	Queens	Astoria	40.768509	-73.915654	1	Bar	Middle Eastern Restaurant	Hookah Bar	Café	Bakery
1	Queens	Woodside	40.746349	-73.901842	1	Grocery Store	Thai Restaurant	Bakery	Latin American Restaurant	Filipino Restaurant
2	Queens	Jackson Heights	40.751981	-73.882821	1	Latin American Restaurant	Peruvian Restaurant	South American Restaurant	Bakery	Thai Restaurant
3	Queens	Elmhurst	40.744049	-73.881656	1	Thai Restaurant	Mexican Restaurant	Chinese Restaurant	Vietnamese Restaurant	Snack Place
4	Queens	Howard Beach	40.654225	-73.838138	1	Italian Restaurant	Pharmacy	Sandwich Place	Fast Food Restaurant	Ice Cream Shop
5	Queens	Corona	40.742382	-73.856825	1	Sandwich Place	Mexican Restaurant	Supermarket	Ice Cream Shop	Bakery
6	Queens	Forest Hills	40.725264	-73.844475	1	Gym / Fitness Center	Gym	Yoga Studio	Thai Restaurant	Pharmacy
7	Queens	Kew Gardens	40.705179	-73.829819	1	Chinese Restaurant	Bus Station	Pizza Place	Bank	Donut Shop
8	Queens	Richmond Hill	40.697947	-73.831833	1	Pizza Place	Bank	Lounge	Latin American Restaurant	Pet Store
9	Queens	Flushing	40.764454	-73.831773	1	Hotpot Restaurant	Chinese Restaurant	Korean Restaurant	Bakery	Bubble Tea Shop
10	Queens	Long Island City	40.750217	-73.939202	1	Hotel	Coffee Shop	Pizza Place	Bar	Café

Table 2. Clusters and top 5 venues in Queens.

Figure 4 also shows us that even though there are hospitals in the borough (Queens), they are not very well distributed, leaving neighborhoods unattended. It is precisely these neighborhoods that were neglected that had the highest cases of COVID-19 contagion.

