The Restaurant Battle of Neighbourhood's in Cologne

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Introduction/Business problem

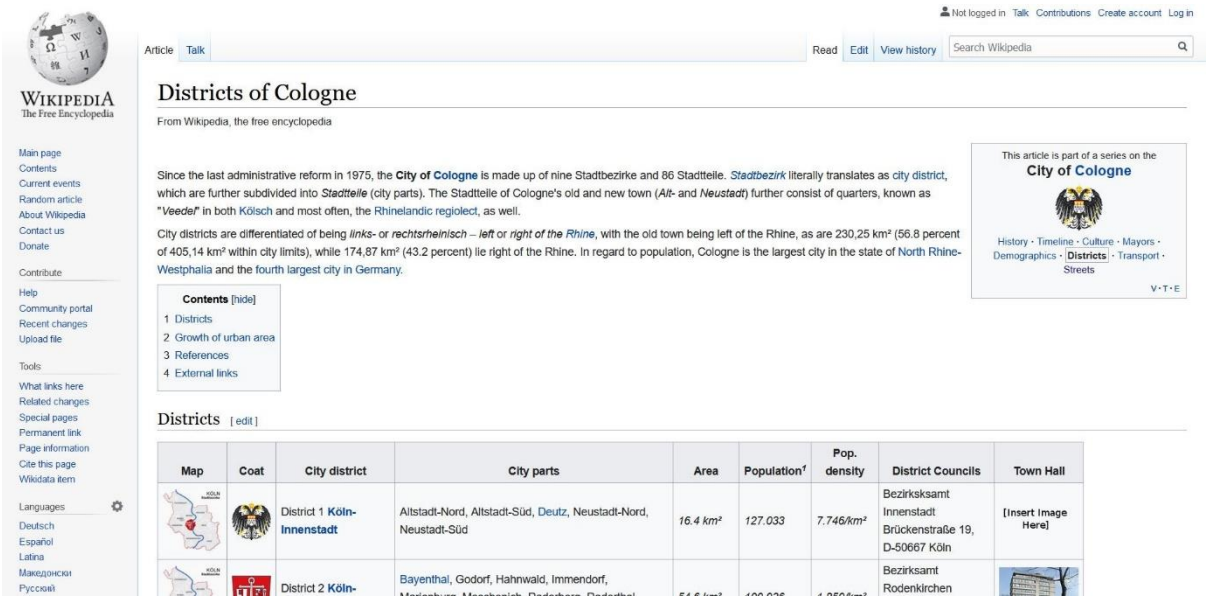
Cologne, the city the author lives in, attracts a large number of tourists, not least due to its famous cathedral, the trade fairs and conventions, its vibrant party scene. For tourists, finding the right place to eat can be a challenge, though. German dishes include a lot of meat, often pork, which many people do not want to eat for health-related, religious, cultural, or moral reasons. This is just one motive for giving tourists a good overview about what to eat where.

Thus, the goal I want to reach with this exercise is to give a simple recommendation to tourists in Cologne: in which district of the city will you find a large number or even concentration of which types of restaurants? Where to eat Mediterranean food, where to find German food, where to get fast food? The target audience are foreign tourists.

Description of the data

I will, as requested by the assignment task, use foursquare data about restaurants in Cologne. Foursquare is a US tech company from New York focusing on location data. Their technology and data powers apps such as Apple's Maps, Uber, Twitter, and many other household names. Here is an example of a vegetarian restaurant in Cologne on foursquare: **https://de.foursquare.com/v/sattgr C3 BCn/5c33306cc824ae002c2b414c**. I will use foursquare data such as the restaurant name, ID, location, and category of food (vegetarian, Italian etc.).

Also, I will use the overview of districts/city parts of Cologne from Wikipedia: **https://en.wikipedia.org/wiki/Districts_of_Cologne**



Districts of Cologne

From Wikipedia, the free encyclopedia

Since the last administrative reform in 1975, the **City of Cologne** is made up of nine Stadtbezirke and 86 Stadtteile. *Stadtbezirk* literally translates as city district, which are further subdivided into *Stadtteile* (city parts). The Stadtteile of Cologne's old and new town (*Alt-* and *Neustadt*) further consist of quarters, known as "*Veedel*" in both Kölsch and most often, the Rhinelandic regiolect, as well.

City districts are differentiated of being *links-* or *rechtsrheinisch* – *left* or *right of the Rhine*, with the old town being left of the Rhine, as are 230,25 km² (56.8 percent of 405,14 km² within city limits), while 174,87 km² (43.2 percent) lie right of the Rhine. In regard to population, Cologne is the largest city in the state of North Rhine-Westphalia and the fourth largest city in Germany.

