The Battle of Neighborhoods – Hospitals & Covid-19 in Rio de Janeiro, Brazil

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Summary

- Introduction
- Data
- Methodology
- Results
- Discussion & Conclusion

Introduction

- The current global pandemic caused by the Covid-19 virus has changed the way our world works.
- Most, if not all countries, do not have a medical infrastructure readily available for such an event. Thus, it becomes crucial to for a country to properly allocate its resources in order to have the most efficient counter measure to this crisis.

Introduction

- Brazil, as one of the underdeveloped countries, is currently struggling in the fight against Covid-19, clocking over 100,000 fatalities with one of the highest numbers of confirmed cases.

Introduction

- Goal: Improve the management of the resources dedicated to deal with this pandemic. By knowing the distribution of Covid-19 cases, it is possible to decide where medical resources should be allocated to. For this project, we will use the city of Rio de Janeiro as a test case.
- Target audience: Both the common people as well as government personnel. For the first, having knowledge of the hotspots of cases in the city can better their awareness of places that should be avoided, while for second group it can help in strategical choices which can optimize resource management while improving the results in the fight against Covid-19.

Data

- Data on Covid-19 Cases:

https://experience.arcgis.com/experience/38efc69787a346959c931568bd9e2cc4 (collected on 04/08/2020)

NOTIFIC	INICIO	BAIRRO	RESID	EVOLUCAO	OBITO	CEP	ATUALIZACAO
01/04/2020	28/03/2020	PACIENCIA	5.3	bito	06/04/2020	23585800	03/08/2020
01/04/2020	01/04/2020	COSTA BARROS	3.3	recuperado		21531991	03/08/2020
01/04/2020	28/03/2020	RAMOS	3.1	recuperado		21060330	03/08/2020
01/04/2020	28/03/2020	CAMPO GRANDE	5.2	recuperado		23013630	03/08/2020
01/04/2020	22/03/2020	LEBLON	2.1	recuperado		22441030	03/08/2020

Data

- Data on Hospitals:

Foursquare Database

	NEIGHBOURHOOD	NEIGHBOURHOOD LATITUDE	NEIGHBOURHOOD LONGITUDE	HOSPITAL	HOSPITAL LATITUDE	HOSPITAL LONGITUDE
0	abolicao	-22.886161	-43.299846	Hospital Psiquiatrico	-22.887598	-43.304885
1	andarai	-22.929084	-43.253486	Hospital Federal do Andaraí	-22.927836	-43.252607
2	andarai	-22.929084	-43.253486	Associação Dos Veteranos do Hospital Do Andarai	-22.927926	-43.253674
3	andarai	-22.929084	-43.253486	Centro Cirúrgico	-22.927771	-43.252309
4	andarai	-22.929084	-43.253486	Ambulatório	-22.927190	-43.252167

Methodology

- 3 main steps were taken:
  - Analysis of hot spots of cases of Covid-19 in the city
  - Hospitals distribution per neghborhood
  - Prioritization of hospitals to be chosen

- For detailed information regarding the code. Please refer to the Jupyter notebook or the report.