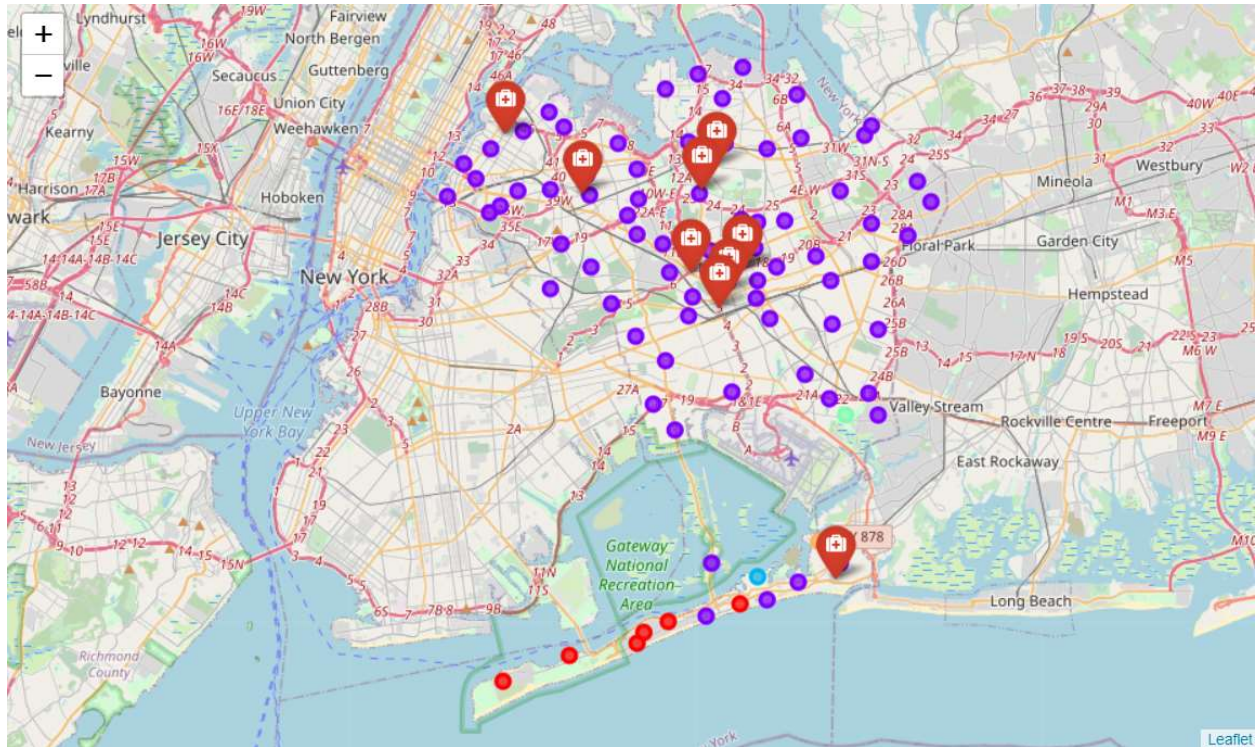


Figure 4. Clusters and existing hospitals in Queens.

In this way, using the polygon tool, it was possible to highlight the neglected area (see Figure 5), where the presence of a hospital with its associated research center is necessary. Additionally, Table 3 shows the coordinates of this area, to initiate the research work regarding the construction of a hospital in this area. The need exists, the pandemic oversight showing that emptiness.

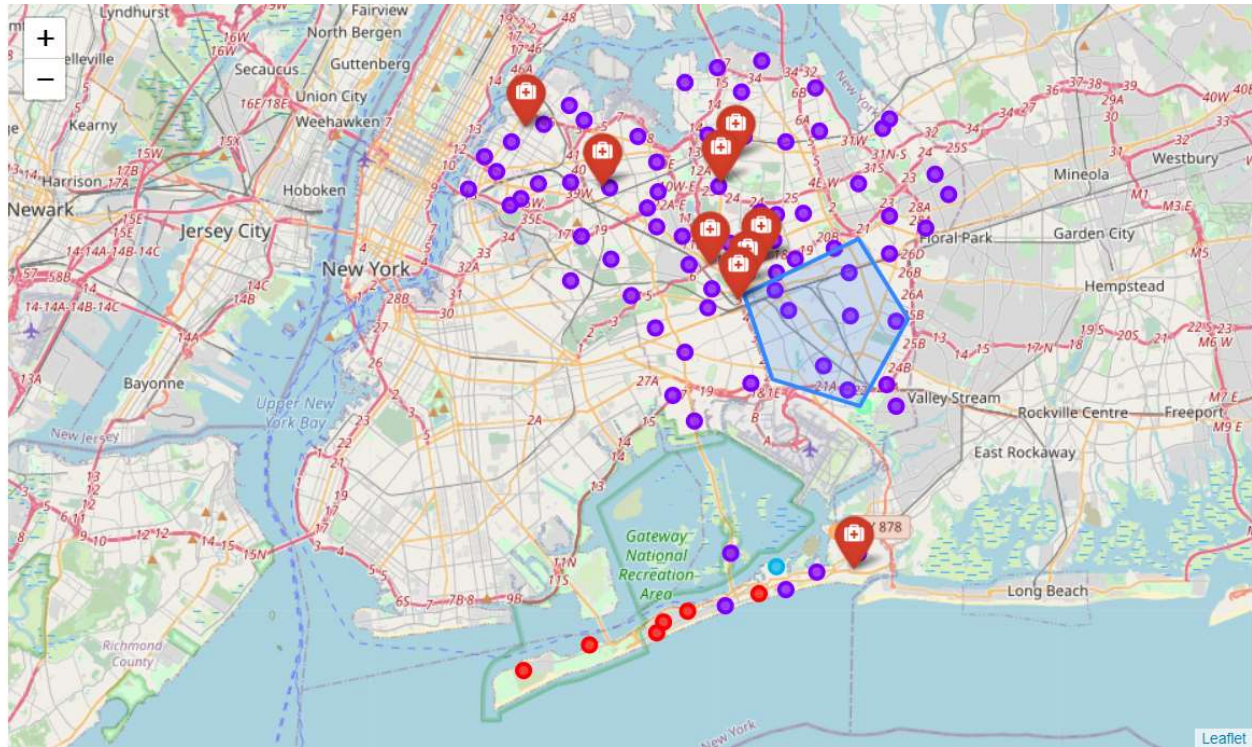


Figure 5. Polygon that shows the area where the H&DRC should be in Queens.

