New York City Health Facility Analysis

1. Introduction

Healthcare facilities are important to provide continuous and timely care to the patients. They play an important role in our society to mitigate disasters ranging from personal injuries and ailment to coping with the spread of diseases such as in a situation of a epidemic or pandemic. The state of New York has various healthcare facilities including hospitals, urgent care facilities, specialty facilities such as radiation or hemodialysis centers.

In this exercise, I'd like to get an understanding of the availability of the healthcare facilities in the state of New York, particularly in New York City, in terms of the type of the facilities and their capacity, and identify the differences in resource among 5 different counties in New York City by machine learning methods such as clustering. The goal is to understand the resource availability and the diversity of the resource distribution.

2. Data

New York County Population Data

I scraped the data from Wikipedia[1] to collect the information on New York counties and their population.

Table 1 Information on NY Counties

	0	1	2	3	4	5	6	7	8
0	None	None	None	None	None	None	None	None	None
1	001	Albany	1683	One of 12 original counties created in the New...	James II of England (James VII of Scotland) (1...	570.74	304,204	533 sq mi(1,380 km2)	
2	003	Belmont	1806	Genesee County	A variant spelling of the Allegheny River	47.34	48,946	1,034 sq mi(2,678 km2)	
3	005	none	1914[7]	New York County	Jonas Bronck (1600?–1643), an early settler of...	24,118.20	1,385,108	57.43 sq mi(149 km2)	
4	007	Binghamton	1806	Tioga County	John Broome (1738–1810), fourth Lieutenant Gov...	280.56	200,600	715 sq mi(1,852 km2)	

The scaped data in Table 1 was cleaned to calculate the population density of each county. The population in each county is listed in Table 2.

Table 2 Population in state of NY

	County	Population Density (ppl per sq mi)	Population
0	Albany	570.74	304,204
1	Allegany	47.34	48,946
2	Bronx	24,118.20	1,385,108
3	Broome	280.56	200,600
4	Cattaraugus	61.31	80,317

[1] https://en.wikipedia.org/wiki/List_of_counties_in_New_York

The data was filtered to get the information on population density of the 5 counties (boroughs) in New York City (NYC). The data is listed in Table 3.

Table 3 Population in NYC

	County	Population Density (ppl per sq mi)	Population	Latitude	Longitude
2	Bronx	24,118.20	1,385,108	40.8505	-73.8404
23	Kings	25,848.30	2,504,700	40.6453	-73.955
30	New York	46,961.00	1,585,873	40.781	-73.9593
40	Queens	12,512.46	2,230,722	40.6525	-73.7914
42	Richmond	4,572.98	468,730	40.5642	-74.1253

Foursquare data

I used Foursquare to get the medical center data based on geolocation of each NYC county (Table 4).

Table 4 Medical Center Data Inquired through Foursquare

	County	County Latitude	County Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Bronx	40.850485	-73.840404	Montefiore Medical Center	40.849072	-73.846181	Hospital
1	Bronx	40.850485	-73.840404	NYC Health + Hospitals/Jacobi	40.856809	-73.846739	Hospital
2	Bronx	40.850485	-73.840404	Montefiore Medical Pavillion	40.880135	-73.878712	Medical Center
3	Bronx	40.850485	-73.840404	Westchester Square Medical Center	40.840897	-73.848290	Hospital
4	Bronx	40.850485	-73.840404	Calvary Hospital	40.848169	-73.843860	Hospital
5	Bronx	40.850485	-73.840404	NewYork-Presbyterian/The Allen Hospital	40.873327	-73.913051	Hospital
6	Bronx	40.850485	-73.840404	Bronx Psychiatric Center	40.850349	-73.838997	Hospital
7	Bronx	40.850485	-73.840404	St. Barnabas Hospital	40.852741	-73.891168	Hospital
8	Bronx	40.850485	-73.840404	Van Etten-Albert Einstein College of Medicine	40.852606	-73.846368	Hospital
9	Bronx	40.850485	-73.840404	Building 1: 9E	40.855960	-73.846450	Hospital
10	Bronx	40.850485	-73.840404	UrgentWay	40.844194	-73.835321	Hospital

Data on medical facilities

To understand the resource availability and the diversity of the resource distribution, I used data of medical facilities acquired through Health Data NY[2]. The data include the number of beds as well as the type of department that holds the bed, indicating the capacity of the facility for particular types of patients.

