The Battle of Neighborhoods

This is a report for the capstone project for Applied Data Science Capstone. It includes six sections as follows:

- Introduction
- Data
- Methodology
- Results
- Discussion
- Conclusion

Introduction

Manchester and Liverpool are two major cities in North West England. Both cities are noted for their culture, architecture, musical exports, sports clubs and transport links.
According to Wikepedia (www.wikipedia.org):

> * Manchester is the third-most visited city in the UK with a population of 545,500 as of 2017 and with a GDP of $102.3bn (2015). The economy grew relatively strongly between 2002 and 2012.
>
> According to 2019 property investment research, Manchester is rated as the second location for "The Best Places to Invest in Property In The UK".
>
> * Liverpool is the fifth-largest city in the UK with a population of 2.24 million in 2011 and with a GDP at $65.8bn (2014). The Economy of Liverpool is one of the largest within the UK.

The important component of Liverpool's economy are the tuourism and leisure sectors. Car manufacturing also takes place in the city.

In this project, the above two cities will be compared in details using machine learning segmentation and clustering along with Foursquare data. The objectives include:

```
* How similar these two cities are?

* Which city is better for living for a university student?
```

Data

In order to apply this study, basic geo data of the two cities need to be collected:

```
      * Postcode for Liverpool
(https://en.wikipedia.org/wiki/L_postcode_area)

      * Postcode for Manchester
 (https://en.wikipedia.org/wiki/M_postcode_area)

The latitude and longitude data also required:
      * (https://www.freemaptools.com/download/outcode-
postcodes/postcode-outcodes.csv)
```

Then the data sets for the two cities are ready to be analyzed:

Fig 1. Geocode and postcode for Manchester area

	postcode	latitude	longitude	Post town	Coverage	Local authority area
0	M1	53.477340	-2.235080	MANCHESTER	Piccadilly, City Centre, Market Street	Manchester
1	M11	53.478340	-2.179330	MANCHESTER	Clayton, Openshaw, Beswick	Manchester
2	M12	53.464820	-2.201870	MANCHESTER	Ardwick, Longsight, Chorlton-on-Medlock	Manchester
3	M13	53.460300	-2.213890	MANCHESTER	Ardwick, Longsight, Chorlton-on-Medlock	Manchester
4	M14	53.447700	-2.224370	MANCHESTER	Fallowfield, Moss Side, Ladybarn, Rusholme, Lo...	Manchester
5	M15	53.465630	-2.250080	MANCHESTER	Hulme, Manchester Science Park, Old Trafford	Manchester, Trafford
6	M16	53.454810	-2.263570	MANCHESTER	Firswood, Old Trafford, Whalley Range, Moss Side	Manchester, Trafford
7	M17	53.469060	-2.317890	MANCHESTER	Trafford Park, The Trafford Centre	Trafford
8	M18	53.461270	-2.168710	MANCHESTER	Abbey Hey, Gorton	Manchester
9	M19	53.436960	-2.194210	MANCHESTER	Levenshulme, Burnage	Manchester, Stockport
10	M2	53.480030	-2.242630	MANCHESTER	Deansgate, City Centre	Manchester
11	M20	53.425210	-2.230270	MANCHESTER	Didsbury, Withington	Manchester
12	M21	53.437710	-2.270990	MANCHESTER	Chorlton-cum-Hardy, Barlow Moor	Manchester
13	M22	53.385600	-2.258630	MANCHESTER	Wythenshawe, Northenden, Sharston Industrial Area	Manchester
14	M23	53.399020	-2.287290	MANCHESTER	Baguley, Brooklands (Manchester and Trafford),...	Manchester, Trafford
15	M24	53.551130	-2.196240	MANCHESTER	Middleton, Alkrington, Chadderton	Rochdale, Oldham
16	M25	53.528500	-2.274590	MANCHESTER	Prestwich, Sedgley Park, Simister	Bury
17	M26	53.561610	-2.333690	MANCHESTER	Radcliffe, Stoneclough	Bury, Bolton
18	M27	53.512160	-2.336310	MANCHESTER	Swinton, Clifton, Pendlebury, Wardley, Agecroft	Salford
19	M28	53.514670	-2.396660	MANCHESTER	Worsley, Walkden, Boothstown, Mosley Common, W...	Salford, Wigan
20	M29	53.508160	-2.456920	MANCHESTER	Tyldesley, Astley	Wigan
21	M30	53.484240	-2.354180	MANCHESTER	Eccles, Monton, Peel Green, Winton, Patricroft...	Salford
22	M31	53.419300	-2.421360	MANCHESTER	Carrington, Partington	Trafford
23	M32	53.450210	-2.308720	MANCHESTER	Stretford, Trafford Park	Trafford
24	M33	53.420500	-2.325060	SALE	Sale, Brooklands (Manchester and Trafford)	Trafford, Manchester

Fig 2. Geocode and postcode for Liverpool

	postcode	latitude	longitude	Post town	Coverage	Local authority area
0	L1	53.402540	-2.979280	LIVERPOOL	City Centre	Liverpool
1	L10	53.473980	-2.926680	LIVERPOOL	Aintree Village, Fazakerley	Sefton, Liverpool, Knowsley
2	L11	53.448010	-2.914070	LIVERPOOL	Clubmoor, Croxteth, Gillmoss, Norris Green	Liverpool
3	L12	53.434670	-2.894210	LIVERPOOL	Croxteth Park, West Derby	Liverpool
4	L13	53.417400	-2.919430	LIVERPOOL	Clubmoor, Old Swan, Stoneycroft, Tuebrook	Liverpool
5	L14	53.418610	-2.878830	LIVERPOOL	Broadgreen, Dovecot, Knotty Ash, Page Moss	Liverpool, Knowsley
6	L15	53.397630	-2.919010	LIVERPOOL	Wavertree	Liverpool
7	L16	53.398760	-2.887440	LIVERPOOL	Broadgreen, Bowring Park, Childwall	Liverpool, Knowsley
8	L17	53.377690	-2.939620	LIVERPOOL	Aigburth, St Michael's Hamlet, Sefton Park	Liverpool
9	L18	53.380640	-2.906610	LIVERPOOL	Allerton, Mossley Hill	Liverpool
10	L19	53.359100	-2.901650	LIVERPOOL	Garston, Grassendale, Aigburth,	Liverpool
11	L2	53.406960	-2.988410	LIVERPOOL	City Centre	Liverpool
12	L20	53.452810	-2.987970	BOOTLE	Bootle, Orrell	Sefton, Liverpool
13	L20	53.452810	-2.987970	LIVERPOOL	Kirkdale	Liverpool
14	L21	53.470700	-2.998930	LIVERPOOL	Ford, Litherland, Seaforth	Sefton, Liverpool
15	L22	53.476760	-3.026200	LIVERPOOL	Waterloo	Sefton
16	L23	53.491180	-3.022030	LIVERPOOL	Blundellsands, Brighton-le-Sands, Crosby, Litt...	Sefton
17	L24	53.343390	-2.836720	LIVERPOOL	Hale, Speke	Halton, Liverpool
18	L25	53.378270	-2.862960	LIVERPOOL	Belle Vale, Gateacre, Hunts Cross, Woolton, Ha...	Liverpool, Knowsley
19	L26	53.364100	-2.832620	LIVERPOOL	Halewood	Liverpool, Knowsley
20	L27	53.387440	-2.837580	LIVERPOOL	Netherley	Liverpool
21	L28	53.434900	-2.864110	LIVERPOOL	Stockbridge Village	Liverpool, Knowsley
22	L29	53.506790	-2.983190	LIVERPOOL	Lunt, Sefton Village	Sefton
23	L3	53.408800	-2.983940	LIVERPOOL	City Centre, Everton, Vauxhall	Liverpool
24	L30	53.484420	-2.970620	BOOTLE	Bootle, Netherton	Sefton

