Detect the optimal location for hospitals in Bangalore, India

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1. INTRODUCTION

1.1 Background

Bengaluru (also called Bangalore) is the capital of India's southern Karnataka state. The center of India's high-tech industry, the city is also known for its parks and nightlife. It is the third-most-populous city in India. Since it is the third most populous city in India, we need to take care of the health of the people who are residing there. There are some startups in Bangalore which are working on health platforms. So, this project will be useful for the stakeholders who is planning to build a hospital in order to improve the health of Bangaloreans

1.2 Problem

When the stakeholder is planning to build a hospital in order to help people in emergency situations, it is better to computer distance between existing hospitals and find the areas with no or less hospitals. So, the purpose of this project is to find some optimal locations for hospitals.

Particularly, we are interested in locations of Bangalore, India and we will focus on the areas with less or no hospitals. We are focussing on areas with no hospitals or having less than 2 hospitals within 1 km and close to city center as possible.

We will use data analysis and clustering algorithm to generate the most optimal neighborhoods based on this criteria and suggest 5 neighbourhoods to the stakeholder as a result

2. METHODOLOGY

2. 1 Data requirements

Based on definition of our problem, factors that will influence our decision are:

- number of existing hospitals in the neighborhood
- distance between hospitals in the neighborhood

We decided to use regularly spaced grid of locations, centered around city center, to define our neighborhoods.

Following data sources will be needed to extract/generate the required information:

- centers of candidate areas will be generated algorithmically and approximate addresses of centers of those areas will be obtained using Google Maps API reverse geocoding
- number of hospitals and their location in every neighborhood will be obtained using Foursquare API

2. 2 Data collection

Shivaji nagar is the the centre of the Bangalore city and we will get the coordinates of that center location using Google Maps API. We will generate the centre coordinates of other neighbourhoods around the city center using calculations. Address of those coordinates will be determined using Google Maps API reverse geocoding. All medical related venues in the particular coordinates within specified radius will be gathered using Foursquare API.

In this project. Initially we are considering the radius as 1.2 km and approximately within 24 km from the city center and generated the neighbourhoods based on this radius and distance.

Here is the small sample of generated neighbourhoods along with address which is obtained using Google maps reverse geocoding API

	Address	Distance from center	Latitude	Longitude	X	Y
0	Unnamed Road, Bengaluru, Karnataka 560082	23969.981227	12.779765	77.537288	775469.290857	1.414131e+06
1	Unnamed Road, Bengaluru, Karnataka 560083	23361.506801	12.779551	77.559378	777869.290857	1.414131e+06
2	Unnamed Road, Bengaluru, Karnataka 562112	22988.692873	12.779336	77.581468	780269.290857	1.414131e+06
3	Unnamed Road, Bukkasagara, Karnataka 560105	22863.070660	12.779119	77.603558	782669.290857	1.414131e+06
4	Unnamed Road, Jigani, Karnataka 560105	22988.692873	12.778900	77.625647	785069.290857	1.414131e+06
5	Shagufta, Plot No. 322, Bommasandra Jigani Lin...	23361.506801	12.778679	77.647736	787469.290857	1.414131e+06
6	HENNAGARA Rd, Rajapura, Karnataka 562106	23969.981227	12.778457	77.669824	789869.290857	1.414131e+06
7	kaggalipura,kanakapura main road, opp.masjid,n...	23423.065555	12.798859	77.504336	771869.290857	1.416209e+06
8	Gulakamale Village, Near Kaggalipura 17th Mile...	22417.850031	12.798648	77.526429	774269.290857	1.416209e+06
9	Kaggalipura Road, Bengaluru, Karnataka 560083	21633.307653	12.798435	77.548521	776669.290857	1.416209e+06

Once we are ready with neighbourhoods, we started collecting hospitals using the location coordinates with the help of FourSquare API.

Now, we have data set which contains list of hospitals in our generated neighbourhoods along with their location details.