Methodology

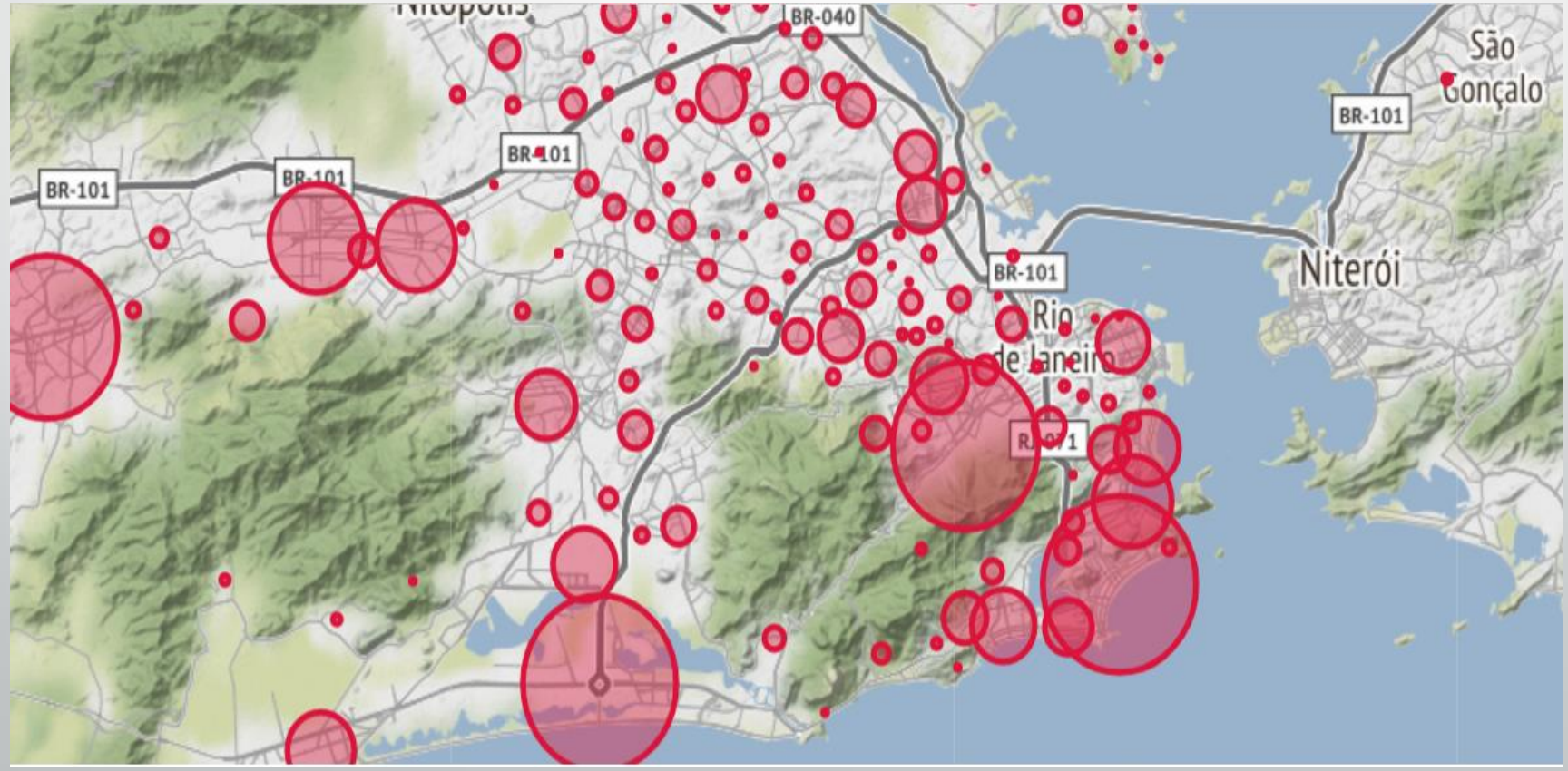
- Analysis of hot spots of cases of Covid-19 in the city
  - Importing database into IBM
  - Connecting to IBM database
  - Creating data frame with desired information
  - Organizing data frame to combine all cases in each neighborhood
  - Getting coordinates of each neighborhood

Out[7]:

	NEIGHBOURHOOD	TOTAL_CASES	LATITUDE	LONGITUDE
0	abolicao	129	-22.886161	-43.299846
1	acari	105	-22.822153	-43.340674
2	agua santa	68	-22.911143	-43.312126
3	alto da boa vista	109	-22.962113	-43.253582
4	anchieta	497	-22.823190	-43.399107

Methodology

- Analysis of hot spots of cases of Covid-19 in the city



Methodology

- Hospitals distribution per neghborhood
  - Querying Foursquare database for hospitals inside each neighborhood

	NEIGHBOURHOOD	NEIGHBOURHOOD LATITUDE	NEIGHBOURHOOD LONGITUDE	HOSPITAL	HOSPITAL LATITUDE	HOSPITAL LONGITUDE
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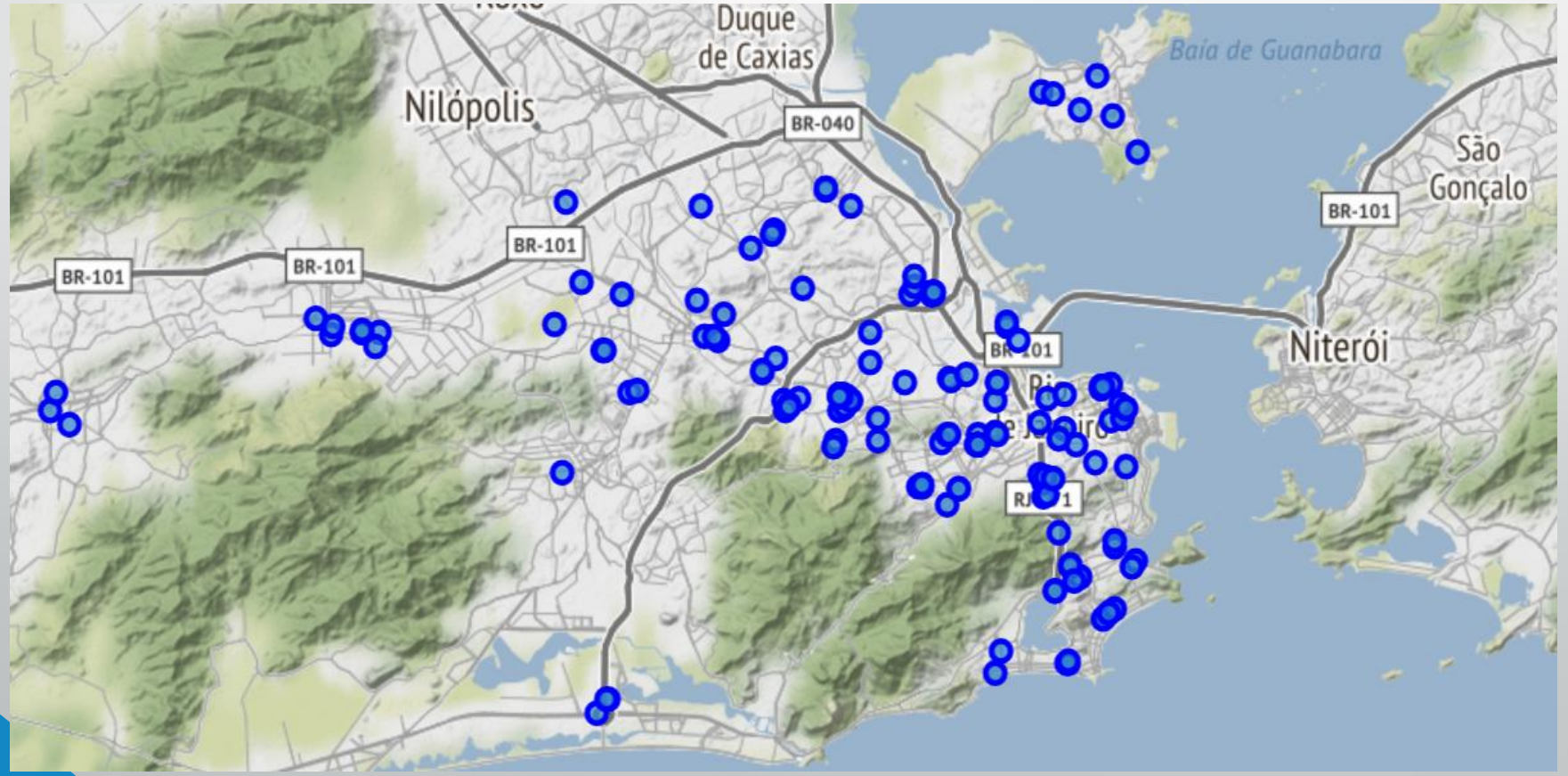
Methodology

