IBM Data Science

Battle of the Neighborhoods

PART-II Week 5

Vision: We are optimized for pandemics

1

Problem Statement and solution introduction, stakeholders

Problem Statement

Hospital overcrowding and lack of beds and personal protective equipment become commonplace in the event of pandemics as well as natural disasters and large scale emergencies. When this happens, an uneven utilization of available assets across area hospitals leads to the need for temporary facilities so that the delivery of assets and logistics can be better managed.

Current practices and pitfalls

The current practice of creating makeshift hospitals in stadiums and conference centers while aimed at reducing logistics planning overheads flies in the face of social separation. A large stadium full of COVID-19 patients cannot be a healthy environment for care givers.
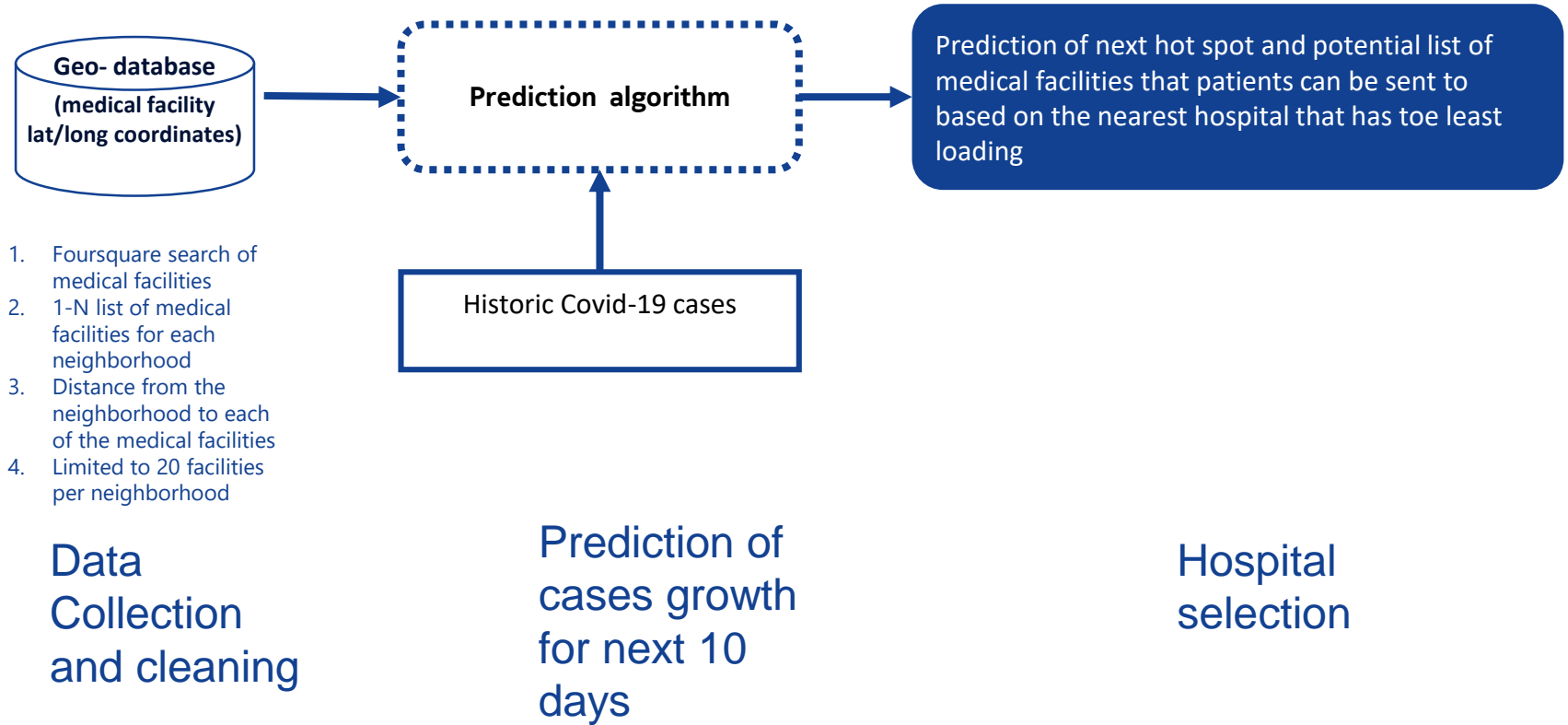More than the pathogenic environment it fosters, the psychological impact on patience being cast shoulder to shoulder in tents separated by semi-transparent plastic sheeting is not emblematic of a first world country!
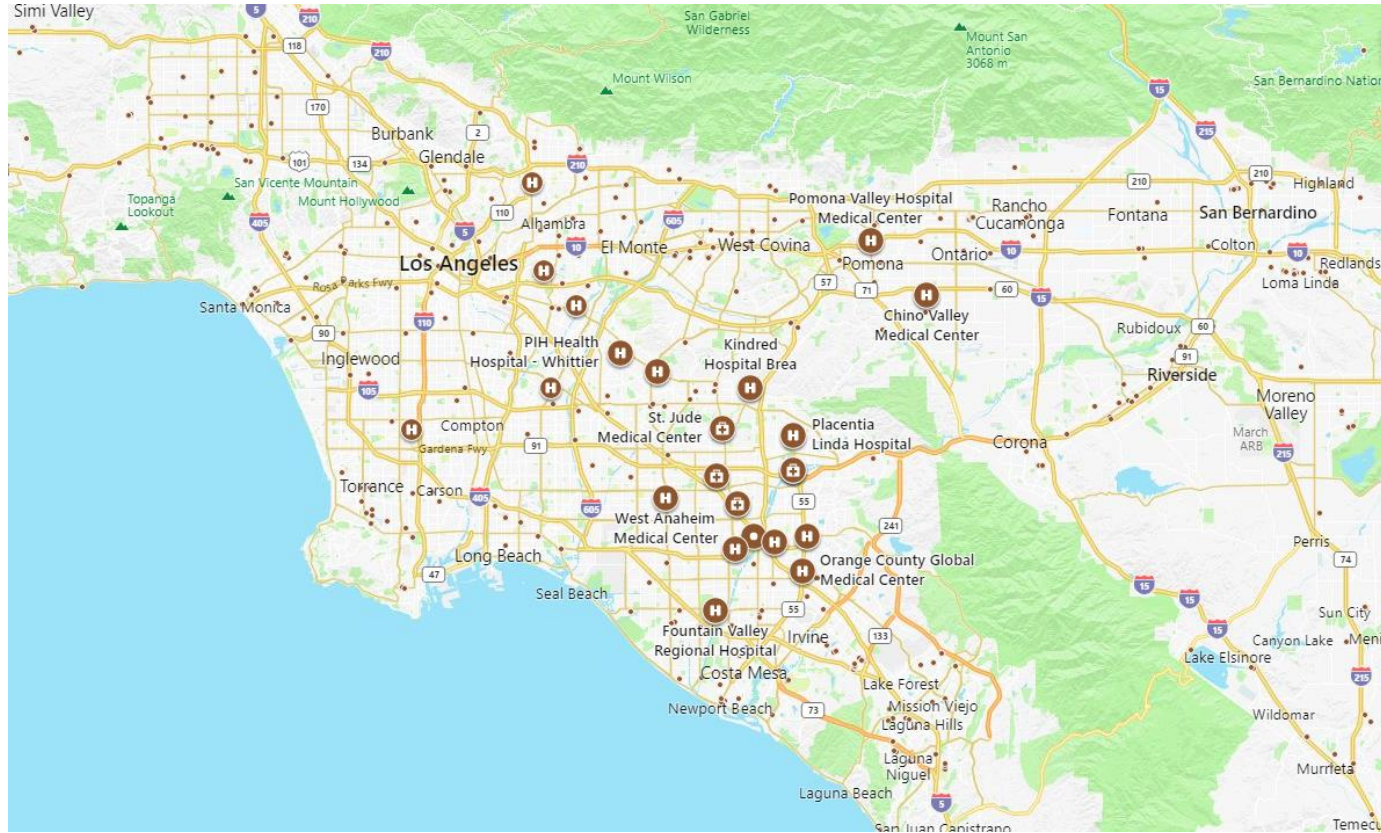
Solution

The problem of uneven utilization of available assets or locating assets in one concentrated area leads to high mobility rates in terms of movement of the assets or the physical movement of people needing those assets. This problem is not very different from mobile networks where equally distributed assets cause uneven loading and lead to addition of more assets rather than using proven "load balancing" measures. The solution envisioned for this problem is to borrow the load balancing methods from mobile networks to the problem of predicting where assets need to be deployed in order to cater to surge conditions.