2. 3 Data understanding

We map our data to numpy array and then we will try to understand the data which we got from the previous step. We have got total of 571 venues related to medical.

```
import numpy as np

print('Total number of hospitals:', len(hospitals))
print('Average number of hospitals in neighborhood:', np.array([len(r) for r in location_hospit
als]).mean())
```

```
Total number of hospitals: 571
Average number of hospitals in neighborhood: 1.39285714286
```

Here is the small sample of list of hospitals which we got from the previous step.

```
print('List of all hospitals')
print('----------------------')
for r in list(hospitals.values())[0:10]:
    print(r)
print('...')
print('Total:', len(hospitals))
```

```
List of all hospitals
----------------------
('5c19fd2c3b8307002c64932a', "Ratkal's Rescue Urology Center", 12.921384, 77.48174, 'No 458, 6th
main road, opposite kalikamba temple, kengeri Satellite Town, Bangalore 560060, Karnātaka, Indi
a', 1088, 769284.0255233254, 1429746.6078434568)
('4d061c8d28926ea8bee473c2', 'Apollo Clinic', 12.956195880819386, 77.70551601419882, 'Bangalore,
Karnātaka, India', 1017, 793540.0061090232, 1433846.308695319)
('58edfa692980db13cf585243', 'Wishing Well Health Care Pvt. Ltd', 12.9991939, 77.59793400000001,
'19/1A 1st Main Rd, Bangalore 560046, Karnātaka, India', 1040, 781811.8000027211, 1438484.433925
7712)
('58480b22dfa6ff4be6f86c06', 'Smiles Dental Clinic', 13.000308, 77.617922, 'India', 1175, 78398
0.0977506011, 1438629.9831477357)
('4f94cface4b01143d31e7faa', 'PD Hinduja Sindhi Hospital', 12.964624439179051, 77.5929426653391
2, 'Sindhi Hospital Road, (12th A Cross, Behind Woodlands Hotel), Sampangirama Nagar 560027, Kar
nātaka, India', 1072, 781308.9562218275, 1434652.4626632233)
('4f448abbe4b00215c5c504fb', 'Narayana Nethralaya', 12.966955182435447, 77.6092272378153, 'Banga
lore, Karnātaka, India', 404, 783074.1383111181, 1434928.4699374768)
('4d3914a8769b6a31a426dccb', 'Impressions Dental Clinic', 12.97861039369236, 77.75115609169006,
'#6 Sindhu Bairavi, Whitefield Main Road (Opposite to Andhara Bank), Bangalore 560067, Karnātak
a, India', 648, 798468.4744019993, 1436380.572631709)
('4ff3c81ce4b0aeae9d0756f6', 'S M Hospital', 13.02103043, 77.60583401, 'Sultanpalya, India', 124
7, 782644.5253592799, 1440910.2816924634)
('4f214cece4b0272a56dc7b35', 'Tooth affair', 12.985145603462755, 77.67369736200135, 'India', 101
6, 790051.9083278645, 1437014.5151415225)
('4feaec89e4b0f8dd20aa3ee9', 'Sri Sai Child Clinic', 13.004496, 77.708906, 'Sri Sai Child Clinic
(Devasandra Main Road), K R Puram, Karnātaka, India', 826, 793851.2331591696, 1439196.938723122
5)
...
Total: 571
```

We can see the small sample of medical related venues around the particular location.

```
print('Hospitals around location')
print('--------------------------')
for i in range(0, 50):
    rs = location_hospitals[i][:8]
    names = ', '.join([r[1] for r in rs])
    print('Hospitals around location {}: {}'.format(i+1, names))
```

```
Hospitals around location
--------------------------
Hospitals around location 1:
Hospitals around location 2:
Hospitals around location 3:
Hospitals around location 4:
Hospitals around location 5:
Hospitals around location 6:
Hospitals around location 7:
Hospitals around location 8:
Hospitals around location 9: cadabams, Cadabam's Amitha - Centre for Short and Long Term Rehabil
itation Care
Hospitals around location 10:
Hospitals around location 11:
Hospitals around location 12:
Hospitals around location 13:
Hospitals around location 14:
Hospitals around location 15:
Hospitals around location 16:
Hospitals around location 17:
Hospitals around location 18:
Hospitals around location 19:
Hospitals around location 20: Sri Sri Ayurveda Hospital, Ashram Clinic
Hospitals around location 21:
Hospitals around location 22:
Hospitals around location 23: Bannerghatta Road Pet Clinic
Hospitals around location 24:
Hospitals around location 25:
Hospitals around location 26:
Hospitals around location 27:
Hospitals around location 28: Narayana Institute Of Cardiac Sciences, Bommasandra, Mazumdar Shaw
Medical Center, Bommasandra, Mazumdar Shaw Cancer Center, Narayana Health City, Narayana Nethral
aya Eye Hospital, Mazumdar-Shaw Cancer Center
Hospitals around location 29:
Hospitals around location 30:
Hospitals around location 31:
```