- Hospitals distribution per neghborhood



Methodology

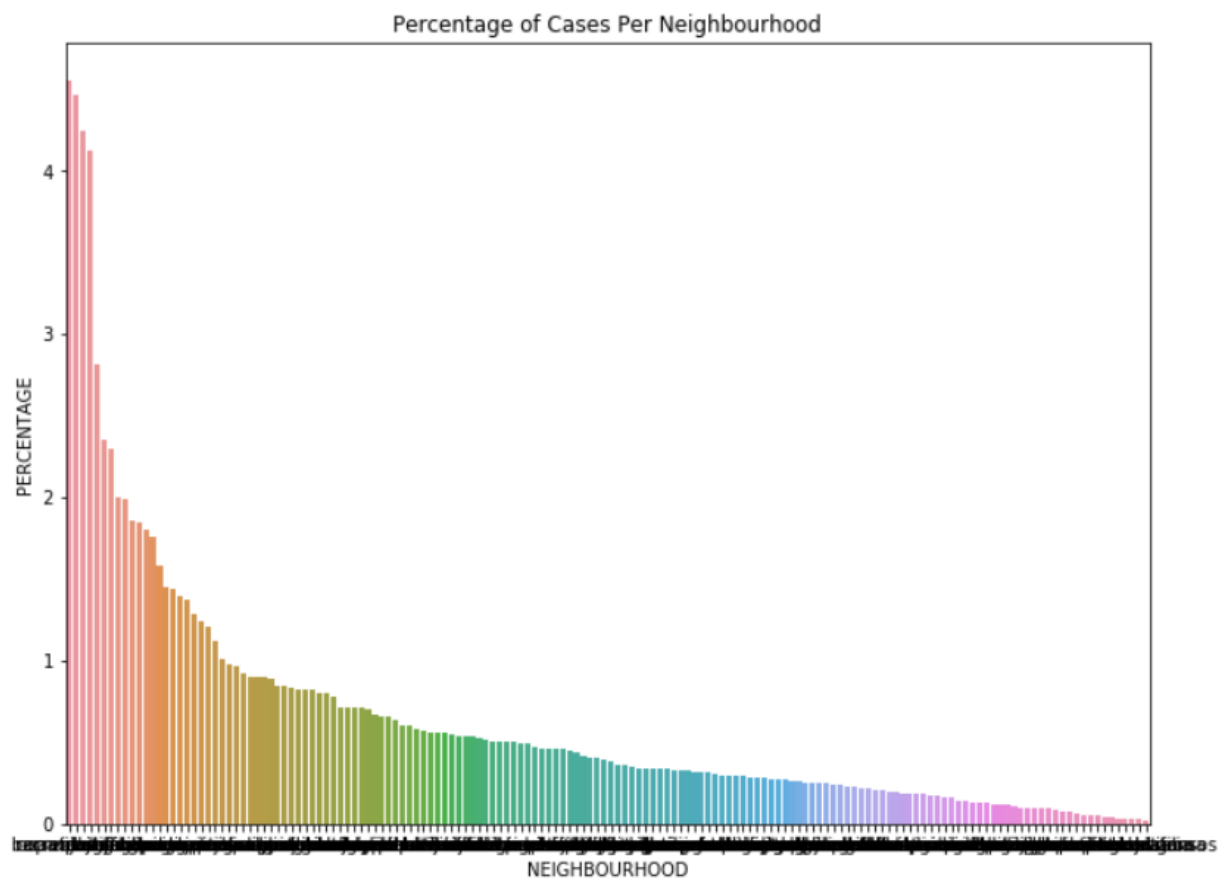
- Prioritization of hospitals to be chosen
  - Ranking neighborhoods with highest number of cases
  - Creating a cut-off based on a 2% percentage of cases in a neighborhood over the total number of cases

```
In [16]: #Getting the neighbourhoods with higher number of cases and calculating the percentage of cases to define threshold
         df_high_cases = df_neighbourhood.sort_values(by=['TOTAL_CASES'], ascending=False)
         df_high_cases['PERCENTAGE'] = (df_high_cases['TOTAL_CASES'] / df_high_cases['TOTAL_CASES'].sum())*100
         df_high_cases.head()
```

