Capstone Project - The Battle of Neighborhoods (Week 2):
Toronto vs. Frankfurt

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Introduction

This project focusses on the challenge of comparing two cities with respect to standard of Living (SoL). The interest in the analysis and results can come from multiple stakeholders on individual but also on corporate level:

1. As an individual relocating to different cities, one wants to understand which city offers more and has what kind of character that fits ones personals preferences.
2. Big corporations might be interested in this kind of analysis if they have to relocate their operations to another town.

The work is motivated two folds. On one hand, the authors personal journey moving from Frankfurt/Main, Germany to Southampton, UK with a brief stint in London, UK, then Paris, France, then finally New York, USA, Melbourne, Australia and Zürich, Switzerland has given him a deep insight into the cultures and feels of a city and an understanding why it is important to have data when moving across continents. On the other, the recent changes in the financial market due to the impending Brexit has many banks move from London to a different location (Butcher, 2019). An important part in deciding where to move is whether the infrastructure or more generally the SoL is the best fit for the person or institution making that choice.

An in-depth analysis of comparing two or more locations is beyond the scope of this work. Hence, the focus is narrowed down to evaluate and compare two cities with respect to venue diversity and Top 10 trending venues in the neighbourhoods of Central Toronto, Canada, and Central Frankfurt/Main, Germany, as a measure of SoL of the two cities.

Methods

The code base with the data processing and analysis can be found in the mre-public git repository (Reumann, 2019)

Data

- Data where you describe the data that will be used to solve the problem and the source of the data.

The data for analysis is gathered in two steps:

1. Scrape online resources to get the location information for the neighborhoods of the two respective cities of Toronto, Canada and Frankfurt/Main, Germany.
2. Use the Foursquare APIs (Foursquare, 2019) to gather the data for analysis and comparison of the two cities with respect to food diversity.

Toronto Data

The list of postal codes for Canada can be gathered from the Wikipedia page https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M. The table of postal codes that can be used to transform the data into a pandas dataframe is scraped using the pandas

```
read_html(<URL>, header = 0))
```

method. The rows where the fields in the "Borough" column are not assigned are dropped. Then the neighborhoods are grouped by boroughs using the pandas groupby() functionality:

```
dfToronto = dfToronto.groupby(['Borough']).agg({'Postcode':
list, 'Neighbourhood': list}).reset_index()
```

Geospatial data is added using the Longitude and Latitude data of the Geospatial_Coordinates.csv file provided in the week 3 assignment of the Capstone Project resulting in a pandas dataframe as depicted in figure 1.

	Postcode	Borough	Neighbourhood	Latitude	Longitude
0	M4N	Central Toronto	[Lawrence Park]	43.728020	-79.388790
1	M4P	Central Toronto	[Davisville North]	43.712751	-79.390197
2	M4R	Central Toronto	[North Toronto West]	43.715383	-79.405678
3	M4S	Central Toronto	[Davisville]	43.704324	-79.388790
4	M4T	Central Toronto	[Moore Park, Summerhill East]	43.689574	-79.383160
5	M4V	Central Toronto	[Deer Park, Forest Hill SE, Rathnelly, South H...	43.686412	-79.400049
6	M5N	Central Toronto	[Roselawn]	43.711695	-79.416936
7	M5P	Central Toronto	[Forest Hill North, Forest Hill West]	43.696948	-79.411307
8	M5R	Central Toronto	[The Annex, North Midtown, Yorkville]	43.672710	-79.405678

Figure 1: Dataframe of Central Toronto neighborhoods

Based on these coordinates, the project is using the Foursquare APIs to further explore the neighborhoods (see Implementation, Analysis and the Results sections below).

Frankfurt Data

The information on the boroughs and cities districts (note: a city district corresponds to a neighborhood) is gained by scraping the following Wikipedia page:

https://en.wikipedia.org/wiki/List_of_Ortsbezirke_of_Frankfurt_am_Main

The result (see Figure 2) is similar to the Toronto dataframe (Figure 1). The skilled and curious programmer will be able to gain the geolocation of the neighborhoods from crawling the respective Wikipedia pages (e. g. https://en.wikipedia.org/wiki/Altstadt_(Frankfurt_am_Main)). Using the same pandas read_html-routine will extract a table for each neighborhood as depicted in Figure 3. The less curious or skilled programmer will do an assessment of whether learning to web crawl will be a bigger overhead than extracting the coordinates manually. Here, we use the manual extraction strategy and store the coordinates of the neighborhoods in Frankfurt in a .csv file, too, that we then read in to finalize the pandas dataframe for Frankfurts neighborhoods and their geolocation (see Figure 4).