Methodology

In this section, the Foursquare API will be applied to expolore neighborhoods in both cities, Manchester and Liverpool. Then, the most common venue categories in each neighborhood will be explored. K-means clustering algorithm will be used to group the neighborhoods into clusters. Clustered data will be presented by using the Folium library.

Import necessary Libraries

```
import requests # library to handle requests
import pandas as pd # library for data analsysis
import numpy as np # library to handle data in a vectorized manner
import random # library for random number generation
```

```
!conda install -c conda-forge geopy --yes
from geopy.geocoders import Nominatim # module to convert an address
into latitude and longitude values
```

```
# libraries for displaying images
from IPython.display import Image
from IPython.core.display import HTML
```

```
# tranforming json file into a pandas dataframe library
from pandas.io.json import json_normalize
```

```
!conda install -c conda-forge folium=0.5.0 --yes
import folium # plotting library
```

```
print('Folium installed')
```

```
print('Libraries imported.')
```

Define Foursquare Credentials and Version

```
CLIENT_ID = '40TA5YCVA3CXTBIWMNPDMBKLDL4O4BVC5E4BFN5KXKMMKHL4' #
Foursquare ID
```

```
CLIENT_SECRET =
'OFICYUUXDQKDMPHZOTTNFIWVMK5EFL23DO1HPXN2SKZMBJZM' # Foursquare
Secret
VERSION = '20180604'
LIMIT = 30

print('My credentails:')

print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

Since we now have all the data we need in hand, we can explore it for a test before we conduct our main project. Suppose there is a student who loves Chinese food and get offers from The University of Liverpool and The University of Manchester. The number of Chinese restaurant around the university is a factor that student consider with. Let's have a look.

Chinese restaurants around The University of Liverpool

```
address_l = 'Chatham St, Liverpool L69 7ZN'

geolocator_l = Nominatim(user_agent="foursquare_agent")

location_l = geolocator_l.geocode(address_l)
latitude_l = location_l.latitude
longitude_l = location_l.longitude

print(latitude_l, longitude_l)

53.4001881 -2.9644371

search_query= 'Chinese'
radius_l = 1000
print(search_query + ' .... OK!')
url_l =
'https://api.foursquare.com/v2/venues/search?client_id={}&client
_secret={}&ll={},{}&v={}&query={}&radius={}&limit={}'.format(CLI
ENT_ID, CLIENT_SECRET, latitude_l, longitude_l, VERSION,
search_query, radius_l, LIMIT)

url_l

results_l = requests.get(url_l).json()

results_l
```

Here's what we found:

Fig 3. Chinese restaurant around the University of Liverpool

```
0              Campus real Chinese restaurant
1                    Lida Chinese supermarket
2         Arch Chinese Restaurant And Takeaway
3                  Hondo Chinese Supermarket
4                     Mabo Chinese restaurant
5                   SIDA Chinese Supermarket
6                   favorite Chinese take away
7                 Mr Chilli Chinese Restaurant
8           Liverpool Chinese Gospel Church
9                   SIDA Chinese Supermarket
10                    Chung Wah Supermarket
11                                     Mei Mei
```

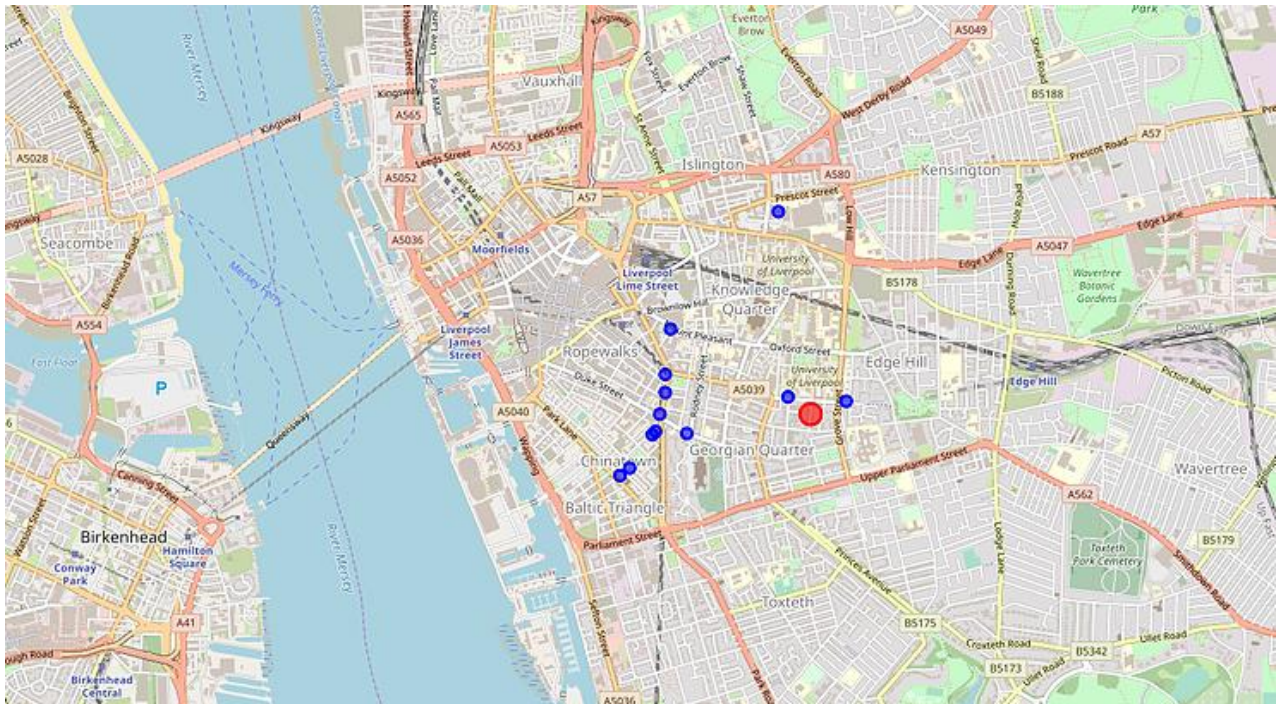**Fig 4**. Map of Chinese restaurant around the University of Liverpool

Fig 5. Chinese restaurant around the University of Manchester