Out[16]:

	NEIGHBOURHOOD	TOTAL_CASES	LATITUDE	LONGITUDE	PERCENTAGE
35	copacabana	2768	-22.971964	-43.184343	4.557804
9	barra da tijuca	2713	-22.999740	-43.365993	4.467241
138	tijuca	2580	-22.933216	-43.238145	4.248242
23	campo grande	2507	-22.902953	-43.559129	4.128040
8	bangu	1708	-22.875305	-43.464880	2.812402

Methodology



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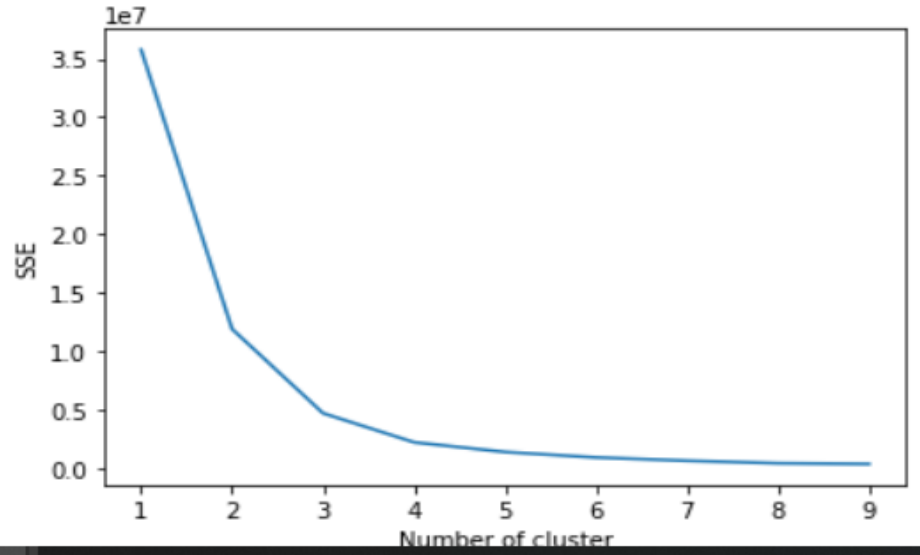
8	bangu	1708	-22.875305	-43.464880	2.812402
114	realengo	1432	-22.877274	-43.430103	2.357939
15	botafogo	1397	-22.948845	-43.179829	2.300308

Methodology

- Prioritization of hospitals to be chosen
  - 20 hospitals chosen inside selected neighborhoods.
  - K-means algorithm used to try to further narrow this number.
  - Selection of number of k-clusters
  - Clustering of neighborhoods and connection to hospitals