Target Users: First responders, City planners, Hospital planners, Traffic modelers, state and federal agencies

Predictive load offloading

Geo- database

(medical facility lat/long coordinates)

Prediction algorithm

Prediction of next hot spot and potential list of medical facilities that patients can be sent to based on the nearest hospital that has toe least loading

1. Foursquare search of medical facilities
2. 1-N list of medical facilities for each neighborhood
3. Distance from the neighborhood to each of the medical facilities
4. Limited to 20 facilities per neighborhood

Historic Covid-19 cases

Data Collection and cleaning

Prediction of cases growth for next 10 days

Hospital selection

Example of hospital density in Los Angeles (Source: google maps)

Data shows sufficient hospital distribution densities to make this exercise useful

Note: Both ⓗ and brown dots(.) are hospital facilities

Useful Links for the project

- To Locate the coordinates of addresses, cities, countries, and landmarks across the globe
    - https://api.foursquare.com/v2/venues/search?   → Hospital locations searched here
    - https://worldhospitaldirectory.com   → Alternate source for validation
    - https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M   → Toronto postal codes
    - http://cocl.us/Geospatial_data   → Lat long for each postal code
        - Alternate source: Geocoder library

- Sources for covid-spread data
    - https://github.com/CSSEGISandData/COVID-19
    - *https://raw.githubusercontent.com/datasets/covid-19/master/data/key-countries-pivoted.csv*

- Prediction tool used
        https://facebook.github.io/prophet/   → Facebook Prophet for prediction

IBM Data Science

How the battle was won?

PART-II Week 5

Vision: We are optimized for pandemics

Let's first get a list of 20 hospitals for each Toronto postal code (borough)

```
hospital_names= df_hosp['name'].value_counts()
hospital_names
```

```
Out[18]:  St. Joseph's Health Centre                                              103
          Humber River Hospital                                                   103
          Bridgepoint Health                                                      103
          Toronto Rehabilitation Institute                                        103
          Michael Garron Hospital                                                 103
          Mount Sinai Hospital                                                    103
          North York General Hospital                                             103
          The Hospital for Sick Children (SickKids)                               103
          Princess Margaret Cancer Centre                                         103
          Toronto Western Hospital                                                103
          Providence HealthCare                                                   103
          Rouge Valley Centenary Hospital                                         103
          Sunnybrook Health Sciences Centre                                       103
          Women's College Hospital                                                103
          Markham Stouffville Hospital                                            102
          Etobicoke General Hospital                                               99
          Trillium Health Centre                                                   98
          Credit Valley Hospital                                                   81
          Toronto General Hospital                                                 58
          Southlake Regional Health Centre EMERGENCY                               46
          Southlake Regional Health Centre                                         46
          Brampton Civic Hospital                                                  34
          Sunnybrook Hospital                                                      32
          Oakville Trafalgar Memorial Hospital                                     13
          Childbirth & Children's Centre Wing at Markham Stouffville Hospital       5
          Emergency Toronto East General Hopital                                    2
          M-wing: Sunnybrook                                                        2
          Name: name, dtype: int64
```
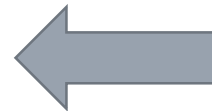
Four square search with category:

categoryID= '4bf58dd8d48988d1 96941735'

category for hospitals

Cleansed data shown here with number of unique occurences of each hospital

7

Let's map this data to the neighborhoods and also determine each hospitals individual lat/long location and distance to the borough