	Name	City districts
0	Innenstadt I	Altstadt, Bahnhofsviertel, Gallus, Gutleutvier...
1	Innenstadt II	Bockenheim, Westend-Nord, Westend-Süd,
2	Innenstadt III	Nordend-Ost, Nordend-West
3	Bornheim/Ostend	Ostend, Bornheim
4	Süd	Flughafen, Niederrad, Oberrad, Sachsenhausen-S...

Figure 2: Dataframe of city districts and neighborhoods of Frankfurt

	Altstadt	Altstadt.1
0	Stadtteil of Frankfurt am Main	Stadtteil of Frankfurt am Main
1	Coat of arms	Coat of arms
2	Location of the Altstadt (red) and the Ortsbez...	Location of the Altstadt (red) and the Ortsbez...
3	Altstadt Altstadt	Altstadt Altstadt
4	Coordinates: 50°06′49″N 08°41′04″E / 50.1136...	Coordinates: 50°06′49″N 08°41′04″E / 50.1136...
5	Country	Germany
6	State	Hesse

Figure 3: Table with information of a neighborhood in Frankfurt.

	Borough	Neighbourhood	Latitude	Longitude	ZIP code
0	Innenstadt I	Altstadt	50.113610	8.684444	60311; 60313
1	Innenstadt I	Bahnhofsviertel	50.101667	8.659444	60329
2	Innenstadt I	Gallus	50.103611	8.645556	60325; 60326; 60327; 60329; 60486
3	Innenstadt I	Gutleutviertel	50.101667	8.659444	60327; 60329
4	Innenstadt I	Innenstadt	50.120278	8.682778	60310; 60311; 60313; 60318; 60322; 60329
5	Innenstadt III	Bockenheim	50.123889	8.639167	60325; 60431; 60486; 60487
6	Innenstadt III	Westend	50.118056	8.663333	60320; 60322; 60323; 60431; 60306; 60308; 6032...
7	Innenstadt III	Nordend	50.123056	8.692222	60316; 60318; 60385; 60389; 60316; 60318; 6032...

Figure 4: Final dataframe of neighborhoods in Frankfurt including geolocation.

To limit the scope of this projects, only the neighborhoods of Central Toronto and Central Frankfurt (i. e. Innenstadt) will be further considered (see Figure 1 and Figure 4) which corresponds to 9 ZIP code areas in Central Toronto vs. 8 neighborhoods in Central Frankfurt and therefore makes it a good comparison. Note that the two neighborhoods Westend-Nord and Westend-Süd, are combined to one neighborhood "Westend", as well as Nordend-Ost and Nordend-West to the neighborhood "Nordend" due to the fact that the longitudinal and latitudinal values were the same for the respective neighborhoods.

