

# Neighbourhoods of Bali Island

## 1. Introduction

### 1.1. Background

Bali is one of Indonesia's main tourist destinations. It is renowned for its highly developed arts, including traditional and modern dance, sculpture, painting, leather, metalworking, and music. The Indonesian International Film Festival is held every year in Bali. In March 2017, TripAdvisor named Bali as the world's top destination in its Traveller's Choice award.

In 2017, international tourists visiting Bali reached more than 5 million tourists. It was almost one million more than the number of tourists coming to Bali in 2016. Tourism-related business makes up 80% of its economy, accounted for 40% of Indonesia tourism sector. This sector includes tourist attractions, means of accommodation, transportation and other related business.

### 1.2. Problem

Growing tourism business in the area shows both investor's and tourist's interest in Bali. Therefore, it's advantageous for investor and tourist to get to know more about Bali. This project aims to segment and cluster Bali neighbourhoods based on given data about Bali administrative area and venues. This project sets focus on 2 main tourist destinations and neighbouring cities in Bali: Denpasar and Badung city.

## 2. Data

### 2.1. Data description

In order to do the prediction, several data required including:

- List of Bali's boroughs, neighbourhoods and cities from local government.
- Latitudes and longitudes of each neighbourhoods obtained from Google Geocoding API.
- Nearby venues for each neighbourhood will be obtained using Foursquare API.

We will use district lists from local government to define the neighbourhood. This is preferable because a tourism attraction distance to another could vary and each district offers different kind of attraction.

Denpasar is the capital city of Bali Island. So, there will be administrative offices too. The neighbouring city, Badung, is well-known for beach-themed tourist destinations. Badung spreads from southern part of Bali to its central part, north of Denpasar. Both cities geographical situation shown on figure 1 and figure 2.



*Figure 1. Denpasar*



*Figure 2. Badung*

## 2.2. Data Preparation / Cleaning

This project chooses to focus on 2 main tourist destinations and neighbouring cities in Bali: Denpasar and Badung city. Denpasar has 4 boroughs and 43 neighbourhoods. Badung has 6 boroughs and 62 neighbourhoods. Head of neighbourhood list is shown on table 1.

	Neighbourhood	Borough	City
0	Dauh Puri Kaja	Denpasar Utara	Denpasar
1	Dauh Puri Kangin	Denpasar Barat	Denpasar
2	Dauh Puri	Denpasar Barat	Denpasar
3	Dauh Puri Kauh	Denpasar Barat	Denpasar
4	Dauh Puri Klod/Kelod	Denpasar Barat	Denpasar

Table 1. Neighbourhoods in Denpasar and Badung

Initially, this project tried using postal codes as focal points of research. But, later found that postal codes don't represent the spread of neighbourhoods, venues and tourist attractions in the area. Therefore, we chose neighbourhoods as focal points. Approximate points distribution of postal codes retrieved from Google Geocode API shown in figure 3.