Table 5 Data on Medical Facilities by Health Data NY

	Facility ID	Facility Name	Description	Short Description	Attribute Type	Attribute Value	Measure Value	Sub Type	County	Regional Office	Effective Date
2284	277	Brooklyn-Queens Nursing Home	Residential Health Care Facility - SNF	NH	Bed	RHCF	140.0	Permanent	Kings	Metropolitan Area Regional Office - New York City	10/01/1998
7156	845	ODA Primary Health Care Network, Inc	Diagnostic and Treatment Center	DTC	Service	Optometry O/P	NaN	Processing Stations	Kings	Metropolitan Area Regional Office - New York City	01/24/2012
7196	856	Grand Manor Nursing & Rehabilitation Center	Residential Health Care Facility - SNF	NH	Bed	RHCF	240.0	Permanent	Bronx	Metropolitan Area Regional Office - New York City	01/01/1991
						Chemical				Metropolitan Area	

[2] https://health.data.ny.gov/api/views/2g9y-7kqm/rows.csv?accessType=DOWNLOAD

3. Methodology

The data was first explored by visualization through bar chart, choropleth map, scatter chart, data fitting and clustering machine learning method.

First the demographic information was explored to see the population distribution in NY. Then places with highest population density was further explored and the local available medical resource was plotted using geolocation data.

The data on medical facility was used to understand the capacity of hospital beds and how they relate to local population. Further the facilities were clustered into 4 different clustered based on the number of beds each facility has for various departments.

4. Results

The data was mainly explored by visualization. Population density of New York Counties was visualized by bar chart (Figure 1)and choropleth map (Figure 2).

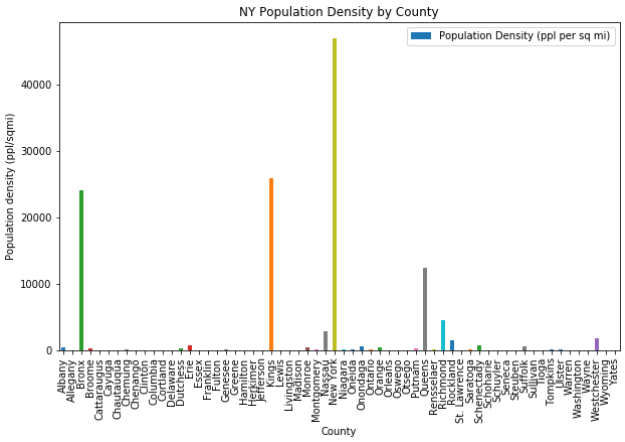

Figure 1 New York Population Density by County

Visualization on the choropleth map clearly shows that the population is most dense in the five counties in NYC.

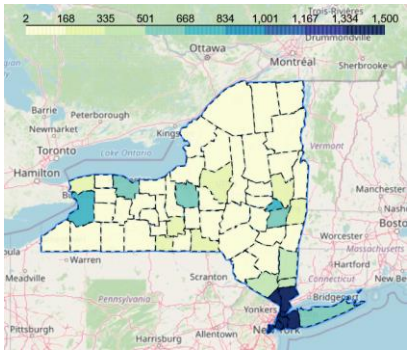

Figure 2 Visualization of the New York County Population Density

Then the data specific to NYC was plotted. The bar chart (Figure 3) shows that the population is most dense in Manhattan (New York County), followed by Brooklyn (Kings County), Bronx, Queens and State Island (Richmond County).