We calculated the average distance to closest hospital from each area center and it is about 2890m and refer the attached the screenshot below

```
distances_to_hospitals = []

for area_x, area_y in zip(xs, ys):
    min_distance = 10000
    for hosp in hospitals.values():
        res_x = hosp[6]
        res_y = hosp[7]
        d = calc_xy_distance(area_x, area_y, res_x, res_y)
        if d<min_distance:
            min_distance = d
    distances_to_hospitals.append(min_distance)

df_locations['Distance to Hospitals'] = distances_to_hospitals

df_locations.head(10)

print('Average distance to closest hospital from each area center:', df_locations['Distance to
 Hospitals'].mean())
```

```
Average distance to closest hospital from each area center: 2890.4462357494567
```

2. 4 Data Preparation

We will compute the distance of nearest hospital and count of nearby hospitals since these are major factors for out problem. Please the refer the screenshot below for a sample data which has the computed values

	Distance to hospitals	Hospitals nearby	Latitude	Longitude	X	Y
365	650.526222	2	13.050409	77.639543	786269.290857	1.444200e+06
366	310.108138	3	13.050334	77.646914	787069.290857	1.444200e+06
367	1011.315021	0	13.050258	77.654284	787869.290857	1.444200e+06
368	294.423340	6	13.057152	77.591696	781069.290857	1.444893e+06
369	734.336719	6	13.057078	77.599068	781869.290857	1.444893e+06
370	466.025129	3	13.057004	77.606439	782669.290857	1.444893e+06
371	530.950441	1	13.056930	77.613810	783469.290857	1.444893e+06
372	633.835450	1	13.056855	77.621181	784269.290857	1.444893e+06
373	966.167665	1	13.056780	77.628553	785069.290857	1.444893e+06
374	1105.425068	0	13.056705	77.635924	785869.290857	1.444893e+06