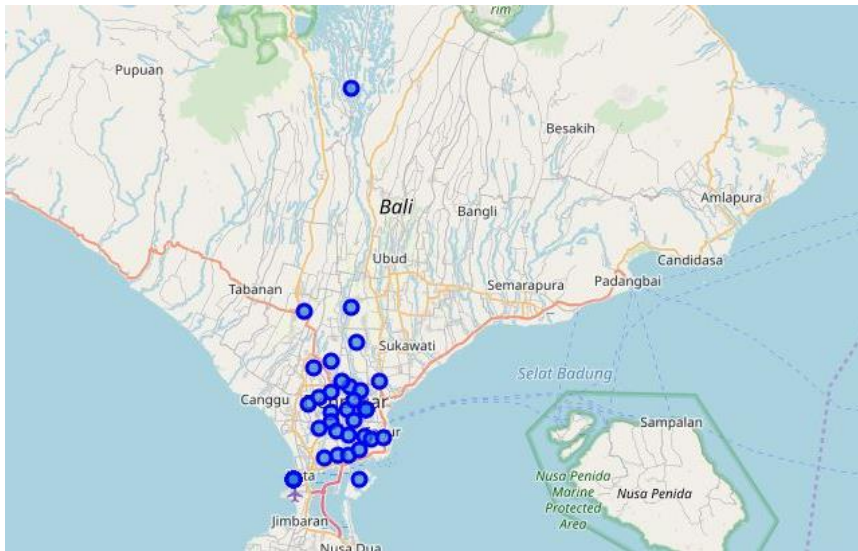


Figure 3. Postal code distribution of Denpasar and Badung

### 3. Methodology

As a database, I used GitHub repository in my study. My master data which has the main components City, Borough, Neighbourhood, Latitude and Longitude. I merged latitudes and longitudes of each neighbourhood retrieved from Google Geocode API with the list of neighbourhoods.

I used the latitudes and longitudes to find nearby venues around each neighbourhood with Foursquare API. I utilized the Foursquare API to explore the boroughs and segment them. I designed the limit as 100 venue and the radius 1 km for each borough from their given latitude and longitude information.

Later, I found 6 neighbourhoods don't have any nearby venues at all. These neighbourhoods were dropped and not used in further analysis. Head of neighbourhood latitudes and longitudes list is shown on table 2.

	Neighbourhood	Borough	City	Latitude	Longitude	Address
0	Dauh Puri Kaja	Denpasar Utara	Denpasar	-8.641273	115.214111	Dauh Puri Kaja, North Denpasar, Denpasar City,...
1	Dauh Puri Kangin	Denpasar Barat	Denpasar	-8.658289	115.214852	Dauh Puri Kangin, West Denpasar, Denpasar City...
2	Dauh Puri	Denpasar Barat	Denpasar	-8.663823	115.217075	Dauh Puri, West Denpasar, Denpasar City, Bali,...
3	Dauh Puri Kauh	Denpasar Barat	Denpasar	-8.679832	115.205219	Dauh Puri Kauh, West Denpasar, Denpasar City, ...
4	Dauh Puri Klod/Kelod	Denpasar Barat	Denpasar	-8.677422	115.221521	Dauh Puri Klod, West Denpasar, Denpasar City, ...

Table 2. Latitudes and longitudes of the neighbourhoods

## 4. Analysis and Result

We have some common venue categories in boroughs. In this reason I used unsupervised learning K-means algorithm to cluster the boroughs. K-Means algorithm is one of the most common cluster methods of unsupervised learning. First, I analyzed the K-Means with elbow method. I use both distortion and inertia to find optimum k of the k-means. Neither distortion nor inertia really showed optimum k. I chose to cluster the neighbourhoods into 5 clusters because both graphs showed refraction from 5 degree later on. Both graphs shown on figure 4 and figure 5.

