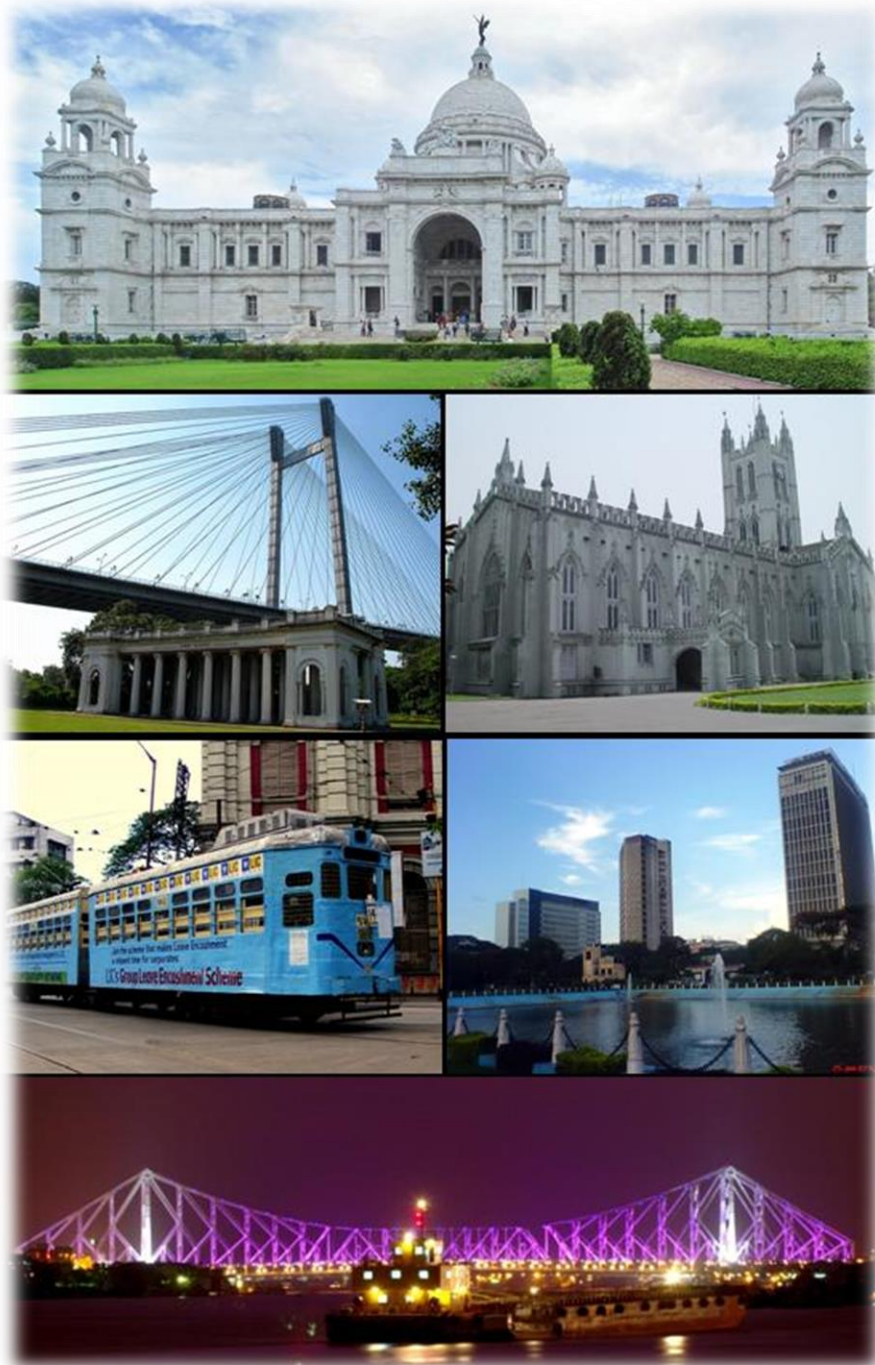


IBM Applied Data Science Capstone by Coursera

Opening a New Shopping Mall in Kolkata, India

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Introduction

For many shoppers, visiting shopping malls is a great way to relax and enjoy themselves during weekends and holidays. They can do grocery shopping, dine at restaurants, shop at the various fashion outlets, watch movies and perform many more activities. Shopping malls are like a one-stop destination for all types of shoppers. For retailers, the central location and the large crowd at the shopping malls provides a great distribution channel to market their products and services. Property developers are also taking advantage of this trend to build more shopping malls to cater to the demand. As a result, there are many shopping malls in the city of Kolkata and many more are being built. Opening shopping malls allows property developers to earn consistent rental income. Of course, as with any business decision, opening a new shopping mall requires serious consideration and is a lot more complicated than it seems. Particularly, the location of the shopping mall is one of the most important decisions that will determine whether the mall will be a success or a failure.

Business Problem

The objective of this capstone project is to analyse and select the best locations in the city of Kolkata, India to open a new shopping mall. Using data science methodology and machine learning techniques like clustering, this project aims to provide solutions to answer the business question: In the city of Kolkata, India, if a property developer is looking to open a new shopping mall, where would you recommend that they open it?

Target Audience of this project

This project is particularly useful for property developers and investors looking to open or invest in new shopping malls respectively in the city of Kolkata, the easternmost and one of the four metropolitan cities in India. This project is timely as the city is currently suffering from a disproportionate distribution of shopping malls which leads over-congestion in some parts of the city while other parts of the city are eagerly awaiting shopping malls in their vicinity. This also leads to huge problems in traffic management by the Kolkata Traffic Police as people from all over the city and its suburbs move into the areas having a high density of shopping malls. The other related issue would be provisioning of adequate public transport by the Kolkata State Transport Corporation authorities for the movement of people in and out of the areas with high density of shopping malls which at times leads to taxis/cabs charging exorbitant prices especially during peak hours as well as late night hours.

Data

To solve the problem, we will need the following data:

- List of neighbourhoods in Kolkata. This defines the scope of this project which is confined to the city and suburbs of Kolkata which is the easternmost and one of the 4 metropolitan cities of India
- Latitude and longitude coordinates of those neighbourhoods. This is required in order to plot the map and also to get the venue data.

- Venue data, particularly data related to shopping malls. We will use this data to perform clustering on the neighbourhoods.

Sources of data and methods to extract them

The Wikipedia page https://en.wikipedia.org/wiki/Category:Neighbourhoods_in_Kolkata contains a list of neighbourhoods in Kolkata and its suburb, with a total of 198 neighbourhoods. We will use web scraping techniques to extract the data from the Wikipedia page, with the help of **Python requests** and **Beautiful Soup** packages. Then we will get the geographical coordinates of the neighbourhoods using **Open Cage Geocoder** package which will give us the latitude and longitude coordinates of the neighbourhoods.

After that, we will use **Foursquare API** to get the venue data for those neighbourhoods. Foursquare has one of the largest database of 105+ million places and is used by over 125,000 developers. Foursquare API will provide many categories of the venue data, we are particularly interested in the Shopping Mall category in order to help us to solve the business problem put forward. This is a project that will make use of many data science skills, from web scraping (Wikipedia), working with API (Foursquare), data cleaning, data wrangling, to machine learning (K-means clustering) and map visualization (Folium). In the next section, we will present the Methodology section where we will discuss the steps taken in this project, the data analysis that we did and the machine learning technique that was used.

Methodology

Firstly, we need to get the list of neighbourhoods in the city of Kolkata and its suburbs. Fortunately, the list is available in the Wikipedia page (https://en.wikipedia.org/wiki/Category:Neighbourhoods_in_Kolkata). We will do web scraping using Python requests and BeautifulSoup packages to extract the list of neighbourhoods data. However, this is just a list of names. We need to get the geographical coordinates in the form of latitude and longitude in order to be able to use Foursquare API. To do so, we will use the Open Cage Geocoder package that will allow us to convert address into geographical coordinates in the form of latitude and longitude. After gathering the data, we will populate the data into a pandas DataFrame and then visualize the neighbourhoods in a map using Folium package. This allows us to perform a sanity check to make sure that the geographical coordinates data returned by Open Cage Geocoder are correctly plotted in the city of Kolkata.