```
0          Tai Pan Chinese Restaurant | 喜臨門大酒樓
1       Red Chilli Chinese Restaurant | 红椒京川菜馆
2                    Azuma Chinese Restaurant
3       Lameizi Chinese Supermarket & Restaurant
4                    Manchester Chinese Centre
Name: name, dtype: object
```

Fig 6. Map of Chinese restaurant around the University of Manchester
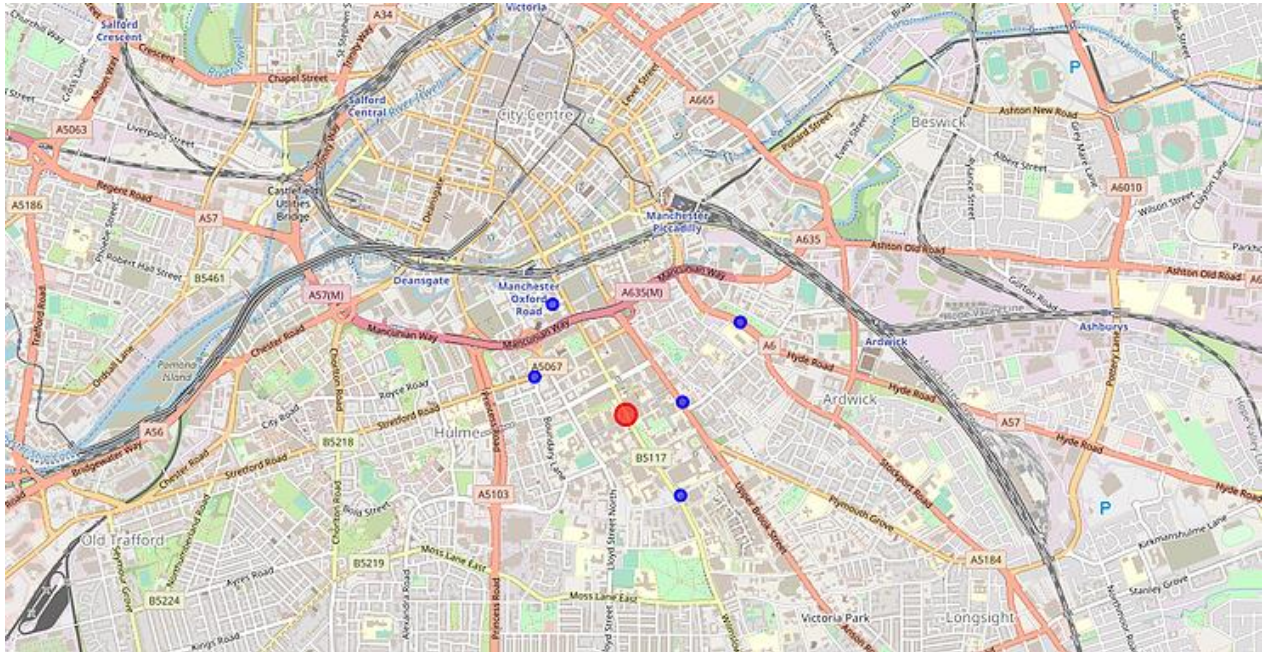
It seems worked very well. Ok, now let's check **all venues for the two cities**.

Fig 7. Venues in Liverpool, by venue category

Venue Category	Area	Area Latitude	Area Longitude	Venue	Venue Latitude	Venue Longitude
American Restaurant	8	8	8	8	8	8
Argentinian Restaurant	1	1	1	1	1	1
Art Gallery	5	5	5	5	5	5
Art Museum	2	2	2	2	2	2
Arts & Crafts Store	1	1	1	1	1	1
Asian Restaurant	2	2	2	2	2	2
Athletics & Sports	2	2	2	2	2	2
BBQ Joint	1	1	1	1	1	1
Bagel Shop	1	1	1	1	1	1
Bakery	5	5	5	5	5	5
Bank	2	2	2	2	2	2
Bar	22	22	22	22	22	22
Bed & Breakfast	1	1	1	1	1	1
Beer Bar	4	4	4	4	4	4
Beer Garden	2	2	2	2	2	2
Bookstore	7	7	7	7	7	7
Botanical Garden	1	1	1	1	1	1
Brazilian Restaurant	3	3	3	3	3	3
Breakfast Spot	4	4	4	4	4	4
Brewery	2	2	2	2	2	2
Bridal Shop	1	1	1	1	1	1
Buffet	1	1	1	1	1	1
Burger Joint	8	8	8	8	8	8
Burrito Place	2	2	2	2	2	2

Fig 8. Venues in Liverpool, by area

Area	Area Latitude	Area Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Aigburth, St Michael's Hamlet, Sefton Park	4	4	4	4	4	4
Aintree Village, Fazakerley	1	1	1	1	1	1
Aintree, Fazakerley, Orrell Park, Walton	5	5	5	5	5	5
Allerton, Mossley Hill	7	7	7	7	7	7
American Express[4]	15	15	15	15	15	15
Anfield, City Centre, Everton, Fairfield, Kensington, Tuebrook	3	3	3	3	3	3
Anfield, Everton, Kirkdale, Vauxhall	5	5	5	5	5	5
Anfield, Kirkdale, Walton	6	6	6	6	6	6
BT Group, large Selectapost users[4]	65	65	65	65	65	65
Belle Vale, Gateacre, Hunts Cross, Woolton, Halewood	5	5	5	5	5	5
Blundellsands, Brighton-le-Sands, Crosby, Little Crosby, Thornton	11	11	11	11	11	11
Bootle, Netherton	10	10	10	10	10	10
Bootle, Orrell	17	17	17	17	17	17
Broadgreen, Bowring Park, Childwall	2	2	2	2	2	2
Broadgreen, Dovecot, Knotty Ash, Page Moss	4	4	4	4	4	4
Burscough, Mawdesley, Scarisbrick, Rufford, Holmeswood	9	9	9	9	9	9
City Centre	193	193	193	193	193	193
City Centre, Dingle, Toxteth	4	4	4	4	4	4
City Centre, Edge Hill, Fairfield, Kensington	5	5	5	5	5	5
City Centre, Everton, Vauxhall	96	96	96	96	96	96
Clubmoor, Croxteth, Gillmoss, Norris Green	1	1	1	1	1	1
Clubmoor, Old Swan, Stoneycroft, Tuebrook	4	4	4	4	4	4
Croxteth Park, West Derby	4	4	4	4	4	4
Ford, Litherland, Seaforth	5	5	5	5	5	5

Fig 9. Venues in Manchester, by venue category

Venue Category	Area	Area Latitude	Area Longitude	Venue	Venue Latitude	Venue Longitude
Adult Boutique	1	1	1	1	1	1
Airport	1	1	1	1	1	1
Airport Lounge	2	2	2	2	2	2
Airport Service	1	1	1	1	1	1
American Restaurant	6	6	6	6	6	6
Antique Shop	1	1	1	1	1	1
Art Gallery	4	4	4	4	4	4
Arts & Crafts Store	4	4	4	4	4	4
Asian Restaurant	7	7	7	7	7	7
Australian Restaurant	1	1	1	1	1	1
Auto Garage	2	2	2	2	2	2
BBQ Joint	2	2	2	2	2	2
Bakery	7	7	7	7	7	7
Bar	38	38	38	38	38	38
Bed & Breakfast	1	1	1	1	1	1
Beer Bar	10	10	10	10	10	10
Beer Store	2	2	2	2	2	2
Bike Shop	1	1	1	1	1	1
Bookstore	10	10	10	10	10	10
Brazilian Restaurant	3	3	3	3	3	3
Brewery	2	2	2	2	2	2
Bubble Tea Shop	3	3	3	3	3	3
Building	1	1	1	1	1	1
Burger Joint	7	7	7	7	7	7

Fig 10. Venues in Manchester, by area

Area	Area Latitude	Area Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Abbey Hey, Gorton	7	7	7	7	7	7
Ancoats, Northern Quarter, Strangeways	86	86	86	86	86	86
Ardwick, Longsight, Chorlton-on-Medlock	7	7	7	7	7	7
Atherton	8	8	8	8	8	8
Baguley, Brooklands (Manchester and Trafford), Roundthorn Industrial Estate	4	4	4	4	4	4
Carrington, Partington	3	3	3	3	3	3
Chorlton-cum-Hardy, Barlow Moor	16	16	16	16	16	16
Clayton, Openshaw, Beswick	1	1	1	1	1	1
Collyhurst, Miles Platting, Moston, New Moston, Newton Heath	4	4	4	4	4	4