	Latitude	Longitude
Queens	40.70277	-73.813
	40.66996	-73.7987
	40.65969	-73.7542
	40.69381	-73.7295
	40.72422	-73.7545

Table 3. Coordinates of the future H&DRC in Queens.

4.2 Borough Brooklyn

Creating the url request and cataloging the venues for Brooklyn using the Foursquare tool, a total of 70 neighborhoods were detected, indicating their coordinates (latitude and longitude). Also, were found 2,722 venues, displayed according to the type of venue, giving their coordinates, and category (289 unique categories). Table 4 shows this information.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Bay Ridge	40.625801	-74.030621	Pilo Arts Day Spa and Salon	40.624748	-74.030591	Spa
1	Bay Ridge	40.625801	-74.030621	Bagel Boy	40.627896	-74.029335	Bagel Shop
2	Bay Ridge	40.625801	-74.030621	Cocoa Grinder	40.623967	-74.030863	Juice Bar
3	Bay Ridge	40.625801	-74.030621	Leo's Casa Calamari	40.624200	-74.030931	Pizza Place
4	Bay Ridge	40.625801	-74.030621	Pegasus Cafe	40.623168	-74.031186	Breakfast Spot
5	Bay Ridge	40.625801	-74.030621	Ho' Brah Taco Joint	40.622960	-74.031371	Taco Place
6	Bay Ridge	40.625801	-74.030621	The Bookmark Shoppe	40.624577	-74.030562	Bookstore
7	Bay Ridge	40.625801	-74.030621	Mimi Nails	40.622571	-74.031477	Spa
8	Bay Ridge	40.625801	-74.030621	Brooklyn Market	40.626939	-74.029948	Grocery Store
9	Bay Ridge	40.625801	-74.030621	Georgian Dream Cafe and Bakery	40.625586	-74.030196	Caucasian Restaurant

Table 4. Data frame that keeps the venues in all the neighborhood in Brooklyn.

Based on the frequency of occurrence for each category given by Foursquare. It can be seen in Figure 6 that most of the places in the neighborhoods most affected by COVID-19 in Brooklyn, are made up of restaurants, stores, and few pharmacies. This confirms the high number of infections, as well as the collapse of existing hospitals. Thus, there is a need for a health center to help manage the situation of the population during the pandemic and in future times.

```

----Borough Park----
      venue  freq
0      Bank  0.15
1  Pizza Place  0.12
2  Pharmacy  0.08
3 Fast Food Restaurant  0.08
4      Restaurant  0.04

----East Flatbush----
      venue  freq
0 Chinese Restaurant  0.17
1 Department Store  0.08
2      Supermarket  0.08
3 Caribbean Restaurant  0.08
4      Liquor Store  0.08

----Williamsburg----
      venue  freq
0  Pizza Place  0.06
1      Bar  0.06
2  Bagel Shop  0.06
3  Coffee Shop  0.06
4 Grocery Store  0.03

```

Figure 6. How often people in Brooklyn go to the pharmacy in the neighborhoods most affected by COVID-19.

By creating a cluster of venues in Brooklyn, we can verify in Table 5 the above information. Cluster 1 includes many places where people meet, these being places with a high probability of contagion, few places to attend to in case of illness (hospitals) and few places to self-medicate (pharmacies). In clusters 1 and 4 there are an average of 5 pharmacies in each one. However, in clusters 0, 2 and 3, there are none.