The two geolocations Central Toronto and Central Frankfurt with their neighborhoods are depicted in Figure 5 and
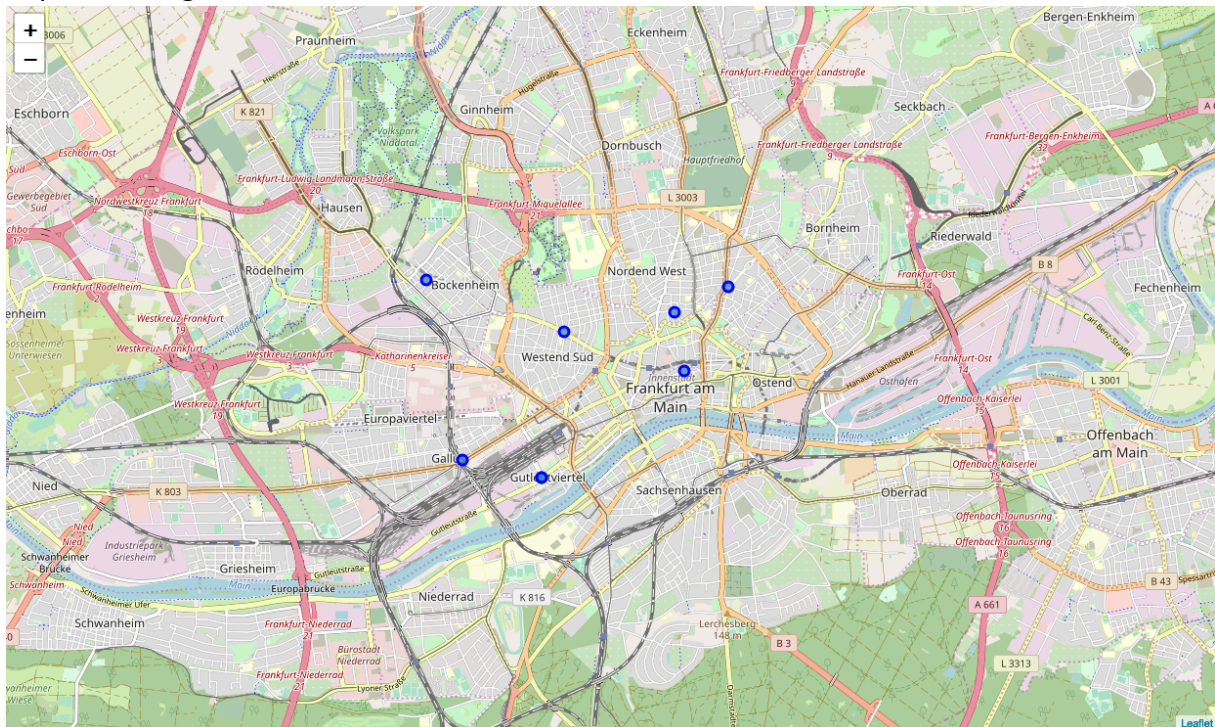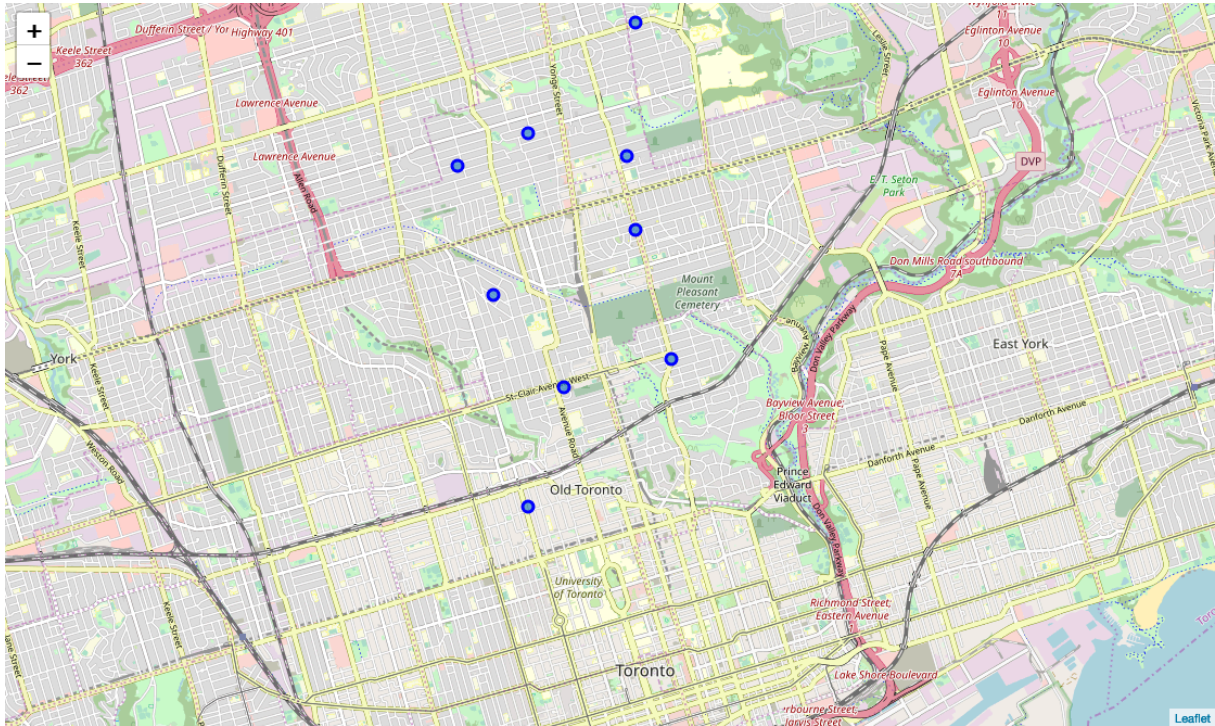

Figure 6, respectively.

