Land usage analyse of Stuttgart

1. Introduction

1.1. Background

Stuttgart is a German city located on the Neckar river in a fertile valley known locally as the "Stuttgart Cauldron". It lies an hour from the Swabian Jura and the Black Forest. Its urban area has a population of 634,830, making it the sixth-largest city in Germany. 2.8 million people live in the city's administrative region and 5.3 million people in its metropolitan area, making it the fourth-largest metropolitan area in Germany. The city and metropolitan areas are consistently ranked among the top 20 European metropolitan areas by GDP.

1.2. Problem

Data that might contribute to determining the usage of land in Stuttgart. The positions of different venues and numbers on Internet may show us, which category of business is adapt for different neighborhoods in Stuttgart. This analysis may help to know the land usage in Stuttgart.

1.3. Interest

For someone who plans to open a new shop in Stuttgart would be very interested, and who isn't familiar with Stuttgart. But this analysis is only a reference, we could only analyze the data for now.

2. Data acquisition and cleaning

2.1. Data sources

The Postcodes, neighborhoods name, and positions of the neighborhoods in Germany are accumulated. The data from Foursquare are also used, in order to get categories of different venues, and the number of comments for each venue in Stuttgart, which indicates the popularity of different categories of venues.

2.2. Data cleaning

The geodata of Germany includes also geodata from other states and cities, in this case, we only need data from Stuttgart, therefore the rows relevant with Stuttgart are picked out. After that, some columns of data are not be used, such as the name of states and name the country, so that these columns are delated. Finally, the geodata which is going to be analyzed has 125 rows and 5 columns.

	Postal code	Neighborhood	Borough	Latitude	Longitude
1481	70173	Stuttgart Stuttgart-Mitte	Stuttgart	48.7786	9.1767
1482	70173	Stuttgart	Stuttgart	48.7667	9.1833
1483	70174	Stuttgart Stuttgart-Mitte	Stuttgart	48.7827	9.1720
1484	70174	Stuttgart	Stuttgart	48.7667	9.1833
1485	70174	Stuttgart Stuttgart-Nord	Stuttgart	48.7978	9.1921
1486	70176	Stuttgart Stuttgart-Mitte	Stuttgart	48.7752	9.1585
1487	70176	Stuttgart	Stuttgart	48.7667	9.1833
1488	70176	Stuttgart Stuttgart-West	Stuttgart	48.7736	9.1641
1489	70178	Stuttgart	Stuttgart	48.7667	9.1833
1490	70178	Stuttgart Stuttgart-West	Stuttgart	48.7736	9.1641
1491	70178	Stuttgart Stuttgart-Mitte	Stuttgart	48.7728	9.1731

Then, the data of venue's categories and number of comments are accumulated. The API „Foursquare" are being used. The URL is constructed to send a request to the API to search for a

specific type of venues, to explore a particular venue, to explore a Foursquare user, to explore a geographical location.

	name	categories	lat	lng
0	Weinstube Hirsch	Greek Restaurant	48.726627	9.145099
1	Reyerhof	Farmers Market	48.724423	9.145183
2	Gasthaus Zur Linde	Swabian Restaurant	48.727674	9.150446
3	Osteria Tra Noi	Trattoria/Osteria	48.727878	9.144788
4	Jakes Diner Bar	Burger Joint	48.730788	9.148538

Finally, the geographical location of each neighborhoods and categories are combined with different venues. The venues in a distance of 600m of a neighborhood are divided into this neighborhood.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Stuttgart Stuttgart-Mitte	48.7786	9.1767	Feinkost Böhm	48.778077	9.176317	Gourmet Shop
1	Stuttgart Stuttgart-Mitte	48.7786	9.1767	Old Bridge	48.780007	9.177899	Ice Cream Shop
2	Stuttgart Stuttgart-Mitte	48.7786	9.1767	Schlossplatz	48.778549	9.179855	Plaza
3	Stuttgart Stuttgart-Mitte	48.7786	9.1767	Oggi Tavola Mediterranea	48.778835	9.176266	Italian Restaurant
4	Stuttgart Stuttgart-Mitte	48.7786	9.1767	Die Bierothek	48.779198	9.178369	Beer Store

2.3. Feature selection

After data cleaning, there are 6 attributes and 3039 different venues in the data, which belong to 189 different venue categories. There are also neighbourhoods for every venue, through these data the most common venues in a neighbourhood could be obtained, which help us to analyse the usage of land and classified.