Crumpsall, Cheetham Hill	8	8	8	8	8	8
Deansgate, City Centre	100	100	100	100	100	100
Denton, Audenshaw	16	16	16	16	16	16
Didsbury, Withington	11	11	11	11	11	11
Droylsden	5	5	5	5	5	5
Eccles, Monton, Peel Green, Winton, Patricroft, Barton-upon-Irwell, Ellesmere Park	7	7	7	7	7	7
Failsworth	5	5	5	5	5	5
Fallowfield, Moss Side, Ladybarn, Rusholme, Longsight	8	8	8	8	8	8
Firswood, Old Trafford, Whalley Range, Moss Side	4	4	4	4	4	4
Harpurhey, Blackley	5	5	5	5	5	5
Higher Broughton, Cheetwood, Lower Broughton, Kersal	4	4	4	4	4	4
Hulme, Manchester Science Park, Old Trafford	12	12	12	12	12	12
Irlam, Cadishead	6	6	6	6	6	6
Levenshulme, Burnage	5	5	5	5	5	5

Now, let's calculate the most common venues for each area in the city.

Fig 11. Most common venues in Liverpool, by area

	postcode	latitude	longitude	Post town	Area	Local authority area	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
0	L1	53.402540	-2.979280	LIVERPOOL	City Centre	Liverpool	Hotel	Pub	Coffee Shop	Bar	Café	Italian Restaurant	Clothing Store	Burger Joint
1	L10	53.473980	-2.926680	LIVERPOOL	Aintree Village, Fazakerley	Sefton, Liverpool, Knowsley	Home Service	Zoo Exhibit	Donut Shop	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant
2	L11	53.448010	-2.914070	LIVERPOOL	Clubmoor, Croxteth, Gillmoss, Norris Green	Liverpool	Pool	Hotel	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	Electronics Store
3	L12	53.434670	-2.894210	LIVERPOOL	Croxteth Park, West Derby	Liverpool	Soccer Field	Fast Food Restaurant	Supermarket	Zoo Exhibit	Donut Shop	Falafel Restaurant	Ethiopian Restaurant	English Restaurant
4	L13	53.417400	-2.919430	LIVERPOOL	Clubmoor, Old Swan, Stoneycroft, Tuebrook	Liverpool	Furniture / Home Store	Indian Restaurant	Supermarket	Tea Room	Electronics Store	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant
5	L14	53.418610	-2.878830	LIVERPOOL	Broadgreen, Dovecot, Knotty Ash, Page Moss	Liverpool, Knowsley	Fast Food Restaurant	American Restaurant	Sports Club	Cosmetics Shop	Department Store	Dessert Shop	Diner	Discount Store
6	L15	53.397630	-2.919010	LIVERPOOL	Wavertree	Liverpool	Grocery Store	Pool	Track	Park	Bar	Gym	Indian Restaurant	Department Store
7	L16	53.398760	-2.887440	LIVERPOOL	Broadgreen, Bowring Park, Childwall	Liverpool, Knowsley	Grocery Store	Park	Zoo Exhibit	French Restaurant	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant
8	L17	53.377690	-2.939620	LIVERPOOL	Aigburth, St Michael's Hamlet, Sefton Park	Liverpool	Park	Outdoor Sculpture	Botanical Garden	Pub	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant
9	L18	53.380640	-2.906610	LIVERPOOL	Allerton, Mossley Hill	Liverpool	Coffee Shop	Chinese Restaurant	Restaurant	Supermarket	Grocery Store	Thai Restaurant	Sandwich Place	Discount Store
10	L19	53.359100	-2.901650	LIVERPOOL	Garston, Grassendale, Aigburth,	Liverpool	Pub	Pool	Supermarket	Café	Playground	Convenience Store	Cosmetics Shop	Department Store
11	L2	53.406960	-2.988410	LIVERPOOL	City Centre	Liverpool	Hotel	Pub	Coffee Shop	Bar	Café	Italian Restaurant	Clothing Store	Burger Joint
12	L20	53.452810	-2.987970	BOOTLE	Bootle, Orrell	Sefton, Liverpool	Pharmacy	Discount Store	Stationery Store	Supermarket	Pub	Grocery Store	Thrift / Vintage Store	Coffee Shop
13	L20	53.452810	-2.987970	LIVERPOOL	Kirkdale	Liverpool	Pharmacy	Discount Store	Stationery Store	Supermarket	Pub	Grocery Store	Thrift / Vintage Store	Coffee Shop
14	L21	53.470700	-2.998930	LIVERPOOL	Ford, Litherland, Seaforth	Sefton, Liverpool	Sandwich Place	Fast Food Restaurant	Clothing Store	Gym Pool	Café	Dog Run	Falafel Restaurant	Ethiopian Restaurant
15	L22	53.476760	-3.026200	LIVERPOOL	Waterloo	Sefton	Grocery Store	Pub	Gym / Fitness Center	Sandwich Place	Spanish Restaurant	Restaurant	Movie Theater	Asian Restaurant
16	L23	53.491180	-3.022030	LIVERPOOL	Blundellsands, Brighton-le-Sands, Crosby, Litt...	Sefton	Coffee Shop	Bar	Italian Restaurant	Discount Store	Tapas Restaurant	Gym	Grocery Store	Restaurant