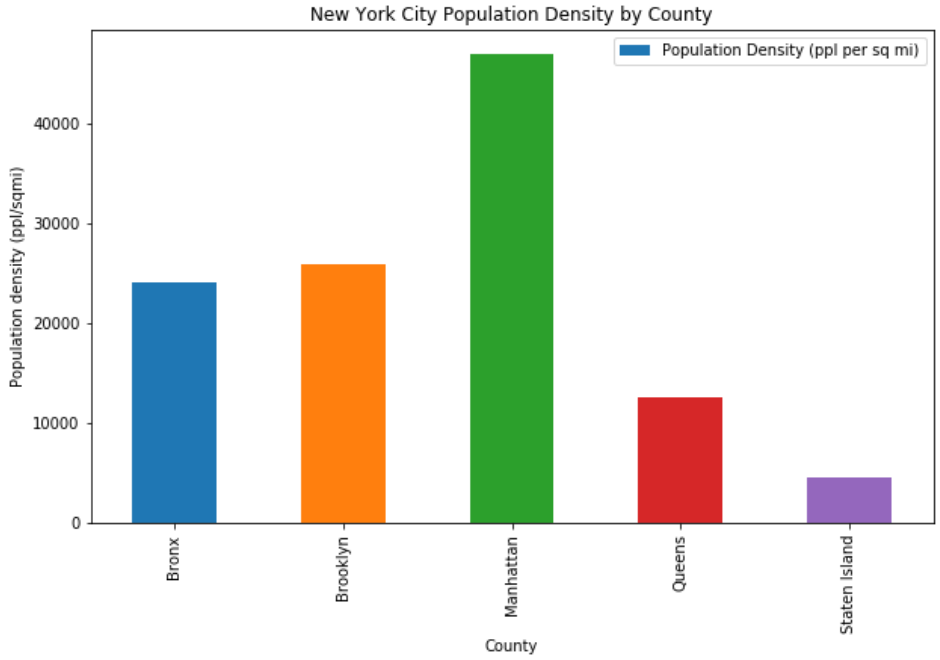

Figure 3 New York City Population Density by County

The Medical Centers in NYC acquired by inquiring through Foursquare was plotted on the map to visualization their location and distribution across the city.

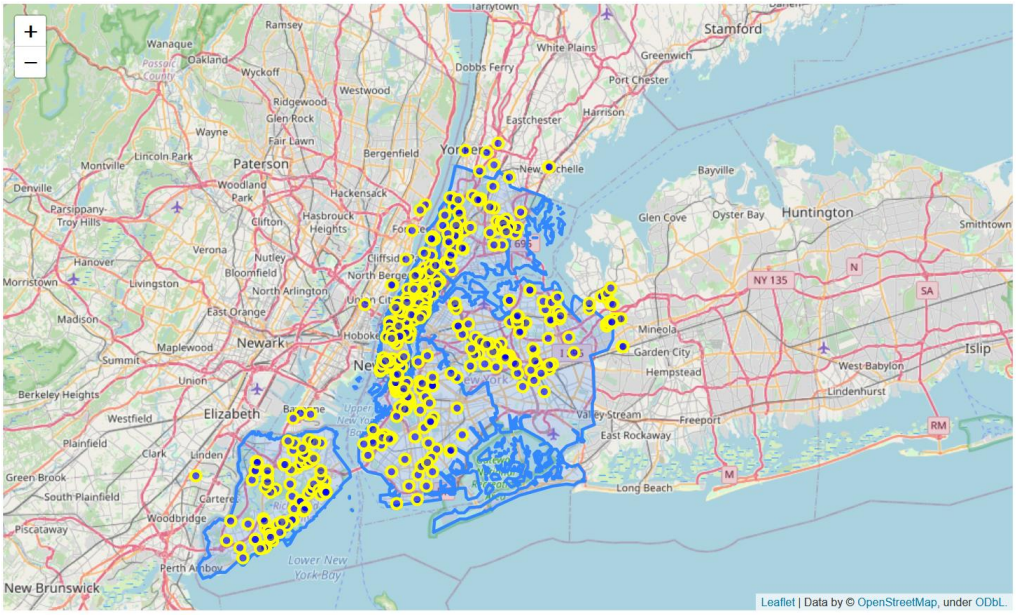

Figure 4 Visualization of the Medical Centers in NYC

The population in each county in NYC was plotted against the total number of beds to get a general idea of the relationship between the capacity across different department compared to the local population. The data was linearly fitted to see what counties are above the expectation and what counties are below the expectation.

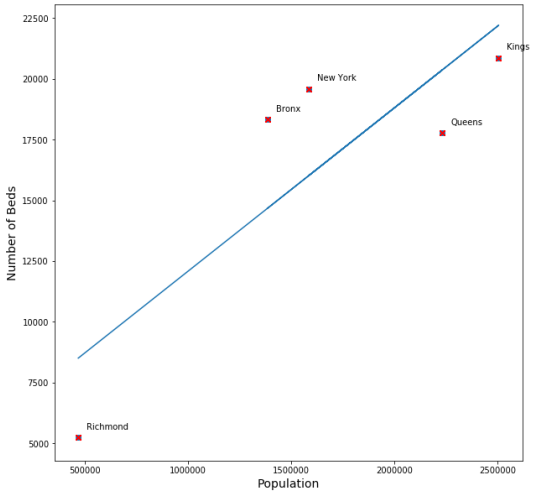

Figure 5 Relationship between county population and bed number

Then the bed capacity in each facility was further segmented into various types of departments with that capacity to investigate the level of resource available to different types of patients.