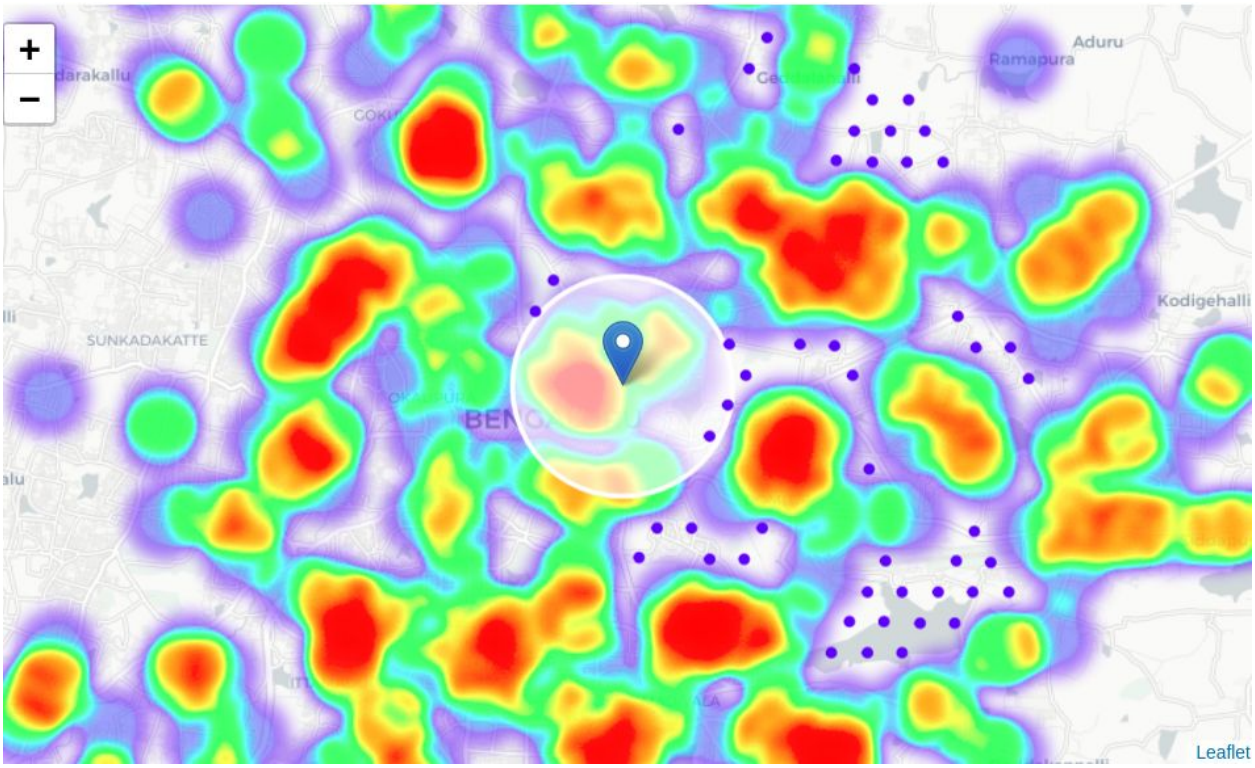
We are interested in locations where there is no hospitals or having less than 2 hospitals and here is our number of locations which satisfies our criteria

```
good_hosp_count = np.array((df_roi_locations['Hospitals nearby']<=2))
print('Locations with no more than two hospitals nearby:', good_hosp_count.sum())

good_hosp_distance = np.array(df_roi_locations['Distance to hospitals']>=1000)
print('Locations with no hospitals within 1km:', good_hosp_distance.sum())

good_locations = np.logical_and(good_hosp_count, good_hosp_distance)
print('Locations with both conditions met:', good_locations.sum())

df_good_locations = df_roi_locations[good_locations]
```

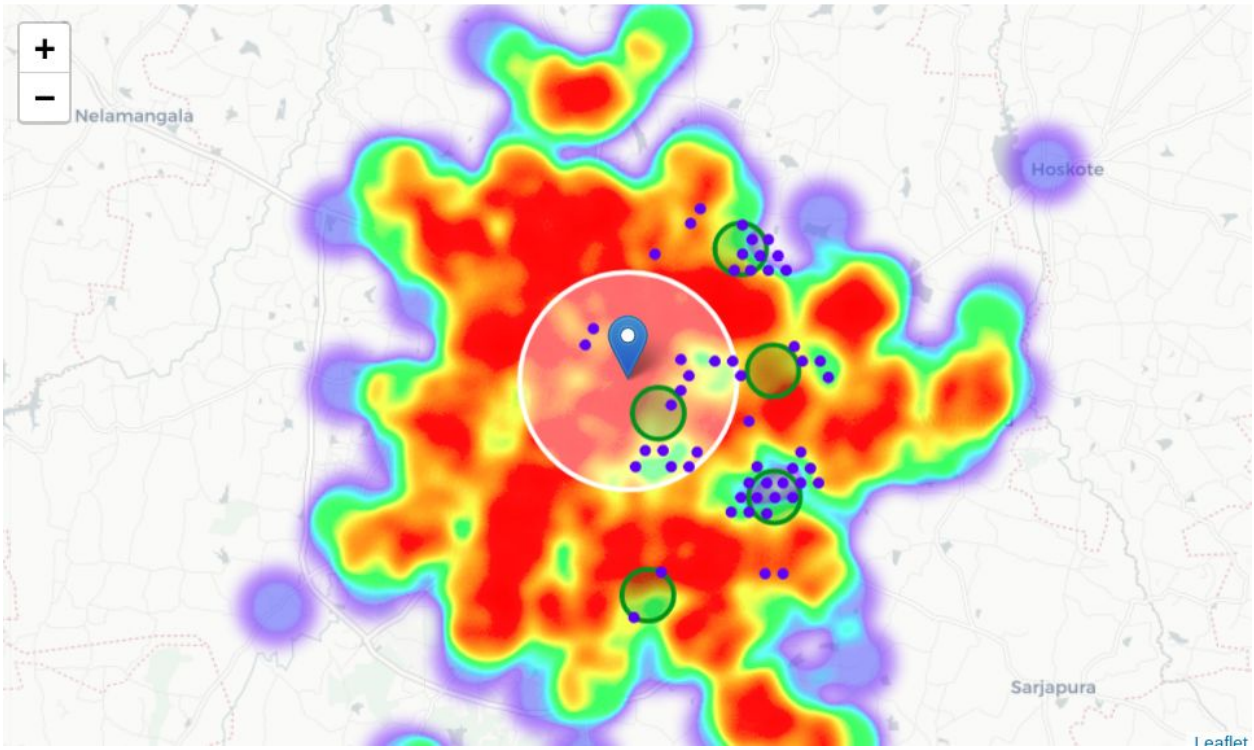
```
Locations with no more than two hospitals nearby: 181
Locations with no hospitals within 1km: 53
Locations with both conditions met: 53
```