17	L24	53.343390	-2.836720	LIVERPOOL	Hale, Speke	Halton, Liverpool	Food & Drink Shop	Clothing Store	Supermarket	Café	Zoo Exhibit	Electronics Store	Fast Food Restaurant	Falafel Restaurant

Fig 12. Most common venues in Manchester, by area

	postcode	latitude	longitude	Post town	Area	Local authority area	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
0	M1	53.477340	-2.235080	MANCHESTER	Piccadilly, City Centre, Market Street	Manchester	Hotel	Gay Bar	Bar	Pub	Coffee Shop	Cocktail Bar	Sushi Restaurant	Indian Restaurant
1	M11	53.478340	-2.179330	MANCHESTER	Clayton, Openshaw, Beswick	Manchester	Indian Restaurant	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store
2	M12	53.464820	-2.201870	MANCHESTER	Ardwick, Longsight, Chorlton-on-Medlock	Manchester	College Cafeteria	Asian Restaurant	Park	Liquor Store	Bus Stop	Pharmacy	Convenience Store	Cosmetics Shop
3	M13	53.460300	-2.213890	MANCHESTER	Ardwick, Longsight, Chorlton-on-Medlock	Manchester	College Cafeteria	Asian Restaurant	Park	Liquor Store	Bus Stop	Pharmacy	Convenience Store	Cosmetics Shop
4	M14	53.447700	-2.224370	MANCHESTER	Fallowfield, Moss Side, Ladybarn, Rusholme, Lo...	Manchester	Gym / Fitness Center	Bed & Breakfast	Fried Chicken Joint	Park	Racetrack	Bus Station	Coffee Shop	Art Gallery
5	M15	53.465630	-2.250080	MANCHESTER	Hulme, Manchester Science Park, Old Trafford	Manchester, Trafford	Café	Grocery Store	Deli / Bodega	Discount Store	Vegetarian / Vegan Restaurant	Park	Convenience Store	Fast Food Restaurant
6	M16	53.454810	-2.263570	MANCHESTER	Firswood, Old Trafford, Whalley Range, Moss Side	Manchester, Trafford	Grocery Store	Bus Stop	Sandwich Place	Yoga Studio	Duty-free Shop	Donut Shop	Dive Bar	Discount Store
7	M17	53.469060	-2.317890	MANCHESTER	Trafford Park, The Trafford Centre	Trafford	Sandwich Place	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store
8	M18	53.461270	-2.168710	MANCHESTER	Abbey Hey, Gorton	Manchester	Gym / Fitness Center	Hotel	Gym	Supermarket	Sandwich Place	Market	Deli / Bodega	Donut Shop
9	M19	53.436960	-2.194210	MANCHESTER	Levenshulme, Burnage	Manchester, Stockport	Gym / Fitness Center	Restaurant	Indoor Play Area	Pakistani Restaurant	Park	Deli / Bodega	Donut Shop	Dive Bar
10	M2	53.480030	-2.242630	MANCHESTER	Deansgate, City Centre	Manchester	Coffee Shop	Italian Restaurant	Steakhouse	Hotel	Asian Restaurant	Pub	Plaza	Thai Restaurant
11	M20	53.425210	-2.230270	MANCHESTER	Didsbury, Withington	Manchester	Pizza Place	Bus Station	Wine Bar	Gym / Fitness Center	Tram Station	Thai Restaurant	Tennis Court	Deli / Bodega
12	M21	53.437710	-2.270990	MANCHESTER	Chorlton-cum-Hardy, Barlow Moor	Manchester	Grocery Store	Bar	Indian Restaurant	Gas Station	Japanese Restaurant	Falafel Restaurant	Fabric Shop	Music Venue
13	M22	53.385600	-2.258630	MANCHESTER	Wythenshawe, Northenden, Sharston Industrial Area	Manchester	Tram Station	Coffee Shop	Supermarket	Dance Studio	Duty-free Shop	Donut Shop	Dive Bar	Discount Store
14	M23	53.399020	-2.287290	MANCHESTER	Baguley, Brooklands (Manchester and Trafford),...	Manchester, Trafford	Park	Fast Food Restaurant	Tram Station	Yoga Studio	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar
15	M24	53.551130	-2.196240	MANCHESTER	Middleton, Alkrington, Chadderton	Rochdale, Oldham	Stadium	Pub	Grocery Store	Supermarket	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar
16	M25	53.528500	-2.274590	MANCHESTER	Prestwich, Sedgley Park, Simister	Bury	Park	Coffee Shop	Pub	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	Discount Store
17	M26	53.561610	-2.333690	MANCHESTER	Radcliffe, Stoneclough	Bury, Bolton	Pub	Pool	Fast Food Restaurant	Furniture / Home Store	Yoga Studio	Dance Studio	Donut Shop	Dive Bar

K-mean Cluster

Now, we can try to classify the clusters for each neighborhood. Let's set the number of clusters is three.