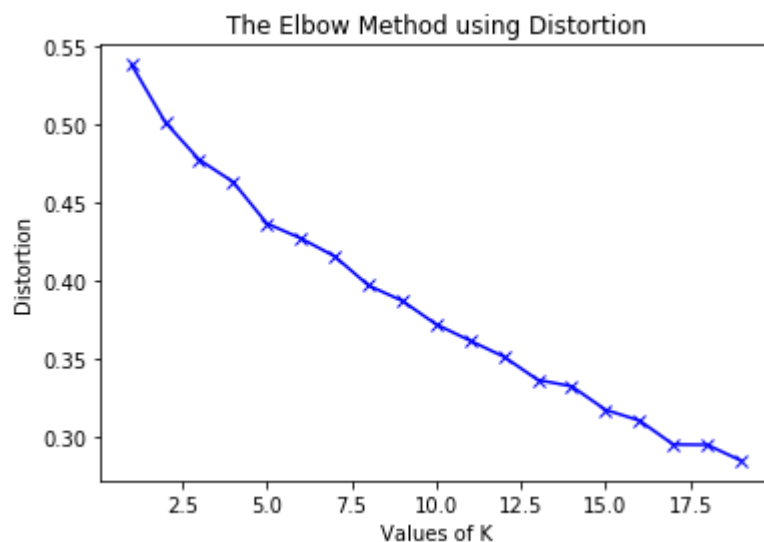


Figure 4. The elbow method using distortion

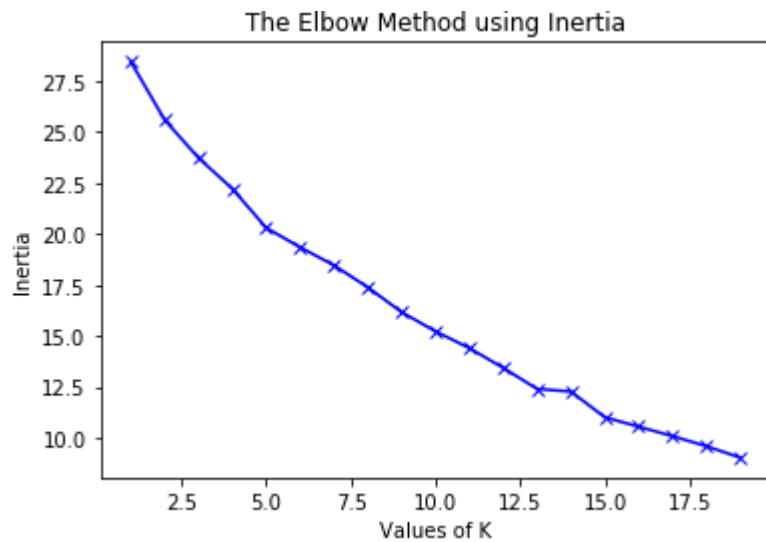


Figure 5. The elbow method using inertia

Head of merged table with cluster labels for each neighbourhood can be shown on table 3.

	Neighbourhood	Borough	City	Latitude	Longitude	Address	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	Dauh Puri Kaja	Denpasar Utara	Denpasar	-8.641273	115.214111	Dauh Puri Kaja, North Denpasar, Denpasar City, ...	0.0	Soccer Field	Coffee Shop	Snack Place	Hotel	Fast Food Restaurant	Middle School	Electronics Store	Flea Market	Fish Market	Fish & Chips Shop
1	Dauh Puri Kangin	Denpasar Barat	Denpasar	-8.658289	115.214852	Dauh Puri Kangin, West Denpasar, Denpasar City, ...	2.0	Jewelry Store	Asian Restaurant	Coffee Shop	Dessert Shop	Office	Chinese Restaurant	Monument / Landmark	Fast Food Restaurant	Flea Market	Food Truck
2	Dauh Puri	Denpasar Barat	Denpasar	-8.663823	115.217075	Dauh Puri, West Denpasar, Denpasar City, Bali, ...	2.0	Kids Store	Spa	Accessories Store	Indonesian Restaurant	Food Truck	Juice Bar	Food & Drink Shop	Noodle House	Dessert Shop	Department Store
3	Dauh Puri Kauh	Denpasar Barat	Denpasar	-8.679832	115.205219	Dauh Puri Kauh, West Denpasar, Denpasar City, ...	0.0	Electronics Store	Indonesian Restaurant	Bakery	Restaurant	Asian Restaurant	Karaoke Bar	Bistro	Bed & Breakfast	Javanese Restaurant	Japanese Restaurant
4	Dauh Puri Klod/Kelod	Denpasar Barat	Denpasar	-8.677422	115.221521	Dauh Puri Klod, West Denpasar, Denpasar City, ...	0.0	Indonesian Restaurant	Snack Place	Paper / Office Supplies Store	Bookstore	Noodle House	Vegetarian / Vegan Restaurant	Print Shop	Diner	Asian Restaurant	University

Table 3. Clusters of neighbourhoods in Denpasar and Badung

The spread of neighbourhood clusters can be shown in figure 6.