Next, we will use Foursquare API to get the top 100 venues that are within a radius of 2000 meters. We need to register a Foursquare Developer Account in order to obtain the Foursquare ID and Foursquare secret key. We then make API calls to Foursquare passing in the geographical coordinates of the neighbourhoods in a Python loop. Foursquare will return the venue data in JSON format and we will extract the venue name, venue category, venue latitude and longitude. With the data, we can check how many venues were returned for each neighbourhood and examine how many unique categories can be curated from all the returned venues. Then, we will analyse each neighbourhood by grouping the rows by neighbourhood and taking the mean of the frequency of occurrence of each venue category. By doing so, we are also preparing the data for use in clustering. Since we are analysing the “Shopping Mall” data, we will filter the “Shopping Mall” as venue category for the neighbourhoods.

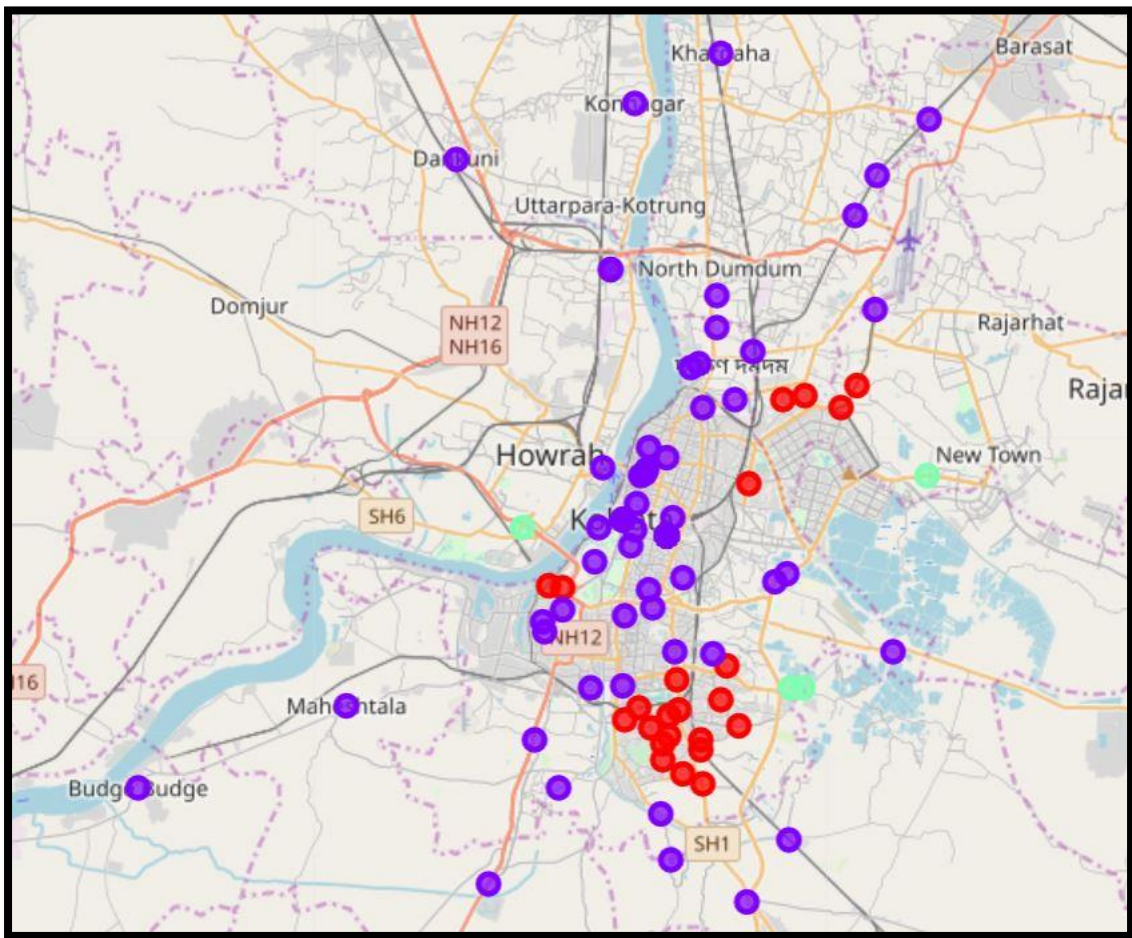
Lastly, we will perform clustering on the data by using k-means clustering. K-means clustering algorithm identifies k number of centroids, and then allocates every data point to the nearest cluster, while keeping the centroids as small as possible. It is one of the simplest and popular unsupervised machine learning algorithms and is particularly suited to solve the problem for this project. We will cluster the neighbourhoods into 3 clusters based on their frequency of occurrence for “Shopping Mall”. The results will allow us to identify which neighbourhoods have higher concentration of shopping malls while which neighbourhoods have fewer number of shopping malls. Based on the occurrence of shopping malls in different neighbourhoods, it will help us to answer the question as to which neighbourhoods are most suitable to open new shopping malls. 5