2. 5 Modelling Algorithm

The following heatmap is showing the possible coordinates where a medical venue can be built satisfying our criteria



We will use **K-means clustering algorithm** to cluster the neighbourhoods which has more scope for building hospitals. The heat map will look the below attached figure after the neighborhoods are clustered



3. RESULTS & DISCUSSION

We have formed 5 clusters using K-means clustering which in turn we have got the 5 optimal locations for hospitals which satisfies our criteria "**Areas having no hospitals or less than 2 hospitals nearby and close to the city center as possible**"

So, we started with center of the city and generated the neighbourhoods. We got the list of hospitals using FourSquare API and find out the locations where building the hospital will really help the people and the stakeholders

Here is our curated list of optimal locations in bangalore to build a hospital or a medical venue.

```
candidate_area_addresses = []
print('================================================================')
print('Addresses of centers of areas recommended for further analysis')
print('================================================================\n')
for lon, lat in cluster_centers:
    addr = get_address(google_api_key, lat, lon).replace(', India', '')
    candidate_area_addresses.append(addr)
    x, y = lonlat_to_xy(lon, lat)
    d = calc_xy_distance(x, y, location_center_x, location_center_y)
    print('{}{} => {:.1f}km from Shivaji nagar'.format(addr, ' '*(50-len(addr)), d/1000))
```

```
================================================================
Addresses of centers of areas recommended for further analysis
================================================================

4th A Cross Road, Banjara Residency, Lakeview Residency, Bengaluru, Karnataka 560043 => 7.9km fr
om Shivaji nagar
Unnamed Road, Kempapura, Bellandur, Bengaluru, Karnataka 560017 => 8.6km from Shivaji nagar
18, MG Road, Craig Park Layout, Ashok Nagar, Bengaluru, Karnataka 560001 => 2.0km from Shivaji n
agar
45/1, 10th B Cross Rd, Nagavarapalya, C V Raman Nagar, Bengaluru, Karnataka 560093 => 6.7km from
Shivaji nagar
1, 1st Cross Rd, Kodichikknahalli, Bommanahalli, Bengaluru, Karnataka 560076 => 9.8km from Shiva
ji nagar
```

4. CONCLUSION

The main purpose of this project was to identify Bangalore areas close to center with low number of hospitals or no hospitals in order to aid stakeholders in narrowing down the search for optimal location for a new hospital. Final decision of location will be taken by stakeholders based on their additional needs like cost of building hospital in that area, road facilities etc..

5. REFERENCES

1. FourSquare API
2. Google maps
3. Wikipedia page about Bangalore Population