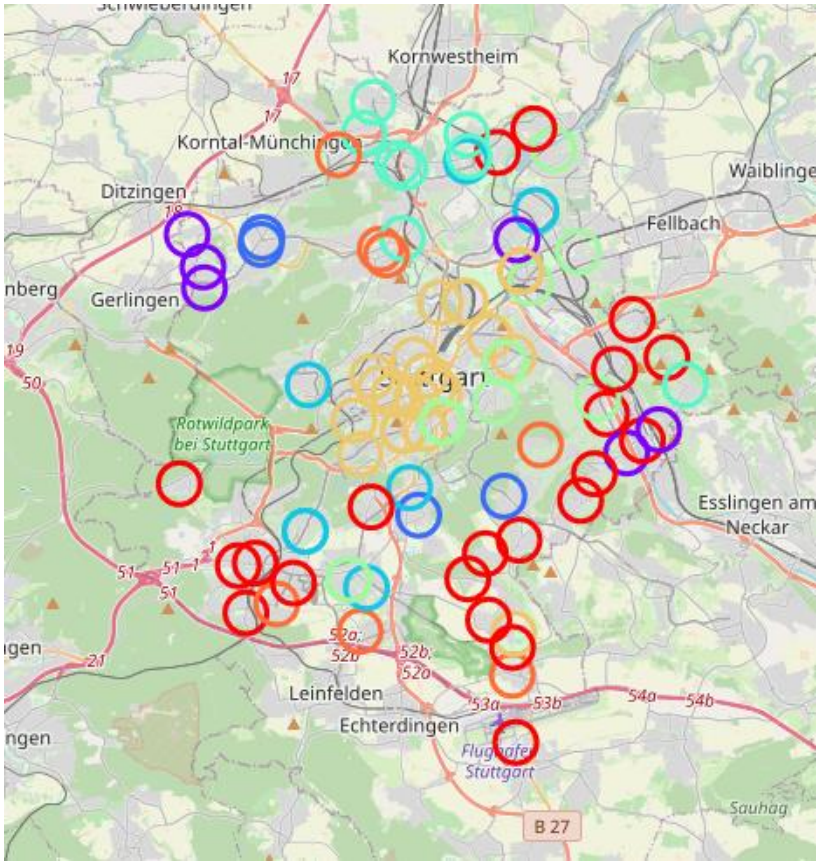
	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
0	Stuttgart	Bakery	German Restaurant	Hotel
1	Stuttgart Asemwald	Gastropub	Bus Station	Flower Shop
2	Stuttgart B?? snau	Bar	Plaza	Sandwich Place
3	Stuttgart Bad Cannstatt	Café	Bar	Plaza
4	Stuttgart Bergheim	Supermarket	Plaza	Business Service

After that, in order to process the cluster algorithms, the categorical variable has to convert variable into dummy/indicator variables. The geodata of the venues are also added to data in order to make a cluster. See the form below.

Neighborhood	African Restaurant	Asian Restaurant	Bakery	Bar	Big Box Store	Building	Bus Station	Café	Chinese Restaurant	Concert Hall	Fast Food Restaurant	Fried Chicken Joint	Gastropub	German Restaurant	Hc
Stuttgart	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
Stuttgart Asemwald	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
Stuttgart B?? snau	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
Stuttgart Bad Cannstatt	0	0	0	0	0	0	0	1	0	0	0	0	0	0	
Stuttgart Bergheim	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stuttgart Birkach	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stuttgart	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

3. Exploratory Data Analysis

In this case, the k-mean cluster algorithms to divide different neighbourhoods into 8 clusters. The map with different circles indicate different categories of neighborhoods.



In the map above, the neighborhoods in Stuttgart downtown are classified into one category, see the table below.

Neighborhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
Stuttgart Wangen	0	Concert Hall	German Restaurant	Ice Cream Shop
Stuttgart Rotenberg	0	German Restaurant	Park	Yoga Studio
Stuttgart Untert?? rkheim	0	Gastropub	Wine Shop	Pool
Stuttgart Luginsland	0	Playground	Italian Restaurant	German Pop-Up Restaurant
Stuttgart Rohracker	0	Fast Food Restaurant	Supermarket	Light Rail Station
Stuttgart Freiberg	0	Park	Bakery	Drugstore

The most common venues in downtown are various. That indicates the function of this area. In downtown, there are a lot of categories of venues. It indicates the commercial district in Stuttgart.

And the neighborhoods in Vaihingen and the neighborhoods in suburbs are classified into another category, in which most common venue is the supermarket. These areas belong to residential areas.

Neighborhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
Stuttgart Hedelfingen	1	Supermarket	Fast Food Restaurant	Lounge
Stuttgart Obert??rkheim	1	Supermarket	Fast Food Restaurant	Bus Station
Stuttgart Burgholzhof	1	Supermarket	Bakery	Hotel
Stuttgart Hausen	1	Supermarket	Italian Restaurant	Warehouse Store
Stuttgart Giebel	1	Supermarket	Metro Station	Plaza
Stuttgart Bergheim	1	Supermarket	Plaza	Business Service

And the most common venues are metro stations. These areas could be residential areas without enough supply of basic demand or enough jobs. These areas could also be a large enterprise or factory which have a large amount of employees. That means the people here have a high demand for public traffic.

Neighborhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
Stuttgart Botnang	3	Metro Station	Supermarket	Dance Studio
Stuttgart M?? nster	3	Metro Station	Supermarket	Botanical Garden
Stuttgart Rot	3	Metro Station	Train Station	Bus Stop
Stuttgart Degerloch	3	Metro Station	Supermarket	Bakery
Stuttgart Kaltental	3	Metro Station	Garden	German Restaurant

But some of clusters could not indicate the usage of area, like the neighbourhoods below.

Neighborhood	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
Stuttgart Wolfbusch	2	Ice Cream Shop	Supermarket	Drugstore
Stuttgart Weilimdorf	2	Ice Cream Shop	Supermarket	Drugstore
Stuttgart Hoffeld	2	Ice Cream Shop	Bakery	Supermarket
Stuttgart Sillenbuch	2	Ice Cream Shop	Pizza Place	Supermarket

4. Conclusions

The clusters of different neighborhoods could indicate some land usage in Stuttgart, but there is also an area that could not be right clustered. In conclusion, this method could be used in the geographic analysis as a reference.

5. Future directions

In this case, only the position of the neighborhoods and the most common venues are considered. In future, more attributes may be considered, such as the terrain, population, and air pollution. These attributes may contribute to a more accurate result.