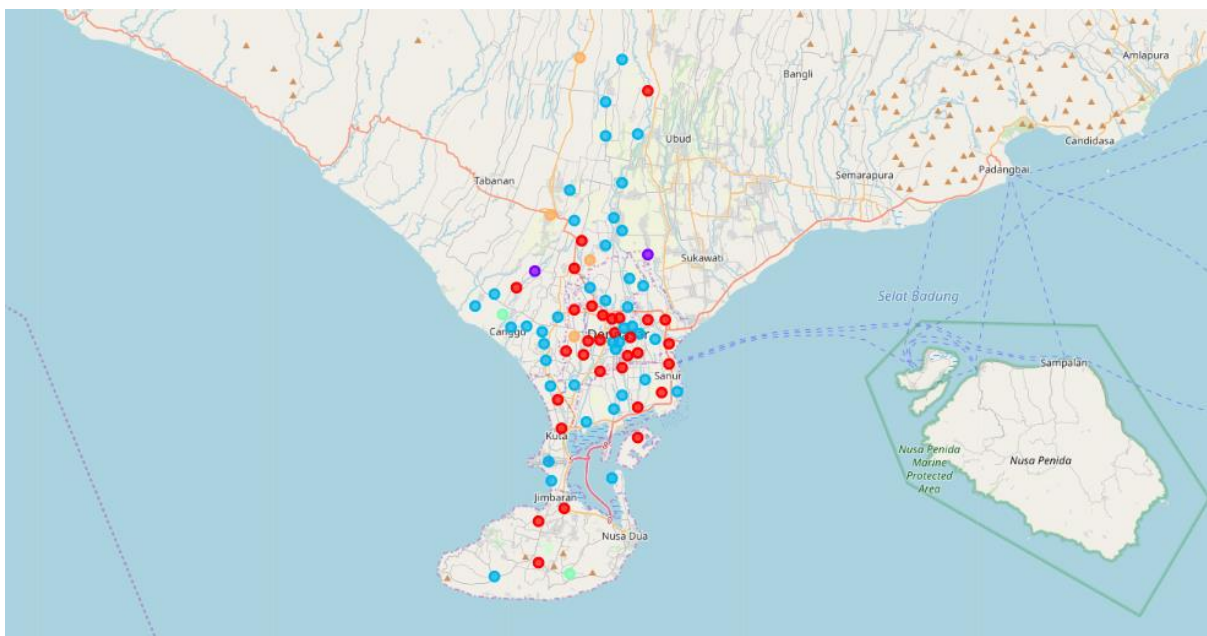


Figure 6 The spread of neighbourhoods clusters

## **5. Discussion**

Our analysis show that there are diverse venues for each neighbourhood so that segmenting and clustering with k-means doesn't really show optimum degree to cluster. Clustering result shows that most of neighbourhoods in Denpasar belong to cluster 0 and cluster 2. Neighbourhoods in Badung are more diverse and spread to all clusters.

Just like in Denpasar, neighbourhoods in Badung closer to means of transportation and tourist destination. Other neighbourhoods which belong to other cluster tend to be residential area with less destination.

Some neighbourhoods in Badung, especially in Mengwi and Abiansema have to be dropped from further analysis because there are no nearby venues in designated radius. This is possible due to lack of data available on Foursquare API. Future research is also possible by improving venues data with other APIs sources and by adding other variables such as distance from tourist attraction for tourism purpose or hotel rooms price and rating for accommodation purpose.

## **6. Conclusion**

Even though both Denpasar and Badung are close to each other, characteristics of both cities are different. Denpasar as the capital of Bali tends to be more organized and similar in all its neighbourhoods. Meanwhile, Badung is more diverse in form and characteristics of each neighbourhoods.