# IBM Data Science Specialization:
# Capatone Project

## *Opening a new Chinese Restaurant in Mumbai, India*

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# Introduction

Mumbai is fast becoming one of the places where people prefer to have Chinese cuisines and good service. Chinese food is always favoured by people of all ages-Soups, momos, noodles and dim sums to name a few. People in Mumbai are no different. Nowadays most teenagers in Mumbai savour eating Chinese noodles which could range from Hakka, chilli chicken, tom yum soups etc. The following business case aims to study the density and population of such restaurants all over the city of Mumbai in an attempt to suggest the best possible location for a business owner to start & set up a new Chinese restaurant in Mumbai.

**Business Problem**

The objective of this capstone project is to analyse and select the best locations in the city of Mumbai, India to open a new Chinese restaurant. 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 Mumbai, India, if a business owner is looking to open a new Chinese restaurant, where would you recommend that they open it?

**Target Audience of this project**

This project is particularly useful to business owners and investors looking to open or invest in new Chinese restaurants in the largest city of India i.e. Mumbai. This project is timely as the city is currently suffering from oversupply of Chinese restaurants. Data from the National Property Information Centre (NAPIC) released last year showed that an additional 15 per cent will be added to existing restaurant space, and the agency predicted that total occupancy may dip below 86 per cent. The local newspaper The Mumbai Mirror also reported in March last year that the true occupancy rates in restaurants may be as low as 40 per cent in some areas, quoting a Financial Times (FT) article cataloguing the country's continued obsession with building more commercial space despite chronic oversupply.

# Data

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

- List of neighbourhoods in Mumbai. This defines the scope of this project which is confined to the city of Mumbai, the largest city of the country of India in Asia.
- 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 Chinese restaurants. We will use this data to perform clustering on the neighbourhoods.

**Sources of data and methods to extract them**

This Wikipedia page (https://en.wikipedia.org/wiki/Category:Neighbourhoods_in_Mumbai) contains a list of neighbourhoods in Mumbai, with a total of 70 neighbourhoods. We will use web scraping techniques to extract the data from the Wikipedia page, with the help of Python requests and beautifulsoup packages. Then we will get the geographical coordinates of the neighbourhoods using Python 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 Chinese restaurant 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 Mumbai. Fortunately, the list is available in the Wikipedia page (https://en.wikipedia.org/wiki/Category:Neighbourhoods_in_Mumbai). 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 wonderful 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 Geocoder are correctly plotted in the city of Mumbai.

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 “Chinese restaurant” data, we will filter the “Chinese restaurant” as venue category for the neighbourhoods.