```python
from sklearn.cluster import KMeans
# set number of clusters
lclusters = 3
l_grouped_clustering = l_grouped.drop('Area', 1)
# run k-means clustering
kmeans = KMeans(n_clusters=lclusters,
random_state=0).fit(l_grouped_clustering)
# check cluster labels generated for each row in the dataframe

kmeans.labels_[0:10]

kmeans.labels_

len(kmeans.labels_)

#create a new dataframe that includes the cluster as well as the top 10 venues for
each neighborhood.
# add clustering labels
l_merged['Cluster Labels'] = pd.Series(kmeans.labels_)
# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors
#Finally, let's visualize the resulting clusters
# create map
l_clusters = folium.Map(location=[53.40254, -2.97928],
zoom_start=13)
lclusters = 3
# set color scheme for the clusters
x = np.arange(lclusters)
ys = [i+x+(i*x)**2 for i in range(lclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]
l_merged= l_merged.fillna(0)
l_merged['Cluster Labels']=l_merged['Cluster
Labels'].astype(int)
# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(l_merged['latitude'],
l_merged['longitude'], l_merged['Area'], l_merged['Cluster
Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster),
parse_html=True)
```

```
folium.CircleMarker(

    [lat, lon],

    radius=5,
    popup=label,
    color=rainbow[cluster-1],
    fill=True,
    fill_color=rainbow[cluster-1],
    fill_opacity=0.7).add_to(l_clusters)

l_clusters
```

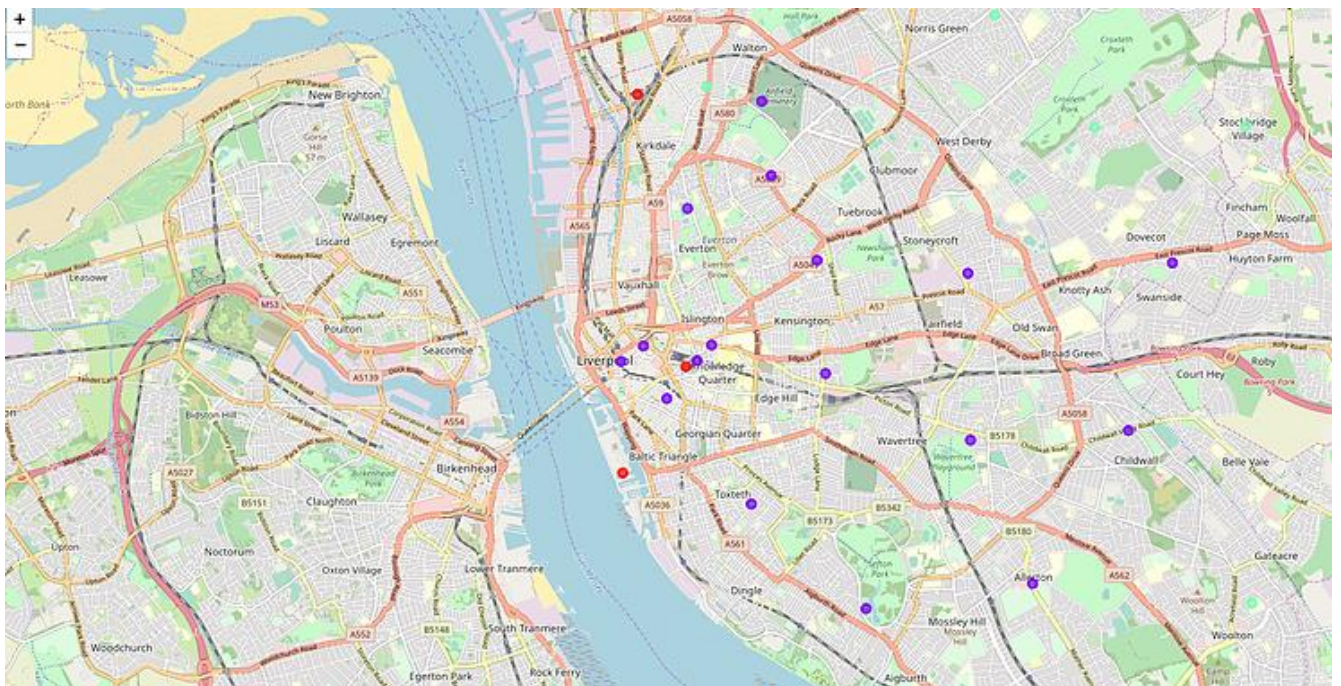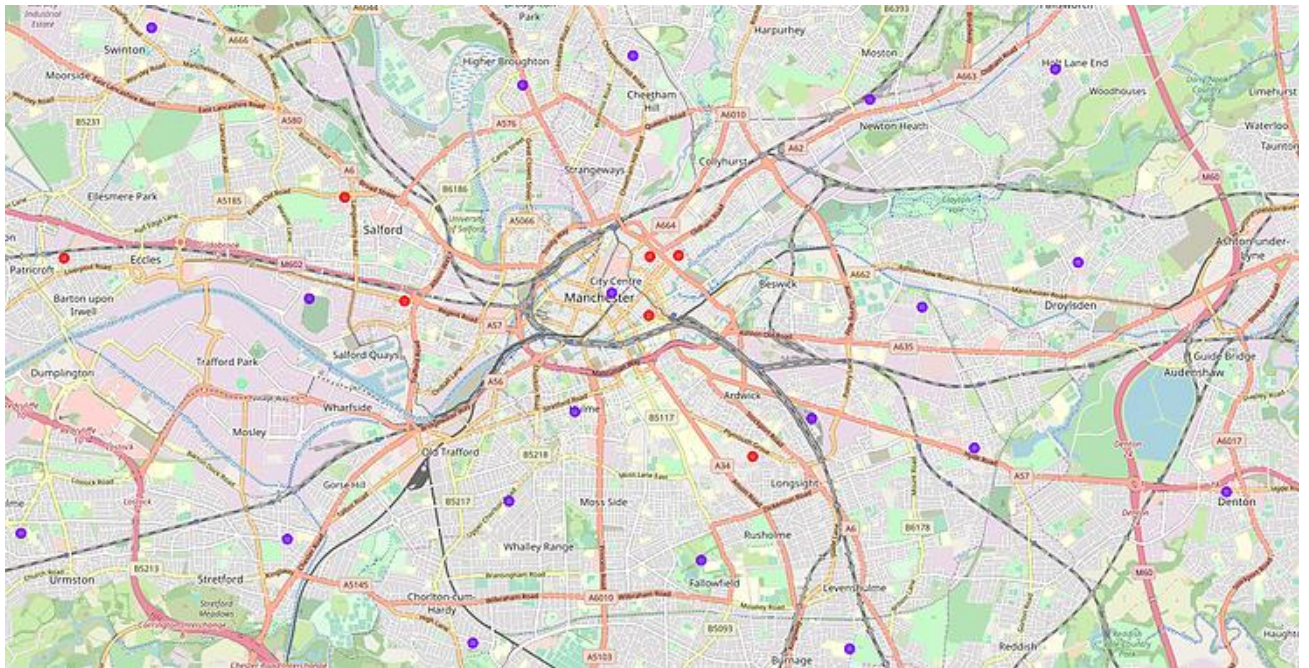**Fig 13**. Map of clusters in Liverpool

Fig 14. Map of clusters in Manchester

Results

Let's see the top three clusters of the two cities