Table 6 Number of Beds for Each Bed Type per Facility

Facility	County	RHCF	Chemical Dependence - Rehabilitation	Chemical Dependence - Detoxification	Psychiatric	Burns Care	Coronary Care	Intensive Care	Maternity	Medical / Surgical	Neonatal Continuing Care	Neonatal Intensive Care	Neonatal Intermediate Care	Pe
Brooklyn-Queens Nursing Home	Kings	140.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Grand Manor Nursing & Rehabilitation Center	Bronx	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
BronxCare Hospital Center	Bronx	0.0	30.0	36.0	104.0	0.0	11.0	26.0	36.0	250.0	6.0	14.0	20.0	
Jacobi Medical Center	Bronx	0.0	0.0	16.0	107.0	8.0	12.0	24.0	26.0	174.0	5.0	10.0	10.0	
Montefiore Medical Center-Wakefield Hospital	Bronx	0.0	0.0	0.0	33.0	0.0	0.0	16.0	30.0	206.0	2.0	4.0	9.0	
Montefiore Medical Center - Henry & Lucy Moses Div	Bronx	0.0	0.0	0.0	22.0	0.0	12.0	48.0	0.0	581.0	0.0	0.0	0.0	
Lincoln Medical & Mental Health Center	Bronx	0.0	0.0	0.0	60.0	0.0	7.0	23.0	35.0	177.0	10.0	5.0	5.0	
Calvary Hospital Inc	Bronx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	200.0	0.0	0.0	0.0	
SBH Health System	Bronx	0.0	0.0	24.0	49.0	0.0	0.0	26.0	16.0	254.0	5.0	0.0	10.0	
North Central Bronx Hospital	Bronx	0.0	0.0	0.0	70.0	0.0	0.0	20.0	26.0	79.0	2.0	7.0	3.0	

The facilities were grouped by clustering method based on the number of beds for each bed type (Table 7).

Table 7 Clustering of the Facilities Based on the Number of Beds for Each Bed Type

Facility	Cluster Labels	County	RHCF	Chemical Dependence - Rehabilitation	Chemical Dependence - Detoxification	Psychiatric	Burns Care	Coronary Care	Intensive Care	Maternity	Medical / Surgical	Neonatal Continuing Care	Neonatal Intensive Care	Neonatal Intermediate Care
Brooklyn-Queens Nursing Home	1	Kings	140.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Manor Nursing & Rehabilitation Center	0	Bronx	240.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BronxCare Hospital Center	2	Bronx	0.0	30.0	36.0	104.0	0.0	11.0	26.0	36.0	250.0	6.0	14.0	20.0
Jacobi Medical Center	2	Bronx	0.0	0.0	16.0	107.0	8.0	12.0	24.0	26.0	174.0	5.0	10.0	10.0
Montefiore Medical Center-Wakefield Hospital	2	Bronx	0.0	0.0	0.0	33.0	0.0	0.0	16.0	30.0	206.0	2.0	4.0	9.0

To understand the clusters and their features of differentiation, average number of bed for each bed type were calculated (Table 8) and plotted (Figure 6).

Table 8 Average Number of Beds per Bed Type for Each Cluster

Cluster Labels	RHCF	Chemical Dependence - Rehabilitation	Chemical Dependence - Detoxification	Psychiatric	Burns Care	Coronary Care	Intensive Care	Maternity	Medical / Surgical	Neonatal Continuing Care	Neonatal Intensive Care	Neonatal Intermediate Care	Pedia
0	251.321739	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.278
1	57.694915	0.745763	2.542373	10.305085	0.050847	0.711864	2.220339	3.627119	24.813559	0.389831	0.915254	0.881356	3.254
2	0.000000	2.341463	6.024390	53.097561	1.000000	8.365854	31.292683	28.756098	304.048780	4.390244	7.341463	7.317073	25.219
3	578.187500	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000