Methodology

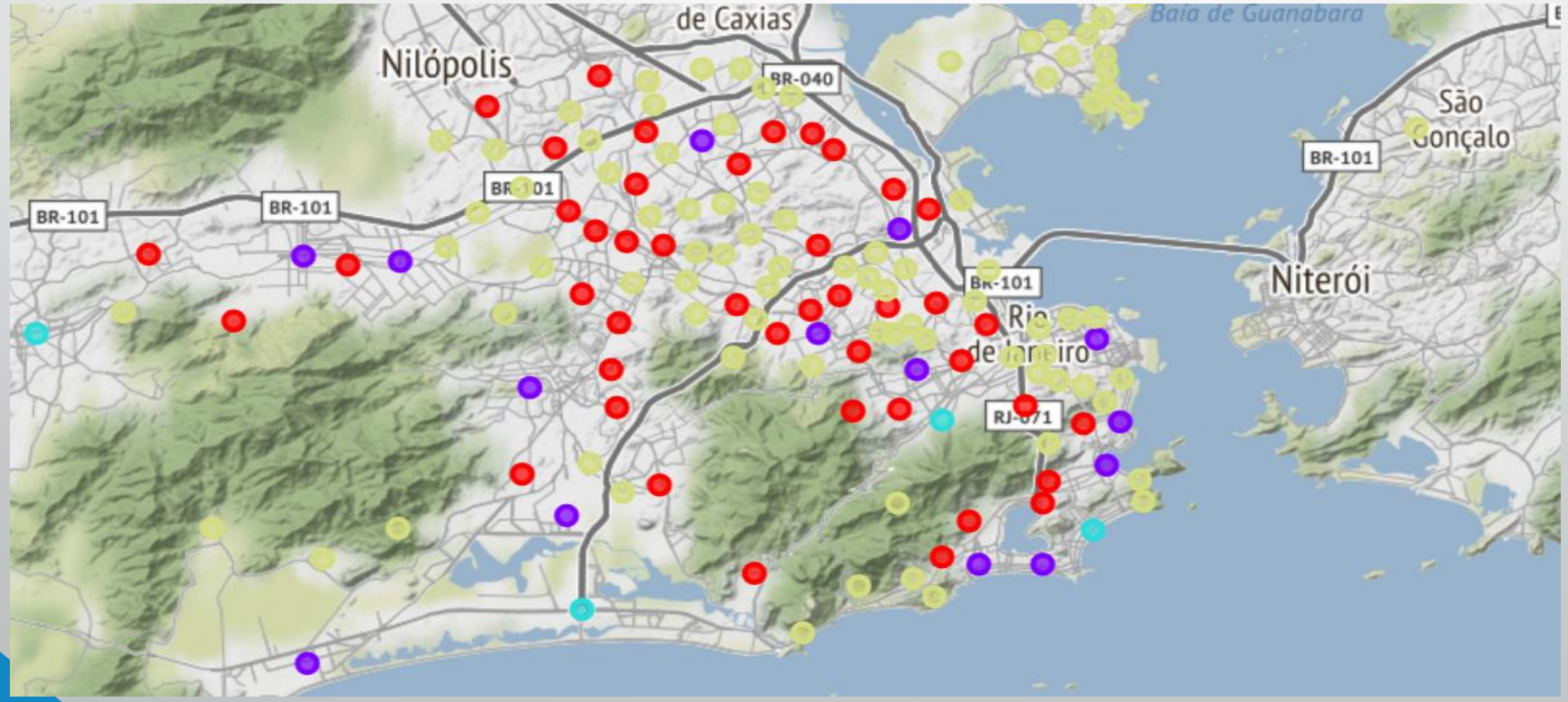
```
#Finding out the ideal number of K
temp_df = df_neighbourhood.drop('NEIGHBOURHOOD', 1)
sse = {}
for k in range(1, 10):
    kmeans = KMeans(n_clusters=k, max_iter=1000).fit(temp_df)
    temp_df["clusters"] = kmeans.labels_
    sse[k] = kmeans.inertia_ # Inertia: Sum of distances of samples to their closest cluster center
plt.figure()
plt.plot(list(sse.keys()), list(sse.values()))
plt.xlabel("Number of cluster")
plt.ylabel("SSE")
plt.show()
```



- 4 clusters selected as optimum number

Methodology

- Prioritization of hospitals to be chosen
  - Hospitals clustered



Methodology

- Prioritization of hospitals to be chosen
  - Selecting hospitals based on distance from the centroid representing the cluster with neighborhoods with highest number of cases

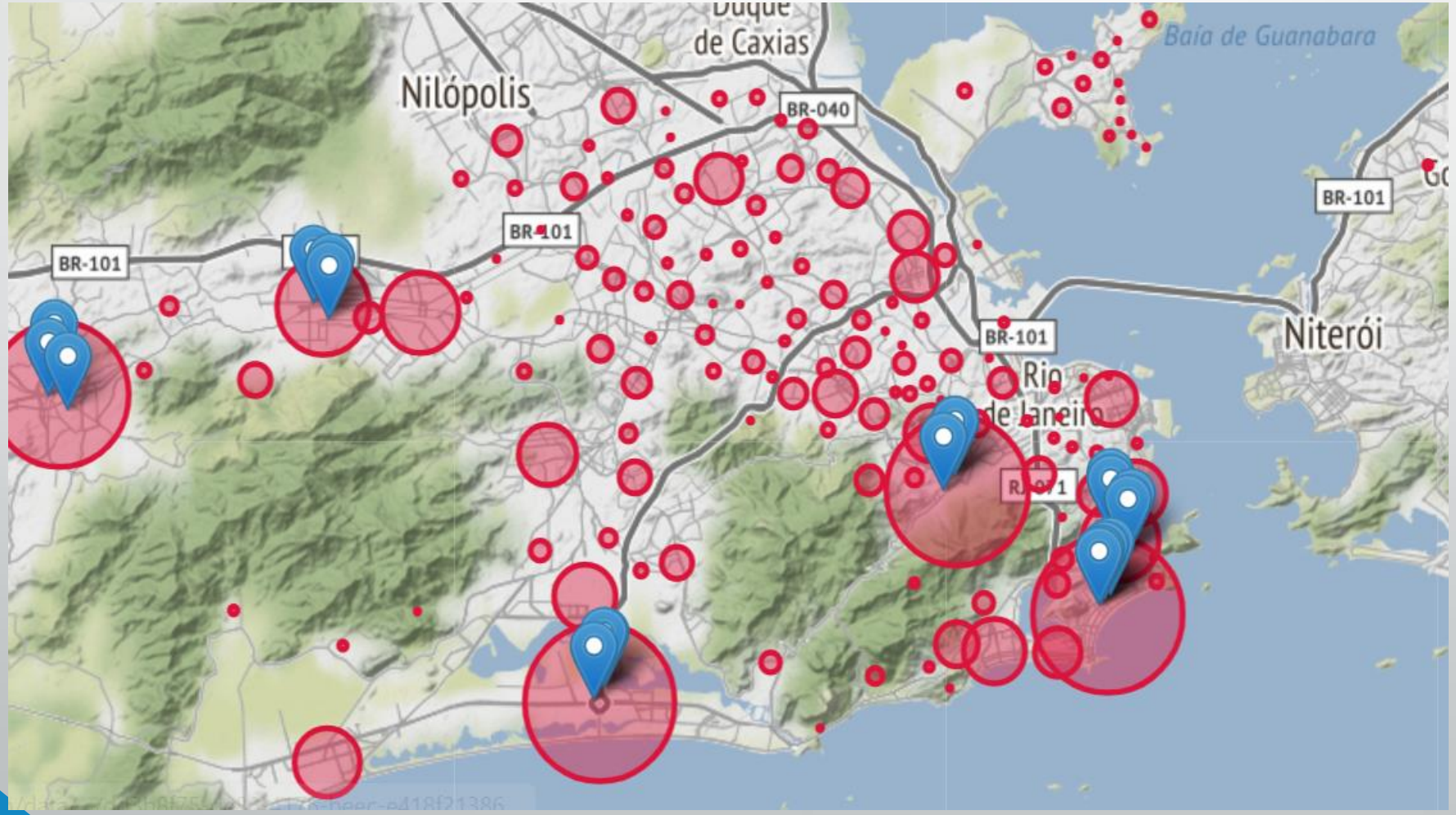
	HOSPITAL	DISTANCE(KM)
147	Hospital Cardoso Fontes	5.509080
9	Hospital Municipal Lourenço Jorge	5.577774
11	BikeRio - Estação 108 Hospital Lourenço Jorge	5.620739
10	Hospital Lourenço Jorge	6.197632
129	Biolife Hospitalar	6.275018