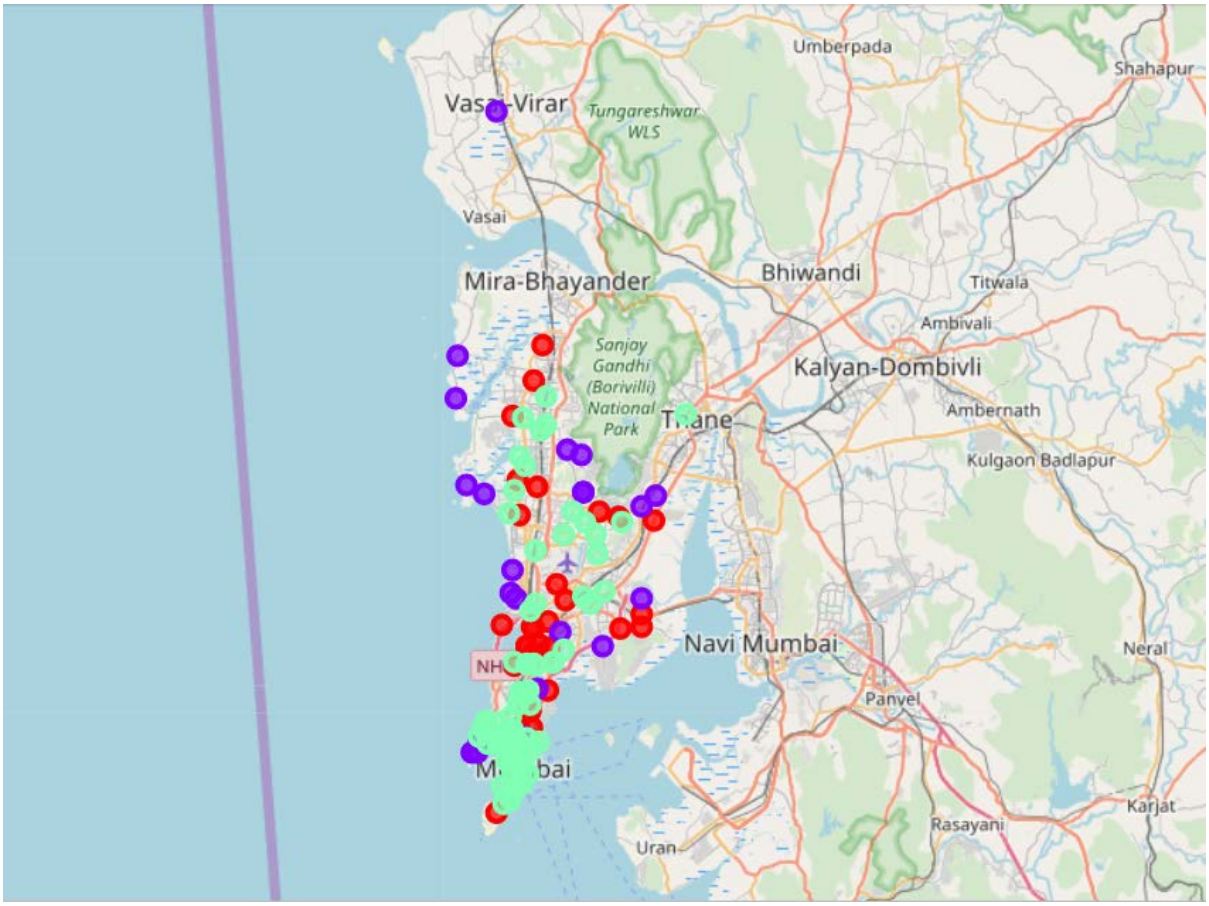
Lastly, we will perform clustering on the data by using k-means clustering. K-means clustering algorithm identifies k number of centroids, and then allocates every data point to the nearest cluster, while keeping the centroids as small as possible. It is one of the simplest and popular unsupervised machine 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 “Chinese restaurant”. The results will allow us to identify which neighbourhoods have higher concentration of Chinese restaurants while which neighbourhoods have fewer number of Chinese restaurants. Based on the occurrence of Chinese restaurants in different neighbourhoods, it will help us to answer the question as to which neighbourhoods are most suitable to open new Chinese restaurants.

# 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 “Chinese restaurant”:

- Cluster 0: Neighbourhoods with moderate number of Chinese restaurants
- Cluster 1: Neighbourhoods with low number to no existence of Chinese restaurants
- Cluster 2: Neighbourhoods with high concentration of Chinese restaurants

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 Chinese restaurants are concentrated in the central area of Mumbai city, with the highest number in cluster 2 and moderate number in cluster 0. On the other hand, cluster 1 has very low number to no Chinese restaurant in the neighbourhoods. This represents a great opportunity and high potential areas to open new Chinese restaurants as there is very little to no competition from existing malls. Meanwhile, Chinese restaurants in cluster 2 are likely suffering from intense competition due to oversupply and high concentration of Chinese restaurants. From another perspective, the results also show that the oversupply of Chinese restaurants mostly happened in the central area of the city, with the suburb area still have very few Chinese restaurants. Therefore, this project recommends business owners to capitalize on these findings to open new Chinese restaurants in neighbourhoods in cluster 1 with little to no competition. business owners with unique selling propositions to stand out from the competition can also open new Chinese restaurants in neighbourhoods in cluster 0 with moderate competition. Lastly, business owners are advised to avoid neighbourhoods in cluster 2 which already have high concentration of Chinese restaurants and suffering from intense competition.

# Limitations and Suggestions for Future Research

In this project, we only consider one factor i.e. frequency of occurrence of Chinese restaurants, there are other factors such as population and income of residents that could influence the location decision of a new Chinese restaurant. 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 Chinese restaurant. In addition, this project made use of the free Sandbox Tier Account of Foursquare API 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. business owners and investors regarding the best locations to open a new Chinese restaurant. 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 Chinese restaurant. 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 Chinese restaurant.