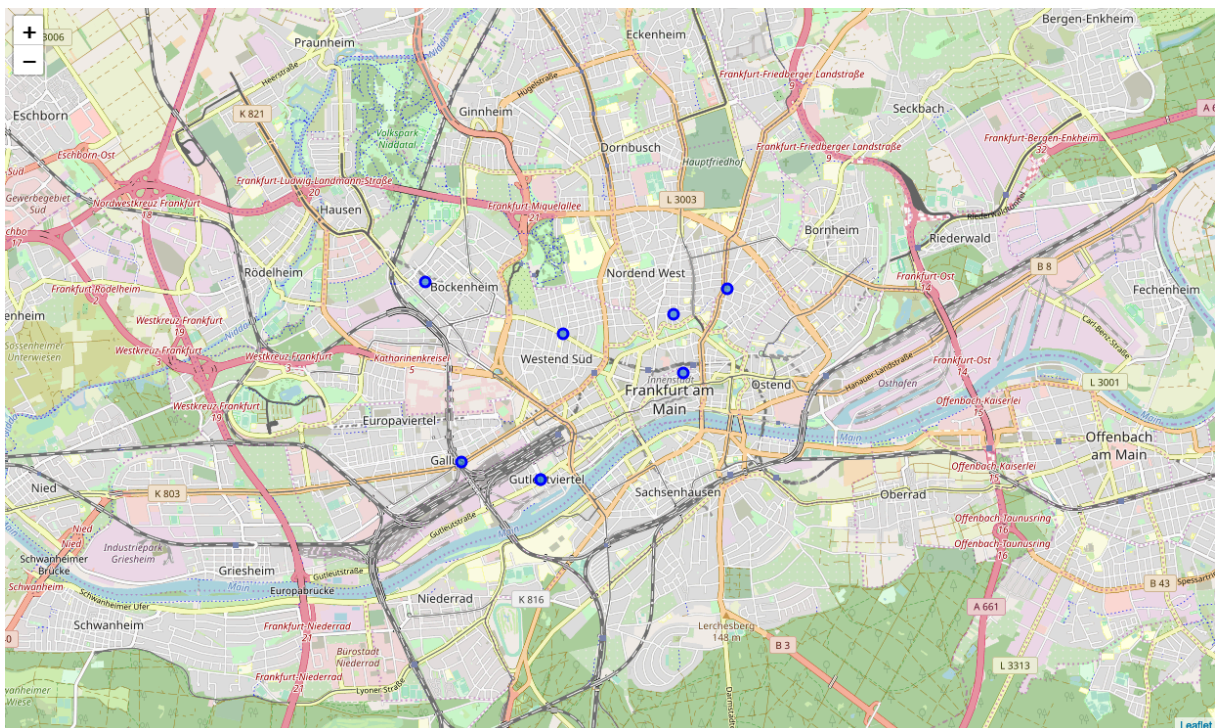*Figure 5: Central Toronto and its neighborhoods according to ZIP codes.*

Figure 6: Central Frankfurt and its neighborhoods

Implementation

The implementation was carried out using Jupyter Notebooks (Jupyter, 2019) under the IBM Developer Skills Network environment. As mentioned before, the code can be found in (Reumann, 2019). The following libraries were included:

- System libraries
  - sys
  - requests
- Data wrangling and analysis
  - numpy
  - pandas
  - json
  - geopy
- Clustering
  - sklearn
- Visualization
  - matplotlib
  - folium

The analysis was carried out using the Foursquare Explore API for venues:

```
url =
'https://api.foursquare.com/v2/venues/explore?client_id={}&cli
ent_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
CLIENT_ID,
CLIENT_SECRET,
VERSION,
neighborhood_latitude,
neighborhood_longitude,
radius,
LIMIT)

results = requests.get(url).json()
```

The radius was limited to 500 m and LIMIT was set to 100. The latitude and longitude values were set in a routine based on the respective geolocation of the neighbourhood.

Data wrangling and presentation was performed using python code with mainly the pandas data structures and functionality.

Analysis

The analysis was carried out for each city following these steps

1. Get all venues for each neighbourhood
2. Get the number and list of unique venue categories
3. Group venues in each neighbourhood
4. List top 10 venues in each neighbourhood

A comparison of the two cities can be found in section "Discussion".

Results

Toronto

Central Toronto has 9 neighborhoods with respect to unique ZIP codes in which one can find 61 unique venue categories (see Appendix 1). The top ten venues for each neighbourhood in Central Toronto are shown in Figure 7.

Frankfurt

Central Frankfurt has 8 neighbourhoods where one can find 105 unique categories (see Appendix 1). The top ten venues for each neighbourhood Central Frankfurt are shown in Figure 8.