	Postal Code	Borough	Neighborhood	Latitude	Longitude	Hospital Name	Hospital lat	Hospital long	Hospital Postal	Hospital Distance	Nearest Hospital	Nearest Distance
0	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Women's College Hospital	43.661491	-79.387602	M5S 1B2	22424	Women's College Hospital	22424
1	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	The Hospital for Sick Children (SickKids)	43.657499	-79.386512	M5G 1X8	22687	Women's College Hospital	22424
2	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Humber River Hospital	43.724337	-79.488066	M3M 0B2	25329	Women's College Hospital	22424
3	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Michael Garron Hospital	43.689573	-79.326173	M4C 3E7	16802	Michael Garron Hospital	16802
4	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Southlake Regional Health Centre	44.061136	-79.452311	L3Y 2P9	35070	Michael Garron Hospital	16802
5	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Toronto General Hospital	43.658762	-79.388292	M5G 2C4	22682	Michael Garron Hospital	16802
6	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Toronto Western Hospital	43.653434	-79.406074	M5T 2S7	24105	Michael Garron Hospital	16802
7	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Southlake Regional Health Centre EMERGENCY	44.060452	-79.452570	L3Y 2P9	35021	Michael Garron Hospital	16802
8	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Toronto Rehabilitation Institute	43.656307	-79.389910	M5G 2A2	22970	Michael Garron Hospital	16802
9	M1B	Scarborough	Malvern / Rouge	43.806686	-79.194353	Markham Stouffville Hospital	43.883569	-79.232452	L3P 7P3	9088	Markham Stouffville Hospital	9088

We now have the 10 nearest hospitals to every Borough in Toronto. We also have the distance (in metres) to these hospitals

8

And a visual….

Willowdale / Newtonbrook, North York, Hospital-->, North York General Hospital, is, 4271,m away

The pop-up shows the distance to the nearest hospital from each neighborhood. Neighborhoods are shown in circles, Hospitals as pin markers.

These were the unique hospitals used with reachability from every neighborhood

```
df_cn_hospitals['Hospital Name'].unique()

24]: array(["Women's College Hospital",
            'The Hospital for Sick Children (SickKids)',
            'Humber River Hospital', 'Michael Garron Hospital',
            'Southlake Regional Health Centre', 'Toronto General Hospital',
            'Toronto Western Hospital',
            'Southlake Regional Health Centre EMERGENCY',
            'Toronto Rehabilitation Institute', 'Markham Stouffville Hospital',
            'Sunnybrook Health Sciences Centre', 'Bridgepoint Health',
            'North York General Hospital',
            "Childbirth & Children's Centre Wing at Markham Stouffville Hospital",
            'Sunnybrook Hospital', 'Providence HealthCare',
            'Mount Sinai Hospital', 'Rouge Valley Centenary Hospital',
            "St. Joseph's Health Centre", 'Princess Margaret Cancer Centre',
            'M-wing: Sunnybrook', 'Emergency Toronto East General Hopital',
            'Etobicoke General Hospital', 'Trillium Health Centre',
            'Brampton Civic Hospital', 'Credit Valley Hospital',
            'Oakville Trafalgar Memorial Hospital'], dtype=object)
```

List of hospitals used

With covid-19 (or any pandemic) growth history, we can predict future cases

The historic data of COVID-19 are obtained from:
https://raw.githubusercontent.com/datasets/covid-19/master/data/key-
countries-pivoted.csv

	ds	yhat	yhat_lower	yhat_upper
93	2020-04-24	9.064529e+05	9.037874e+05	9.090634e+05
94	2020-04-25	9.365384e+05	9.335875e+05	9.396962e+05
95	2020-04-26	9.659274e+05	9.622251e+05	9.693577e+05
96	2020-04-27	9.947620e+05	9.899890e+05	9.990143e+05
97	2020-04-28	1.024011e+06	1.017431e+06	1.030021e+06
98	2020-04-29	1.053512e+06	1.044276e+06	1.061977e+06
99	2020-04-30	1.084070e+06	1.073443e+06	1.095278e+06
100	2020-05-01	1.114952e+06	1.101186e+06	1.128903e+06
101	2020-05-02	1.145038e+06	1.128474e+06	1.160801e+06
102	2020-05-03	1.174427e+06	1.155105e+06	1.193529e+06

A simple Facebook Prophet based prediction tool is used to
predict the next 10 days of cases: yhat and 1-sigma ranges

Lack of granular data from public sources, the next steps are as follows:

With this 10 day prediction horizon, we can distribute the predicted loading across the granularity of our regions (neighborhoods)

A similar capability to monitor current hospital load factors will allow us to direct COVID-19 patients to the other hospitals

Absent hospital load factors, the solution will only predict demand in terms of resources in specific regions without

the capability to direct new cases to unloaded hospitals

Thank you !!