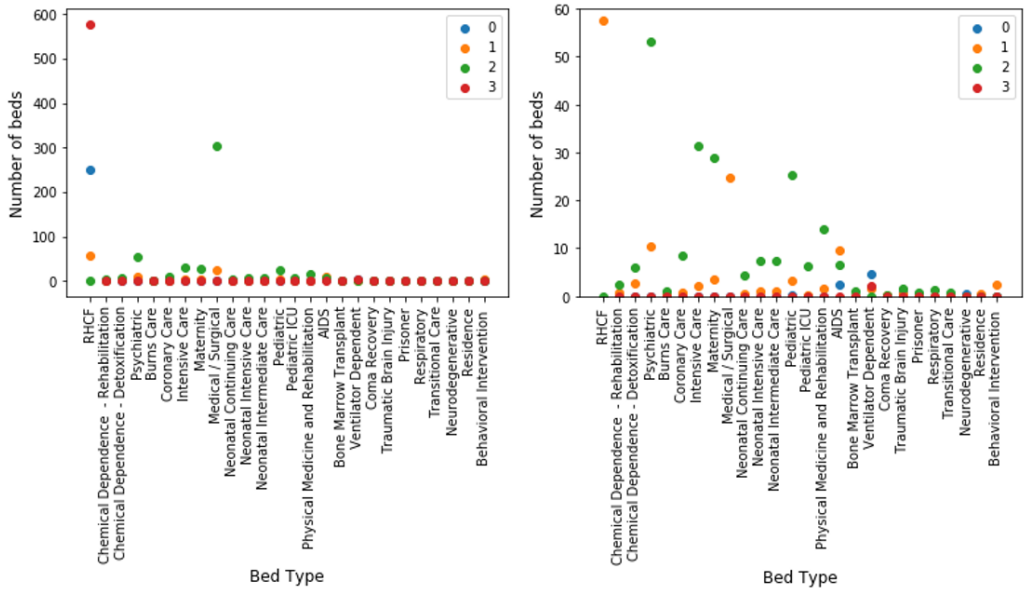

Figure 6 Average Number of Beds per Bed Type for Each Cluster

At last, I'd like to understand the distribution of the type of clusters in each county of the NYC. Percentage of each cluter type are plotted and compared for the five counties in NYC.

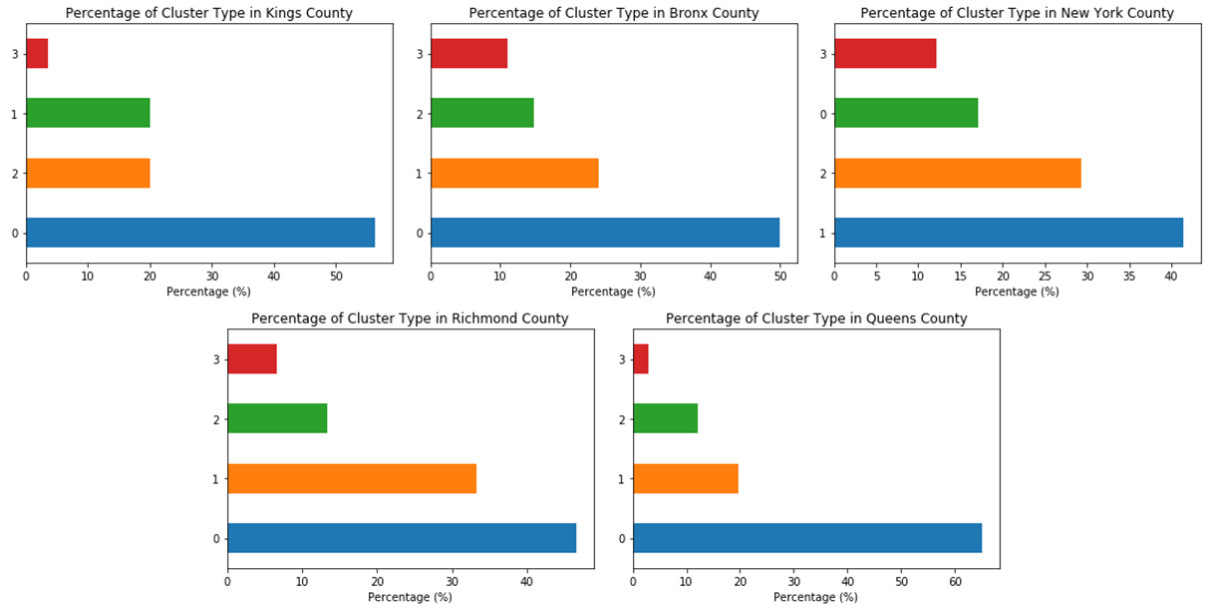

Figure 7 Percentage of Cluster Type in Each NYC County

5. Discussion

Data shows that Category 0 has a high number of beds for RHCF but is not exclusive, Category 1 has relatively higher capacities for medsurg and AIDS patients, Category 2 has large capacity for psychiatric patients as well as for intensive care and pediatric patients, and Category 3 has exclusively RHCF facilities with beds.

6. Conclusion

The resource of bed capacity in health system in NYC is relatively evenly distributed across all five counties, which capacity to population ratio slightly higher in Bronx and New York county (Manhattan) than other three counties. There seem to be an abundance of facilities with exclusive resource for RHCF patients in Queens and Kings (Brooklyn) counties, while the resource diversified for psychiatric, intensive care and pediatric patients is relatively scarce in Queens compared to other counties. There is also a higher ratio of facilities with higher capacities for medsurg and AIDS patients in New York county (Manhattan) and in Richmond (Staten Island) compared to Queens and Kings (Brooklyn) counties.