	Neighborhood	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	Davisville	Dessert Shop	Sandwich Place	Italian Restaurant	Sushi Restaurant	Pizza Place	Café	Coffee Shop	Gym	Park	Greek Restaurant
1	Davisville North	Dance Studio	Clothing Store	Hotel	Food & Drink Shop	Sandwich Place	Convenience Store	Park	Pizza Place	Gym	Breakfast Spot
2	Deer Park, Forest Hill SE, Rathnelly, South Hi...	Pub	Coffee Shop	American Restaurant	Sports Bar	Pizza Place	Health & Beauty Service	Restaurant	Liquor Store	Light Rail Station	Fried Chicken Joint
3	Forest Hill North, Forest Hill West	Sushi Restaurant	Bus Line	Trail	Jewelry Store	Park	Farmers Market	Food & Drink Shop	Fried Chicken Joint	Garden	Yoga Studio
4	Lawrence Park	Swim School	Bus Line	Park	Yoga Studio	Dessert Shop	History Museum	Health & Beauty Service	Gym / Fitness Center	Gym	Greek Restaurant
5	Moore Park, Summerhill East	Restaurant	Gym	Tennis Court	Playground	Dance Studio	History Museum	Health & Beauty Service	Gym / Fitness Center	Greek Restaurant	Gourmet Shop
6	North Toronto West	Coffee Shop	Sporting Goods Shop	Yoga Studio	Spa	Metro Station	Mexican Restaurant	Diner	Park	Dessert Shop	Restaurant
7	Roselawn	Home Service	Garden	Yoga Studio	Indian Restaurant	History Museum	Health & Beauty Service	Gym / Fitness Center	Gym	Greek Restaurant	Gourmet Shop
8	The Annex, North Midtown, Yorkville	Café	Sandwich Place	Coffee Shop	American Restaurant	Indian Restaurant	Jewish Restaurant	Liquor Store	Park	Pharmacy	Pizza Place

Figure 7: Top 10 venues per neighbourhood in Central Toronto

	Neighborhood	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	Altstadt	Café	Italian Restaurant	Restaurant	Department Store	Bar	Thai Restaurant	Plaza	Burger Joint	Coffee Shop	Nightclub
1	Bahnhofsviertel	Hotel	Restaurant	Italian Restaurant	Bistro	Korean Restaurant	Cocktail Bar	Chinese Restaurant	Seafood Restaurant	River	Mexican Restaurant
2	Bockenheim	Asian Restaurant	Café	Spanish Restaurant	Ice Cream Shop	Supermarket	Cocktail Bar	Hookah Bar	Wine Bar	Middle Eastern Restaurant	Department Store
3	Gallus	Asian Restaurant	Café	Pub	Greek Restaurant	Concert Hall	Museum	Event Space	Boarding House	Food Court	Grocery Store
4	Gutleutviertel	Hotel	Restaurant	Italian Restaurant	Bistro	Korean Restaurant	Cocktail Bar	Chinese Restaurant	Seafood Restaurant	River	Mexican Restaurant
5	Innenstadt	Italian Restaurant	Café	Hotel	Thai Restaurant	Indian Restaurant	Bar	Pizza Place	Yoga Studio	Burger Joint	Indie Movie Theater
6	Nordend	Café	Italian Restaurant	Ice Cream Shop	Plaza	Wine Bar	Pub	Bar	Bakery	Pizza Place	Vietnamese Restaurant
7	Westend	Italian Restaurant	Steakhouse	German Restaurant	French Restaurant	Bakery	Café	Supermarket	Pizza Place	Salad Place	Burrito Place

Figure 8: Top 10 venues for each neighbourhood in Central Frankfurt

Discussion

The first observation is that both Central Toronto and Central Frankfurt are diverse places to live in. In general, one could argue that the diversity of venues is higher in Frankfurt compared to Toronto since Central Frankfurt has over 40 more unique venues. However, this generalization might not apply when looking at all neighbourhoods of all Toronto vs. Frankfurt.

Furthermore, one can notice that the most common venues in Frankfurt are Cafes and Bars while Toronto has more lifestyle/activity venues in the Top 10 most common venues. This is a hint of different culture between those cities that one could base a decision on where to move to.

Having said that, future work could do a Jaccard Similarity analysis between boroughs and neighbourhoods of the two cities to gain further insights into the differences of the cities. Also, future analysis should not just be based on the Central part of the cities but include all boroughs and the suroundings. Accessibility like airports, trains, public transport in general as well as schools and recreation opportunities, e. g. how close are the lakes or the mountains, could be a factor for living choices.