Results

- From initial analysis, 20 hospitals appeared as possible options

	NEIGHBOURHOOD	HOSPITAL	HOSPITAL LATITUDE	HOSPITAL LONGITUDE
0	copacabana	Hospital San Magno	-22.969902	-43.187972
1	copacabana	Hospital Copa D'or	-22.968952	-43.187092
2	copacabana	Hospital Miguel Couto - Serviço de Neurocirurgia	-22.966908	-43.183690
3	copacabana	Pronto Atendimento Unimed Rio	-22.967771	-43.185715
4	barra da tijuca	Hospital Municipal Lourenço Jorge	-22.995239	-43.364740
5	barra da tijuca	Hospital Lourenço Jorge	-22.999743	-43.368382
6	barra da tijuca	BikeRio - Estação 108 Hospital Lourenço Jorge	-22.995319	-43.365410
7	tijuca	Hospital Veterinário Canne & Gatto	-22.933902	-43.243249
8	tijuca	Hospital Tijutrauma	-22.928568	-43.239529
9	tijuca	Hospital	-22.928660	-43.239456
10	campo grande	Hospital WestDor	-22.903854	-43.563569
11	campo grande	hospital oeste dor	-22.908304	-43.556354
12	campo grande	Casa de Saúde Nossa Senhora do Carmo	-22.898326	-43.561291
13	bangu	Prosaúde Hospital de Clínicas	-22.879820	-43.463307
14	bangu	Hospital São Lourenço	-22.877684	-43.462823
15	bangu	CMS Waldyr Franco	-22.874973	-43.468639
16	botafogo	Hospital Amiu Botafogo	-22.946703	-43.183936
17	botafogo	Hospital Geral De Fortaleza do Exército	-22.951468	-43.176000
18	botafogo	Hospital Memorial Infantil Botafogo Amiu	-22.945337	-43.184080
19	botafogo	Laboratório Hospital Rocha Maia	-22.953232	-43.177586

Results


Duque
de Caxias
Nilópolis
BR-040
BR-101
BR-101
BR-101
BR-101
Baía de Guanabara
Niterói
Rio
de Janeiro

Results

- By using k-means, we came to a different set of 20 hospitals that were closest to the centroid with the highest number of cases.
- By cross-checking it with the first results we could find a good match for our suggrestion

	HOSPITAL	DISTANCE(KM)
147	Hospital Cardoso Fontes	5.509080
9	Hospital Municipal Lourenço Jorge	5.577774
11	BikeRio - Estação 108 Hospital Lourenço Jorge	5.620739
10	Hospital Lourenço Jorge	6.197632
129	Biolife Hospitalar	6.275018
128	Hospital Beneficência Portuguesa	6.275289
67	Pista do Instituto Nise da Silveira	6.462215
68	Ab Med Hospitalar	6.642900
62	Hospital Pedro II	6.686138
66	Hospital Psiquiátrico Nise da Silveira	6.701888
92	UTQ - Hospital Naval Marcílio Dias	6.735405
91	Hospital Naval Marcílio Dias	6.937256
65	AmericanCor Hospital	7.104640
123	Hospital Municipal da Piedade	7.232810
124	Hospital Municipal Da Piedade	7.251772
107	Hospital dos Óculos	7.732544
44	Hospital Pasteur	7.833094
0	Hospital Psiquiatrico	7.848777
106	Hospital Paster	7.863191
43	Hospital Norte D'Or	7.914414