```
m_merged.loc[m_merged['Cluster Labels'] == 0,
m_merged.columns[[2] + list(range(5, m_merged.shape[1]))]]
```

Fig 15. Top 3 clusters in Liverpool

	longitude	Local authority area	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	Cluster Labels
20	-2.837580	Liverpool	Construction & Landscaping	Pizza Place	Indie Theater	Ethiopian Restaurant	Performing Arts Venue	Donut Shop	Food & Drink Shop	Fast Food Restaurant	0
46	-2.988368	non-geographic	American Restaurant	Park	Hotel	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	0
47	-2.975554	non-geographic	Bar	Hotel	Pub	Coffee Shop	Fast Food Restaurant	Theater	Comic Shop	Middle Eastern Restaurant	0
48	-2.988061	non-geographic	Hotel	Harbor / Marina	Hostel	Pub	Music Venue	Seafood Restaurant	Bed & Breakfast	Rental Car Location	0
49	-2.985222	non-geographic	Construction & Landscaping	Train Station	Brewery	IT Services	Convenience Store	Cosmetics Shop	Department Store	Dessert Shop	0

	longitude	Local authority area	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	Cluster Labels
0	-2.979280	Liverpool	Hotel	Pub	Coffee Shop	Bar	Café	Italian Restaurant	Clothing Store	Burger Joint	1
1	-2.926680	Sefton, Liverpool, Knowsley	Home Service	Zoo Exhibit	Donut Shop	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	1
4	-2.919430	Liverpool	Furniture / Home Store	Indian Restaurant	Supermarket	Tea Room	Electronics Store	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	1
5	-2.878830	Liverpool, Knowsley	Fast Food Restaurant	American Restaurant	Sports Club	Cosmetics Shop	Department Store	Dessert Shop	Diner	Discount Store	1
6	-2.919010	Liverpool	Grocery Store	Pool	Track	Park	Bar	Gym	Indian Restaurant	Department Store	1
7	-2.887440	Liverpool, Knowsley	Grocery Store	Park	Zoo Exhibit	French Restaurant	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	1
8	-2.919620	Liverpool	Park	Outdoor Sculpture	Botanical Garden	Pub	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	1
9	-2.906610	Liverpool	Coffee Shop	Chinese Restaurant	Restaurant	Supermarket	Grocery Store	Thai Restaurant	Sandwich Place	Discount Store	1
11	-2.988410	Liverpool	Hotel	Pub	Coffee Shop	Bar	Café	Italian Restaurant	Clothing Store	Burger Joint	1
12	-2.987970	Sefton, Liverpool	Pharmacy	Discount Store	Stationery Store	Supermarket	Pub	Grocery Store	Thrift / Vintage Store	Coffee Shop	1
14	-2.998930	Sefton, Liverpool	Sandwich Place	Fast Food Restaurant	Clothing Store	Gym Pool	Café	Dog Run	Falafel Restaurant	Ethiopian Restaurant	1
15	-3.026200	Sefton	Grocery Store	Pub	Gym / Fitness Center	Sandwich Place	Spanish Restaurant	Restaurant	Movie Theater	Asian Restaurant	1
16	-3.022030	Sefton	Coffee Shop	Bar	Italian Restaurant	Discount Store	Tapas Restaurant	Gym	Grocery Store	Restaurant	1
17	-2.836720	Halton, Liverpool	Food & Drink Shop	Clothing Store	Supermarket	Café	Zoo Exhibit	Electronics Store	Fast Food Restaurant	Falafel Restaurant	1
19	-2.832620	Liverpool, Knowsley	Grocery Store	Supermarket	Shopping Plaza	Discount Store	Sandwich Place	Dog Run	Falafel Restaurant	Ethiopian Restaurant	1
22	-2.983190	Sefton	0	0	0	0	0	0	0	0	1
23	-2.983940	Liverpool	Pub	Hotel	Café	Coffee Shop	Grocery Store	Bar	Clothing Store	Restaurant	1
25	-2.936590	Sefton	Greek Restaurant	Pub	Supermarket	Breakfast Spot	Zoo Exhibit	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	1
26	-2.889090	Knowsley	Sandwich Place	Market	Discount Store	Gym / Fitness Center	Shopping Mall	Donut Shop	Falafel Restaurant	Ethiopian Restaurant	1
27	-2.875770	Knowsley	Sandwich Place	Market	Discount Store	Gym / Fitness Center	Shopping Mall	Donut Shop	Falafel Restaurant	Ethiopian Restaurant	1
30	-2.839620	Knowsley	Coffee Shop	Fast Food Restaurant	Bus Station	Pub	Mobile Phone Shop	Furniture / Home Store	Supermarket	Convenience Store	1
31	-3.062800	Sefton, West Lancashire	Coffee Shop	Grocery Store	Convenience Store	English Restaurant	Restaurant	Italian Restaurant	Thrift / Vintage Store	Supermarket	1
32	-3.049980	Sefton, West Lancashire	Pub	Train Station	Breakfast Spot	Park	Zoo Exhibit	Donut Shop	Fast Food Restaurant	Falafel Restaurant	1
33	-2.895370	West Lancashire	Dog Run	Arts & Crafts Store	Donut Shop	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	1

	longitude	Local authority area	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	Cluster Labels
2	-2.914070	Liverpool	Pool	Hotel	Food & Drink Shop	Fast Food Restaurant	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	Electronics Store	2
3	-2.894210	Liverpool	Soccer Field	Fast Food Restaurant	Supermarket	Zoo Exhibit	Donut Shop	Falafel Restaurant	Ethiopian Restaurant	English Restaurant	2
10	-2.901650	Liverpool	Pool	Supermarket	Café	Playground	Convenience Store	Cosmetics Shop	Department Store		2
13	-2.987970	Liverpool	Pharmacy	Discount Store	Stationery Store	Supermarket	Pub	Grocery Store	Thrift / Vintage Store	Coffee Shop	2
18	-2.862960	Liverpool, Knowsley	Movie Theater	Garden Center	Fast Food Restaurant	Café	Pub	Cosmetics Shop	Department Store	Dessert Shop	2
21	-2.864110	Liverpool, Knowsley	Movie Theater	Convenience Store	Construction & Landscaping	Home Service	French Restaurant	Hostel	Cosmetics Shop	Department Store	2
24	-2.970620	Sefton	Discount Store	Hotel	Furniture / Home Store	Supermarket	Soccer Field	Bus Stop	Clothing Store	Multiplex	2
28	-2.814450	Knowsley	Zoo Exhibit	Bridal Shop	Playground	Zoo	Art Museum	Electronics Store	French Restaurant	Food & Drink Shop	2
29	-2.782440	Knowsley, St Helens	0	0	0	0	0	0	0	0	2
44	-2.960690	non-geographic	Construction & Landscaping	Soccer Stadium	Soccer Field	Train Station	English Restaurant	Gym / Fitness Center	Zoo Exhibit	Donut Shop	2
45	-2.971429	non-geographic	Pub	Sporting Goods Shop	Discount Store	Outdoor Sculpture	Soccer Stadium	Supermarket	Sandwich Place	Bus Stop	2

Fig 16. Top 3 clusters in Manchester

`m_merged.loc[m_merged['Cluster Labels'] == 0, m_merged.columns[[2] + list(range(5, m_merged.shape[1]))]]`

	longitude	Local authority area	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	Cluster Labels
0	-2.235080	Manchester	Hotel	Gay Bar	Bar	Pub	Coffee Shop	Cocktail Bar	Sushi Restaurant	Indian Restaurant	0