Conclusion

Both Toronto and Frankfurt offer great diversity and one can see differences in the distribution of different venues that demonstrate different culture and lifestyles. Hence, this work illustrates that one can do an analysis of cities to base decisions for relocation on.

Bibliography

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Appendix 1

Unique Venues in Central Toronto

1. American Restaurant
2. Asian Restaurant
3. BBQ Joint
4. Bagel Shop
5. Breakfast Spot
6. Brewery
7. Burger Joint
8. Bus Line
9. Café
10. Chinese Restaurant
11. Clothing Store
12. Coffee Shop
13. Convenience Store
14. Cosmetics Shop
15. Dance Studio
16. Dessert Shop
17. Diner
18. Farmers Market
19. Food & Drink Shop
20. Fried Chicken Joint
21. Garden
22. Gourmet Shop
23. Greek Restaurant
24. Gym
25. Gym / Fitness Center
26. Health & Beauty Service
27. History Museum
28. Home Service
29. Hotel
30. Indian Restaurant
31. Italian Restaurant
32. Jewelry Store
33. Jewish Restaurant
34. Light Rail Station
35. Liquor Store
36. Metro Station
37. Mexican Restaurant
38. Movie Theater
39. Park
40. Pharmacy
41. Pizza Place
42. Playground
43. Pub
44. Rental Car Location
45. Restaurant
46. Salon / Barbershop
47. Sandwich Place
48. Seafood Restaurant
49. Spa
50. Sporting Goods Shop
51. Sports Bar
52. Supermarket
53. Sushi Restaurant

54. Swim School
55. Tennis Court
56. Thai Restaurant
57. Toy / Game Store
58. Trail
59. Vegetarian / Vegan Restaurant
60. Vietnamese Restaurant
61. Yoga Studio

Unique Venues in Central Frankfurt

1. Accessories Store
2. African Restaurant
3. Art Museum
4. Asian Restaurant
5. Athletics & Sports
6. Bakery
7. Bar
8. Beer Bar
9. Beer Store
10. Bistro
11. Boarding House
12. Bookstore
13. Breakfast Spot
14. Brewery
15. Burger Joint
16. Burrito Place
17. Butcher
18. Café
19. Chinese Restaurant#
20. Chocolate Shop
21. Clothing Store
22. Cocktail Bar
23. Coffee Shop
24. Concert Hall
25. Cosmetics Shop
26. Currywurst Joint
27. Department Store
28. Dessert Shop
29. Dim Sum Restaurant
30. Donut Shop
31. Drugstore
32. Eastern European Restaurant
33. Electronics Store
34. Event Space
35. Falafel Restaurant
36. Farmers Market
37. Fast Food Restaurant
38. Food & Drink Shop
39. Food Court
40. French Restaurant
41. Garden
42. Gay Bar
43. German Restaurant
44. Gourmet Shop
45. Greek Restaurant

46. Grocery Store
47. Gym
48. Gym / Fitness Center
49. Historic Site
50. History Museum
51. Hookah Bar
52. Hotel
53. Hotel Bar
54. Ice Cream Shop
55. Indian Restaurant
56. Indie Movie Theater
57. Italian Restaurant
58. Japanese Restaurant
59. Kebab Restaurant
60. Korean Restaurant
61. Lounge
62. Market
63. Men's Store
64. Metro Station
65. Mexican Restaurant
66. Middle Eastern Restaurant
67. Modern European Restaurant
68. Monument / Landmark
69. Museum
70. Nightclub
71. Optical Shop
72. Park
73. Pedestrian Plaza
74. Persian Restaurant
75. Peruvian Restaurant
76. Pizza Place
77. Plaza
78. Pub
79. Radio Station
80. Restaurant
81. River
82. Road
83. Roof Deck
84. Salad Place
85. Sandwich Place
86. Scenic Lookout
87. Seafood Restaurant
88. Shoe Store
89. Shopping Mall
90. Soup Place
91. Spanish Restaurant
92. Sporting Goods Shop
93. Sports Bar
94. Steakhouse
95. Supermarket
96. Sushi Restaurant
97. Tapas Restaurant
98. Tea Room
99. Thai Restaurant
100. Toy / Game Store
101. Trattoria/Osteria
102. Turkish Restaurant
103. Vietnamese Restaurant

104. Wine Bar
105. Yoga Studio