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This article is part of a series on the City of Cologne
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Districts [edit]

Map	Coat	City district	City parts	Area	Population[1]	Pop. density	District Councils	Town Hall
		District 1 Köln-Innenstadt	Altstadt-Nord, Altstadt-Süd, Deutz, Neustadt-Nord, Neustadt-Süd	*16.4 km²*	*127.033*	*7.746/km²*	Bezirksksamt Innenstadt Brückenstraße 19, D-50667 Köln	[Insert Image Here]
		District 2 Köln-	Bayenthal, Godorf, Hahnwald, Immendorf,				Bezirksamt Rodenkirchen	

Here, you will find a table "Districts" which shows the nine city districts and its neighborhoods/city parts. I will use these districts and the data about restaurants in these districts from foursquare to show the density of restaurants in them.

Methodology

In this section, I will describe the data analysis and how I used the data to yield the results.

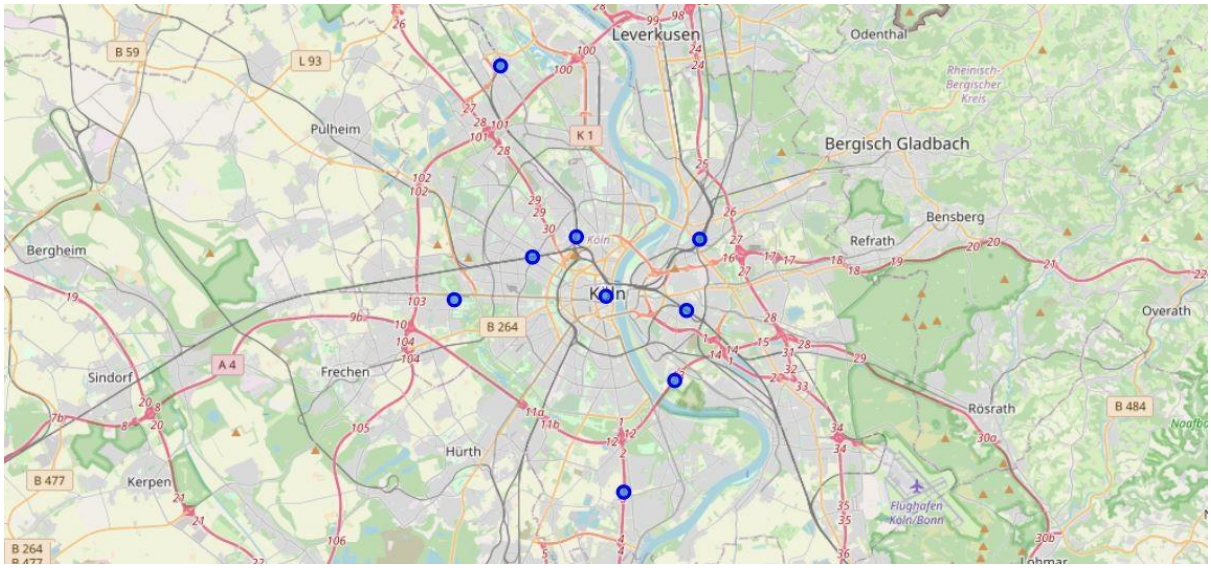
Starting out, I scraped data from Wikipedia to create a dataframe with the city districts of Cologne: **https://en.wikipedia.org/wiki/Districts_of_Cologne**. For this, I used the pandas read function. I had to clean the resulting data frame in terms of unnecessary information or data that could not be handled in a data frame, such as picture data of the coat of arms of each district. The result is a nice data frame:

	City district	City parts	Area	Population1	Pop. density	District Councils
0	Köln-Innenstadt	Altstadt-Nord, Altstadt-Süd, Deutz, Neustadt-N...	16.4 km²	127.033	7.746/km²	Bezirksksamt Innenstadt Brückenstraße 19, D-50...
1	Köln-Rodenkirchen	Bayenthal, Godorf, Hahnwald, Immendorf, Marien...	54.6 km²	100.936	1.850/km²	Bezirksamt Rodenkirchen Hauptstraße 85, D-5099...
2	Köln-Lindenthal	Braunsfeld, Junkersdorf, Klettenberg, Lindenth...	41.6 km²	137.552	3.308/km²	Bezirksamt Lindenthal Aachener Straße 220, 509...
3	Köln-Ehrenfeld	Bickendorf, Bocklemünd/Mengenich, Ehrenfeld, N...	23.8 km²	103.621	4.348/km²	Bezirksamt Ehrenfeld Venloer Straße 419 – 421,...
4	Köln-Nippes	Bilderstöckchen, Longerich, Mauenheim, Niehl, ...	31.8 km²	110.092	3.462/km²	Bezirksamt NippesNeusser Straße 450,D-50733 Köln
5	Köln-Chorweiler	Blumenberg, Chorweiler, Esch/Auweiler, Fühling...	67.2 km²	80.870	1.204/km²	Bezirksamt Chorweiler Pariser Platz 1, D-50765...
6	Köln-Porz	Eil, Elsdorf, Ensen, Finkenberg, Gremberghoven...	78.8 km²	106.520	1.352/km²	Bezirksamt PorzFriedrich-Ebert-Ufer 64–70, D-5...
7	Köln-Kalk	Brück, Höhenberg, Humboldt/Gremberg, Kalk, Mer...	38.2 km²	108.330	2.841/km²	Bezirksamt KalkKalker Hauptstraße 247–273,D-51...
8	Köln-Mülheim	Buchforst, Buchheim, Dellbrück, Dünnwald, Flit...	52.2 km²	144.374	2.764/km²	Bezirksamt Mülheim Wiener Platz 2a,D-51065 Köln

Then, I enabled geopy functions by installing the conda-forge geopy package. I used the nominatim function to add geospatial data to the data frame, that is the latitude and the longitude seen on the right side of the following table.