3	-2.213890	Manchester	College Cafeteria	Asian Restaurant	Park	Liquor Store	Bus Stop	Pharmacy	Convenience Store	Cosmetics Shop	0
15	-2.196240	Rochdale, Oldham	Stadium	Pub	Grocery Store	Supermarket	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	0
19	-2.396660	Salford, Wigan	Sports Club	Park	Yoga Studio	Coffee Shop	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	0
21	-2.354180	Salford	Gym	Grocery Store	Train Station	Pizza Place	Fast Food Restaurant	Sandwich Place	Auto Garage	Yoga Studio	0
28	-2.229090	Manchester	Bar	Coffee Shop	Pub	Cocktail Bar	Tea Room	Bookstore	Record Shop	Beer Bar	0
35	-2.284820	Salford	Brewery	Food Truck	Indian Restaurant	Building	Pizza Place	Duty-free Shop	Donut Shop	Dive Bar	0
36	-2.296960	Salford	Supermarket	Yoga Studio	Ethiopian Restaurant	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	0
42	-2.234866	Manchester	Bar	Pub	Coffee Shop	Café	Tea Room	Record Shop	Cocktail Bar	Bookstore	0

	longitude	Local authority area	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	Cluster Labels
1	-2.179330	Manchester	Indian Restaurant	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
2	-2.201870	Manchester	College Cafeteria	Asian Restaurant	Park	Liquor Store	Bus Stop	Pharmacy	Convenience Store	Cosmetics Shop	1
4	-2.224370	Manchester	Gym / Fitness Center	Bed & Breakfast	Fried Chicken Joint	Park	Racetrack	Bus Station	Coffee Shop	Art Gallery	1
5	-2.250080	Manchester, Trafford	Café	Grocery Store	Deli / Bodega	Discount Store	Vegetarian / Vegan Restaurant	Park	Convenience Store	Fast Food Restaurant	1
6	-2.263570	Manchester, Trafford	Grocery Store	Bus Stop	Sandwich Place	Yoga Studio	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
8	-2.168710	Manchester	Gym / Fitness Center	Hotel	Gym	Supermarket	Sandwich Place	Market	Deli / Bodega	Donut Shop	1
9	-2.194210	Manchester, Stockport	Gym / Fitness Center	Restaurant	Indoor Play Area	Pakistani Restaurant	Park	Deli / Bodega	Donut Shop	Dive Bar	1
10	-2.242630	Manchester	Coffee Shop	Italian Restaurant	Steakhouse	Hotel	Asian Restaurant	Pub	Plaza	Thai Restaurant	1
11	-2.230270	Manchester	Pizza Place	Bus Station	Wine Bar	Gym / Fitness Center	Tram Station	Thai Restaurant	Tennis Court	Deli / Bodega	1
12	-2.270990	Manchester	Grocery Store	Bar	Indian Restaurant	Gas Station	Japanese Restaurant	Falafel Restaurant	Fabric Shop	Music Venue	1
13	-2.258630	Manchester	Tram Station	Coffee Shop	Supermarket	Dance Studio	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
14	-2.287290	Manchester, Trafford	Park	Fast Food Restaurant	Tram Station	Yoga Studio	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	1
16	-2.274590	Bury	Park	Coffee Shop	Pub	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
17	-2.333690	Bury, Bolton	Pub	Pool	Fast Food Restaurant	Furniture / Home Store	Yoga Studio	Dance Studio	Donut Shop	Dive Bar	1
18	-2.336310	Salford	Supermarket	Pizza Place	Park	Yoga Studio	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	1
20	-2.456920	Wigan	Grocery Store	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
22	-2.421360	Trafford	Grocery Store	Antique Shop	Convenience Store	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	1
23	-2.308720	Trafford	Gym / Fitness Center	Warehouse Store	Park	Deli / Bodega	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	1
24	-2.325060	Trafford, Manchester	Pub	Grocery Store	Supermarket	Chinese Restaurant	Pizza Place	Bookstore	Auto Garage	Tram Station	1
25	-2.117480	Tameside	Clothing Store	Mobile Phone Shop	Supermarket	Pharmacy	Café	Coffee Shop	Outlet Store	Shopping Plaza	1
26	-2.152300	Oldham	Gym / Fitness Center	Bakery	Construction & Landscaping	Supermarket	Pub	Gay Bar	Gastropub	College Cafeteria	1
27	-2.420960	Salford	Asian Restaurant	Convenience Store	Department Store	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	1
29	-2.189990	Manchester	Café	Tram Station	Bus Stop	Pub	Concert Hall	Construction & Landscaping	Comic Shop	Convenience Store	1
30	-2.362940	Trafford	Italian Restaurant	Playground	Convenience Store	Dance Studio	Yoga Studio	Deli / Bodega	Duty-free Shop	Donut Shop	1

	longitude	Local authority area	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	Cluster Labels
7	-2.31789	Trafford	Sandwich Place	Yoga Studio	Deli / Bodega	Electronics Store	Duty-free Shop	Donut Shop	Dive Bar	Discount Store	2
39	-2.21269	Manchester	Hotel	Bar	Park	Fish & Chips Shop	Pub	Gift Shop	Gay Bar	Comedy Club	2

Discussion

As mentioned in the Introduction section, both of the two cities are important and popular in the UK. With what we've calculated and mapped in the last section, we can briefly classify the clusters of the two cities using the data of the most common venue.

For Liverpool, cluster 1 is likely for tourism as the cluster 1 of Manchester, cluster 2 is for residential and cluster 3 is mixed of leisure and residential. For Manchester, cluster 1 is more likely for leisure/tourism (bar&pub), cluster 2 is for residential and cluster 3 is for shopping. Based on the clusters calculated, we can draw a conclusion that the two cities are similar in terms of the common venues.

There are several possible explanations for this result. Both of the two cities have highly-reputed football clubs and and museums, therefore, both of them attract people to visit. There are also high ranked universities located in the two cities, so this preliminary finding also suggests that the two cities are suitable for residential.

In addition, if you are a university student live around the University and also like Chinese food then Liverpool provides you more choices than Manchester :)

Conclusion

This project compared two big cities in the North of England, classified the area in the city whether it's for residential, social or others. This was derived using Foursquare data. So the limitation is it was not a all through comparison. We can not jump into a conclusion that which city is better than another.

In the future, we need to consider use other quantitative data such as living cost, house price and job market etc to have a further exploration.