Results

The results from the k-means clustering show that we can categorize the neighbourhoods into 3 clusters based on the frequency of occurrence for “Shopping Mall”:

- Cluster 0: Neighbourhoods with moderate number of shopping malls (23 neighborhoods)
- Cluster 1: Neighbourhoods with low number to no existence of shopping malls (Majority neighborhoods)
- Cluster 2: Neighbourhoods with high concentration of shopping malls (4 neighborhoods)

The results of the clustering are visualized in the map below with cluster 0 in red colour, cluster 1 in purple colour, and cluster 2 in mint green colour.



Discussion

As observations noted from the map in the Results section, most of the shopping malls are highly concentrated in the 4 neighborhoods of Anandapur, Bidhannagar, Jetia and Kasba which forms cluster 2 and moderately concentrated in 23 neighborhoods which forms cluster 0. On the other hand, cluster 1 has very low number to no shopping mall in the neighbourhoods. This represents a great opportunity and high potential areas to open new shopping malls as there is very little to no competition from existing malls.

Meanwhile, shopping malls in cluster 2 are likely suffering from intense competition due to oversupply and high concentration of shopping malls. From another perspective, the results also show that the high density of shopping malls mostly happened in the central area of the city, with the suburb area still have very few shopping malls. Therefore, this project recommends property developers to capitalize on these findings to open new shopping malls in neighbourhoods in cluster 1 with little to no competition. Property developers with unique selling propositions to stand out from the competition can also open new shopping malls in neighbourhoods in cluster 0 with moderate competition. Lastly, property developers are advised to avoid neighbourhoods in cluster 2 which already have high concentration of shopping malls and suffering from intense competition. This will also alleviate the traffic management and public transportation challenges faced by the city authorities

Limitations and Suggestions for Future Research

In this project, we only consider one factor i.e. frequency of occurrence of shopping malls, there are other factors such as population and income of residents that could influence the location decision of a new shopping mall. However, to the best knowledge of this researcher such data are not available to the neighbourhood level required by this project. Future research could devise a methodology to estimate such data to be used in the clustering algorithm to determine the preferred locations to open a new shopping mall. In addition, this project made use of the free Sandbox Tier Account of Foursquare API and Open Cage Geocoder that came with limitations as to the number of API calls and results returned. Future research could make use of paid account to bypass these limitations and obtain more results.

Conclusion

In this project, we have gone through the process of identifying the business problem, specifying the data required, extracting and preparing the data, performing machine learning by clustering the data into 3 clusters based on their similarities, and lastly providing recommendations to the relevant stakeholders i.e. property developers and investors regarding the best locations to open a new shopping mall. To answer the business question that was raised in the introduction section, the answer proposed by this project is: The neighbourhoods in cluster 1 are the most preferred locations to open a new shopping mall. The findings of this project will help the relevant stakeholders to capitalize on the opportunities on high potential locations while avoiding overcrowded areas in their decisions to open a new shopping mall. This will also aim at alleviating the problems related to traffic management and public transportation faced by the city authorities.