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	Brooklyn	Bay Ridge	40.625801	-74.030621	1	Spa	Italian Restaurant	Pizza Place	Bagel Shop	Bar
1	Brooklyn	Bensonhurst	40.611009	-73.995180	1	Chinese Restaurant	Sushi Restaurant	Ice Cream Shop	Grocery Store	Donut Shop
2	Brooklyn	Sunset Park	40.645103	-74.010316	1	Bank	Latin American Restaurant	Mexican Restaurant	Bakery	Pizza Place
3	Brooklyn	Greenpoint	40.730201	-73.954241	1	Pizza Place	Bar	Coffee Shop	Cocktail Bar	Grocery Store
4	Brooklyn	Gravesend	40.595260	-73.973471	1	Lounge	Pizza Place	Bakery	Chinese Restaurant	Italian Restaurant
5	Brooklyn	Brighton Beach	40.576825	-73.965094	1	Eastern European Restaurant	Russian Restaurant	Restaurant	Pharmacy	Beach
6	Brooklyn	Sheepshead Bay	40.586890	-73.943186	1	Dessert Shop	Turkish Restaurant	Yoga Studio	Buffet	Café
7	Brooklyn	Manhattan Terrace	40.614433	-73.957438	1	Pizza Place	Donut Shop	Ice Cream Shop	Convenience Store	Organic Grocery
8	Brooklyn	Flatbush	40.636326	-73.958401	4	Mexican Restaurant	Coffee Shop	Caribbean Restaurant	Bank	Pharmacy
9	Brooklyn	Crown Heights	40.670829	-73.943291	1	Pizza Place	Museum	Café	Coffee Shop	Playground

Table 5. Clusters and top 5 venues in Brooklyn.

Figure 7 shows us that even though there are hospitals in the borough (Brooklyn), they are not very well distributed, leaving neighborhoods unattended. It is precisely these neighborhoods that were neglected that had the highest cases of COVID-19 contagion, like the Queens case.

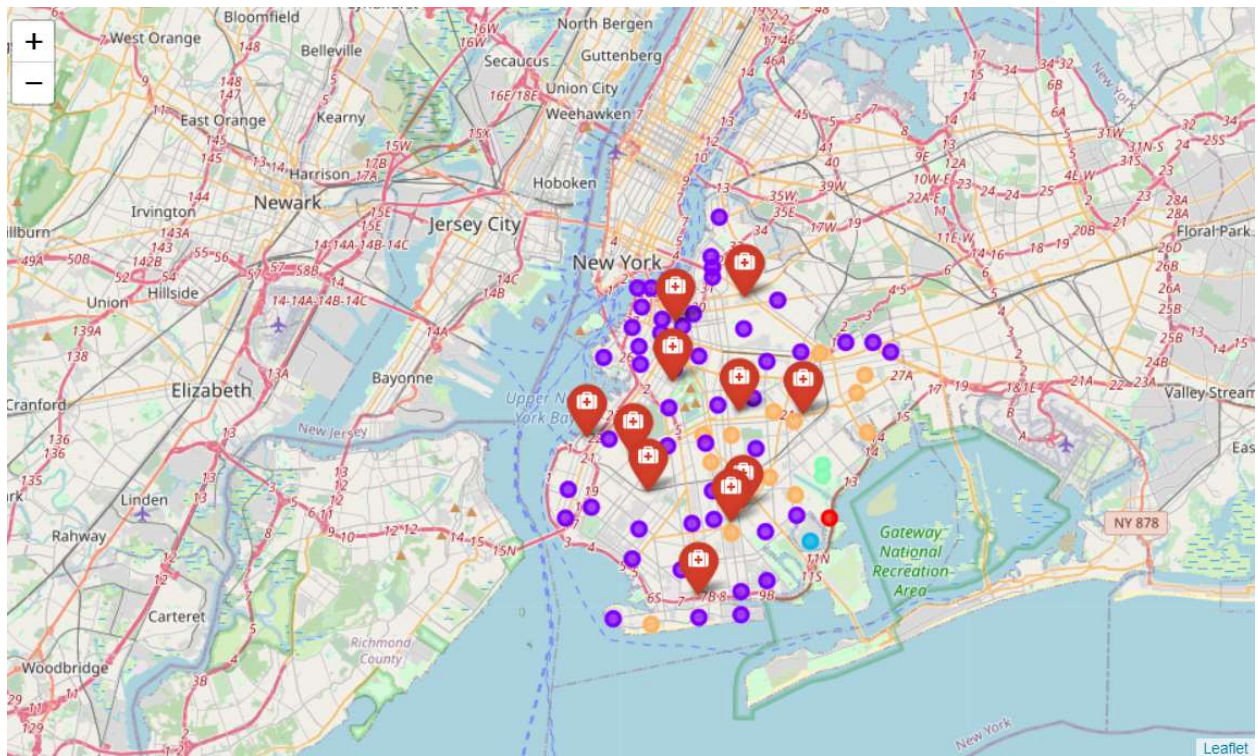


Figure 7. Clusters and existing hospitals in Brooklyn.