Results

```
In [41]: c1_final = df_chosen_hospitals.merge(c1_hospitals, on='HOSPITAL')
         c1_final
```

Out[41]:

	NEIGHBOURHOOD	HOSPITAL	HOSPITAL LATITUDE	HOSPITAL LONGITUDE	DISTANCE(KM)
0	barra da tijuca	Hospital Municipal Lourenço Jorge	-22.995239	-43.364740	5.577774
1	barra da tijuca	Hospital Lourenço Jorge	-22.999743	-43.368382	6.197632
2	barra da tijuca	BikeRio - Estação 108 Hospital Lourenço Jorge	-22.995319	-43.365410	5.620739

- We can see that all 3 hospitals chosen are, in fact, the same hospital.
- This hospital is our 1st suggestion.
- Nonetheless, we can see that the focus of cases in the city are more spread apart, so it might be interesting to have other hospitals suggested

Discussion & Conclusion

- To better handle the distance between the neighborhoods with high number of cases, we decided to add 4 more hospitals.
- By looking at the original 20 hospitals and eliminating some that would not be fit to this type of situation, such as labs and veterinaries, we came to this final suggestion.

	NEIGHBOURHOOD	HOSPITAL	HOSPITAL LATITUDE	HOSPITAL LONGITUDE
0	copacabana	Hospital San Magno	-22.969902	-43.187972
4	barra da tijuca	Hospital Municipal Lourenço Jorge	-22.995239	-43.364740
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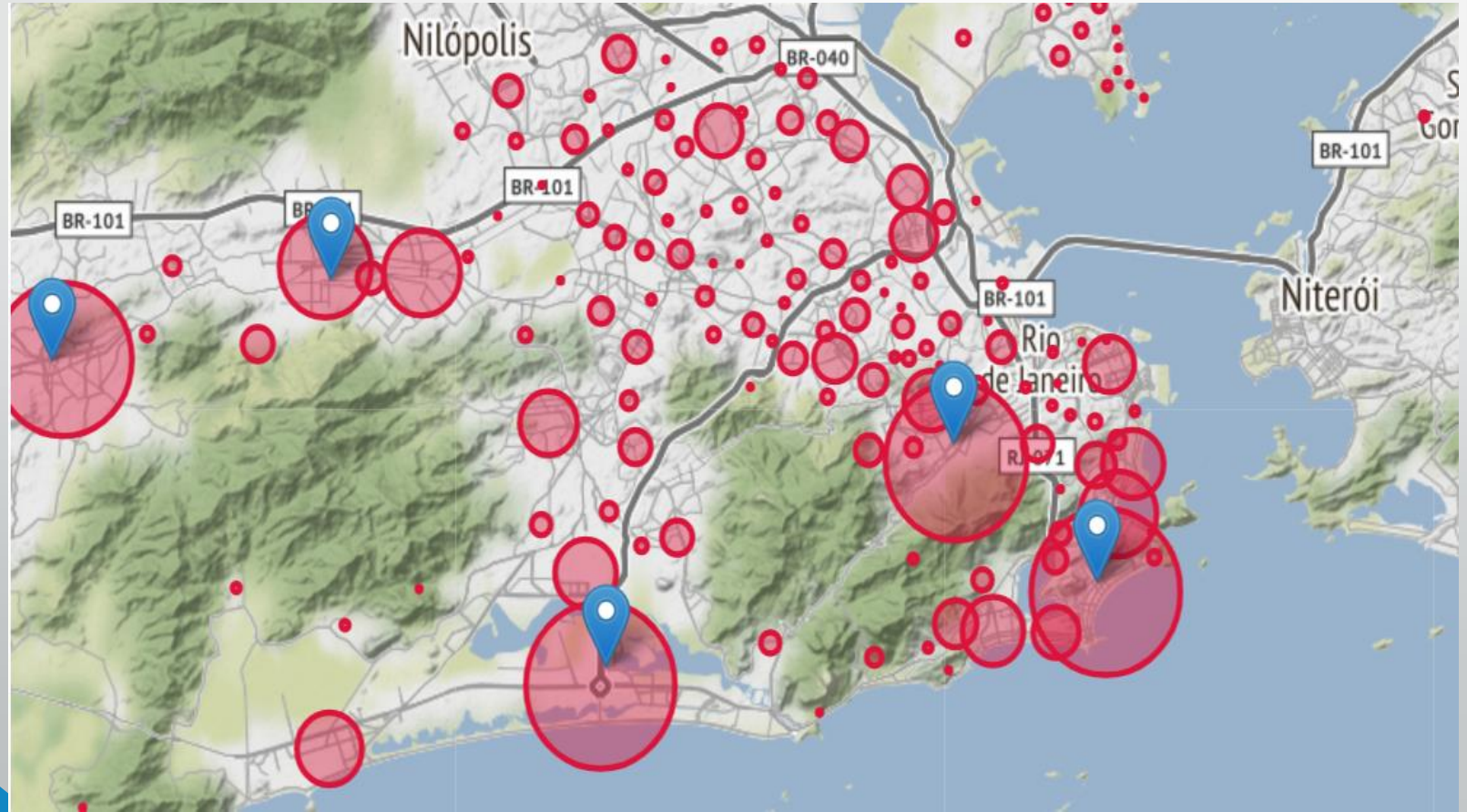
13	bangu	Prosaúde Hospital de Clínicas	-22.879820	-43.463307