References

- Category:Neighbourhoods in Kolkata. *Wikipedia*. Retrieved from https://en.wikipedia.org/wiki/Category:Neighbourhoods_in_Kolkata
- Foursquare Developers Documentation. *Foursquare*. Retrieved from <https://developer.foursquare.com/docs>
- OpenCage Geocoding API Documentation. Retrieved from <https://opencagedata.com/api#tutorials>

Appendix

Cluster 0 comprising of 23 Neighborhoods

Dhakuria, Bijoygarh, Bikramgarh, Jodhpur Park, Hastings, Haltu, Kalikapur, Golf Green, Gobindapur, Kankurgachi, Jadavpur, Katju Nagar, Gariahat Road, Garfa, Garden Reach, Charu Market, Bangur Avenue, Lake Town, Lake Gardens, Dum Dum Park, Baghajatin, Dharmatala, Baguiati

Cluster 1 comprising of 171 neighborhoods

Dum Dum, Hanspukuria, Haridevpur, Harinavi, Dhuiya, Entally, Hatibagan, Hind Motor, Dharmapur, Howrah, Dhapa, Hridaypur, Hatgachha, Hatiara, Gondalpara, Girish Park, Ghola, Gayespur, Durganagar, Garulia, Garshyamnagar, Duttapukur, East Kolkata, Ekbalpur, Garia, Eksara, Ganye Gangadharpur, Fort William, Esplanade, Halisahar, Hugli-Chuchura, Abhirampur, Ichhapur Defence Estate, Keota, Kesabpur, Kestopur, Khalia, Khantora, Khardaha, Kidderpore, Kodalia, Kolkata West International City, Konnagar, Kripampur, Kudghat, Kulihanda, Kumortuli, Lalbazar, Liluah, Madhyamgram, Maheshtala, Mahiari, Kaugachhi, Ichapore, Kanyanagar, Kanganbaria, Jafarpur, Jagacha, Dhalai Bridge, Jagatdal, Janbazar, Jhorhat, Joka, Jorabagan, Jorasanko, Kadamtala, Kaikhali, Kalara, Kalighat, Kalua, Kalyani, Kamalgazi, Kamarhati, Kanaipur, Kanchrapara, Kantlia, Jagadishpur, Dankuni, Daulatpur, Bansdrone, Bantala, Banupur, Baranagar, Barasat, Barisha, Barkalikapur, Barrackpore, Barrackpur Cantonment, Bartala, Baruipur, Batanagar, Behala, Belgachia, Belgharia, Beliaghata, Belur, Beniapukur, Benjanhari Acharial, Bansberia, Bankra, Bandel, Bamunari, Agarpara, Ajoy Nagar, Alipore, Amodghata, Amtala, Ankurhati, Argari, Asuti, B. B. D. Bagh, Debanandapur, Babughat, Bagbazar, Baidyabati, Balaram Pota, Balarampur, Bally, Bally, Ballygunge, Ballygunge Circular Road, Bamangachhi, Badartala, Bhadreswar, Bhadrakali, Bhangar Raghunathpur, Chak Enayetnagar, Chak Garia, Chak Kashipur, Chakapara, Champdani, Chamrail, Chandannagar, Chanddandaha, Chandpur, Chata Kalikapur, Chetla, Chinsurah, Chitpur, Chowringhee, Cossipore, Dakshin Jhapardaha, Dakshin Rajyadharpur, Dakshin Raypur, Dakshineswar, Danga, Makardaha, Chak Baria, Bhandardaha, Smita Bakshi, Calcutta Riverside, Bhasa, Bhatpara, Bhowanipore, Bidyadharpur, Bijpur, Bipra Noapara, Birati, Chak Alampur, Bishnupur, Birlapur, Bow Barracks, Bowali, Bowbazar, Brahmapur, Budge Budge, Buita, Burrabazar, Burtolla, Calcutta International School, Bora Gagangohalia

Cluster 2 – Comprising of 4 Neighborhoods

Anandapur, Bidhannagar, Jetia, Kasba