Using the polygon tool, it was possible to highlight the affected area (see Figure 8), where the presence of a hospital with its associated research center is necessary. Additionally, Table 6 shows the coordinates of this area, to initiate the research work regarding the construction of a hospital in this area.

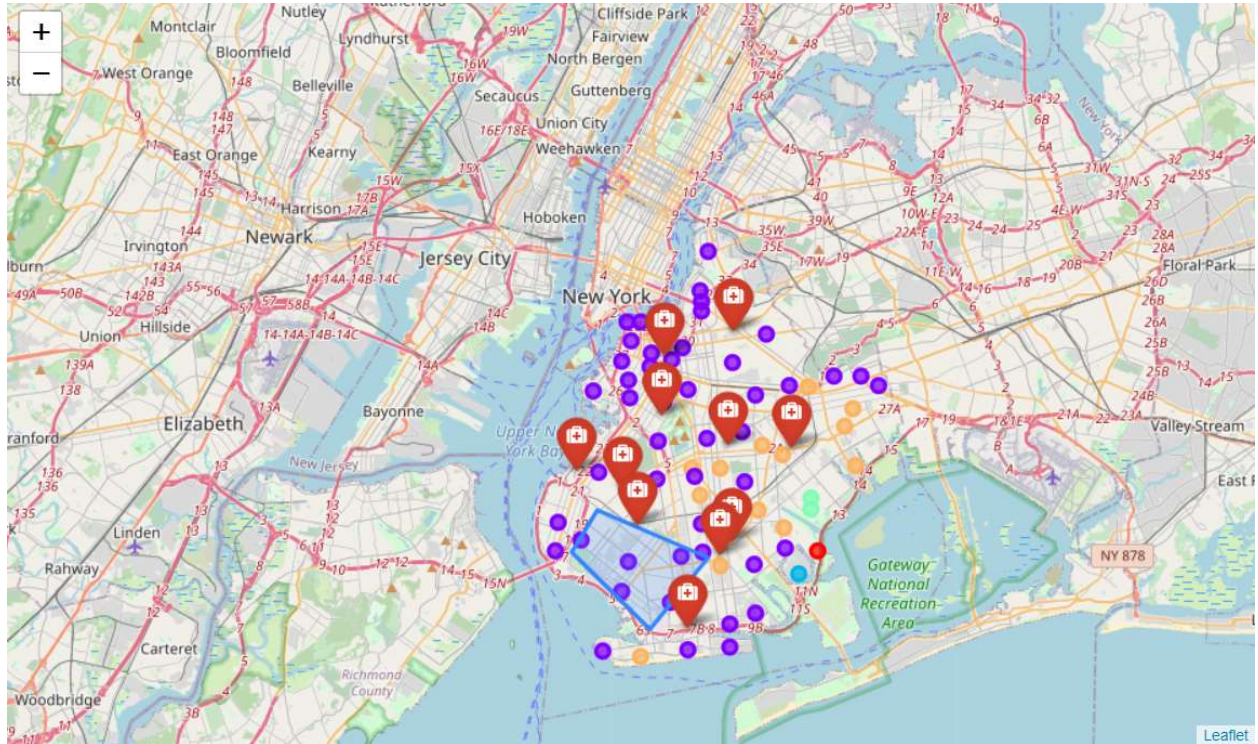


Figure 8. Polygon that shows the area where the H&DRC should be in Brooklyn.

	Latitude	Longitude
Brooklyn	40.63044	-74.0111
	40.61472	-74.0241
	40.58489	-73.9841
	40.61258	-73.9548

Table 6. Coordinates of the future H&DRC in Brooklyn.

5 Conclusion

After performing the analysis, both boroughs have a lack with respect to health centers and research places. In this way, if possible, it would be opportune to build an H & DRC in both Queens and Brooklyn at the coordinates specified in this document.

In the case that construction can only be done in one place, this should be Queens, since it has a greater number of neighborhoods, fewer hospitals, and the existing ones are far from the affected area during the pandemic.

Another advantage that the construction of these centers would give is the generation of direct and indirect jobs, during the planning, construction, start-up, and operation of H&DRC.