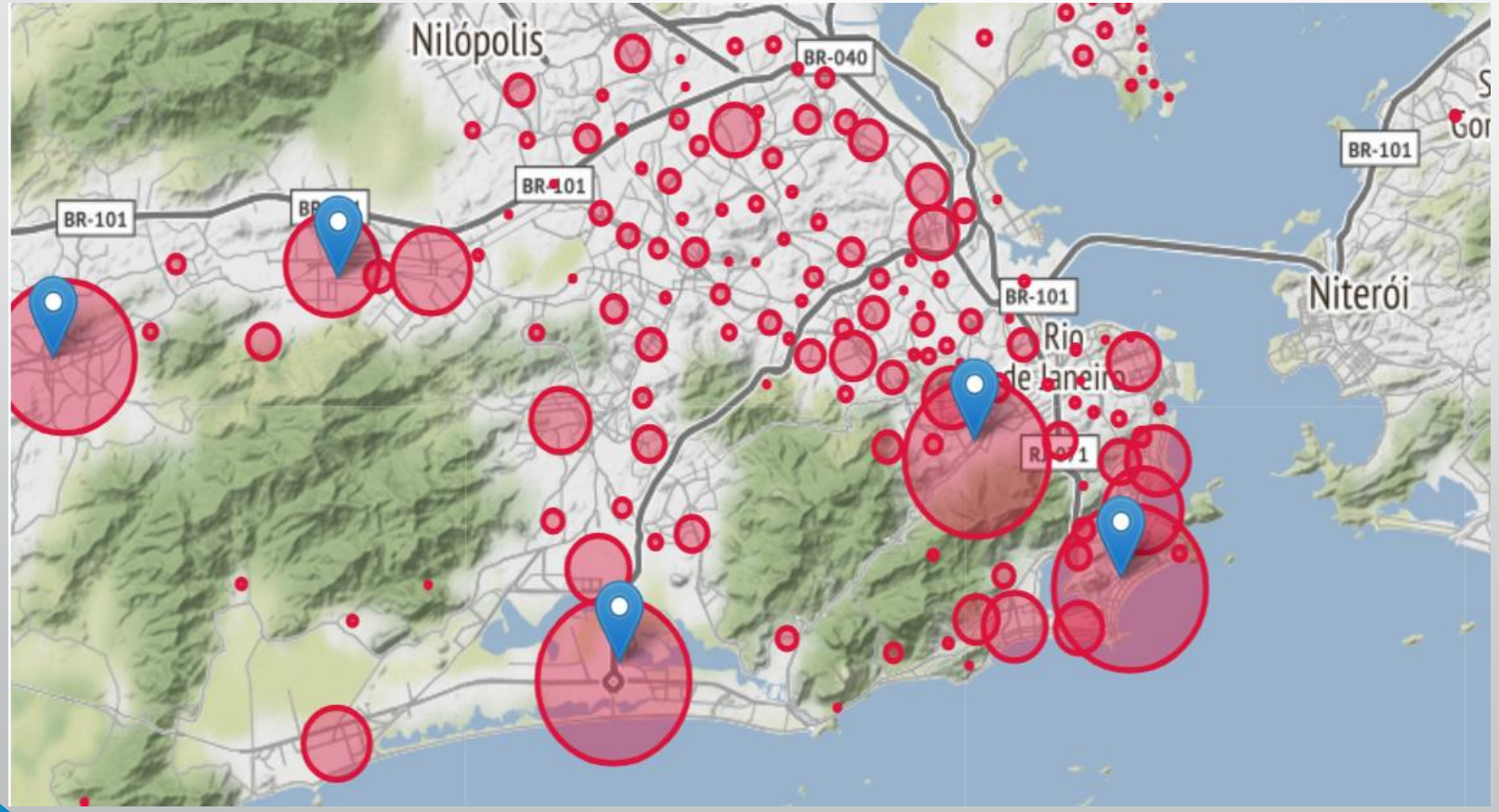
Discussion & Conclusion

- Here are the 5 hospitals distributed accross the city



Discussion & Conclusion

- Here are the 5 hospitals distributed accross the city



Discussion & Conclusion

- After analyzing the data, we suggested 5 hospitals to be the focus of resources to help fight he Covid-19 pandemic in the city of Rio de Janeiro. Even though there are other details that would impact such decisions, this can work as a first step to help decision makers in the government.