	City district	City parts	Area	Population1	Pop. density	District Councils	Latitude	Longitude
0	Köln-Innenstadt	Altstadt-Nord, Altstadt-Süd, Deutz, Neustadt-N...	16.4 km²	127.033	7.746/km²	Bezirksksamt Innenstadt Brückenstraße 19, D-50...	50.937328	6.959234
1	Köln-Rodenkirchen	Bayenthal, Godorf, Hahnwald, Immendorf, Marien...	54.6 km²	100.936	1.850/km²	Bezirksamt Rodenkirchen Hauptstraße 85, D-5099...	50.865622	6.969718
2	Köln-Lindenthal	Braunsfeld, Junkersdorf, Klettenberg, Lindenth...	41.6 km²	137.552	3.308/km²	Bezirksamt Lindenthal Aachener Straße 220, 509...	50.935935	6.871246
3	Köln-Ehrenfeld	Bickendorf, Bocklemünd/Mengenich, Ehrenfeld, N...	23.8 km²	103.621	4.348/km²	Bezirksamt Ehrenfeld Venloer Straße 419 – 421,...	50.951502	6.916529
4	Köln-Nippes	Bilderstöckchen, Longerich, Mauenheim, Niehl, ...	31.8 km²	110.092	3.462/km²	Bezirksamt NippesNeusser Straße 450,D-50733 Köln	50.958994	6.941777
5	Köln-Chorweiler	Blumenberg, Chorweiler, Esch/Auweiler, Fühling...	67.2 km²	80.870	1.204/km²	Bezirksamt Chorweiler Pariser Platz 1, D-50765...	51.021167	6.898034
6	Köln-Porz	Eil, Elsdorf, Ensen, Finkenberg, Gremberghoven...	78.8 km²	106.520	1.352/km²	Bezirksamt PorzFriedrich-Ebert-Ufer 64–70, D-5...	50.906705	6.999129
7	Köln-Kalk	Brück, Höhenberg, Humboldt/Gremberg, Kalk, Mer...	38.2 km²	108.330	2.841/km²	Bezirksamt KalkKalker Hauptstraße 247–273,D-51...	50.931923	7.005806
8	Köln-Mülheim	Buchforst, Buchheim, Dellbrück, Dünnwald, Flit...	52.2 km²	144.374	2.764/km²	Bezirksamt Mülheim Wiener Platz 2a,D-51065 Köln	50.958147	7.013526

Using the folium package and my data frame, I then created a map with the nine city districs on it.



Now, foursquare data comes into play. I first did a view try-outs for the city district "Innenstadt", which I know pretty well, to see if the venues retrieved from foursquare seem reasonable and correct. That was the case.

To find clusters of restaurant types in the different city districts, I first transformed the data frame with the restaurant venues, associated to city districts, by one-hot encoding (0/1), as seen in the picture below.

	Neighborhood	American Restaurant	Asian Restaurant	Austrian Restaurant	Chinese Restaurant	Comfort Food Restaurant	Doner Restaurant	Eastern European Restaurant	Falafel Restaurant	Fast Food Restaurant	French Restaurant	German Restaurant	Greek Restaurant	Indian Restaurant	Italian Restaurant	Japanese Restaurant	Kebab Restaurant	Kurdish Restaurant	A Re
1	Köln-Innenstadt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	Köln-Innenstadt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	Köln-Innenstadt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	Köln-Innenstadt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	Köln-Innenstadt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Next, I used grouping to show the frequency of each category of restaurants in each city district.

	Neighborhood	American Restaurant	Asian Restaurant	Austrian Restaurant	Chinese Restaurant	Comfort Food Restaurant	Doner Restaurant	Eastern European Restaurant	Falafel Restaurant	Fast Food Restaurant	French Restaurant	German Restaurant	Greek Restaurant	Indian Restaurant	Italian Restaurant	Japanese Restaurant	Kebab Restaurant	Kurdish Restaurant	A Re
0	Köln-Chorweiler	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.333333	0.000000	0.000000	0.000000	0.000000	0.333333	0.000000	0.000000	0.000000	
1	Köln-Ehrenfeld	0.000000	0.000000	0.000000	0.038462	0.000000	0.000000	0.000000	0.000000	0.000000	0.038462	0.076923	0.038462	0.000000	0.153846	0.038462	0.038462	0.000000	
2	Köln-Innenstadt	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.041667	0.000000	0.083333	0.083333	0.000000	0.000000	0.291667	0.000000	0.000000	0.000000	
3	Köln-Kalk	0.000000	0.041667	0.000000	0.000000	0.041667	0.041667	0.041667	0.000000	0.000000	0.000000	0.041667	0.083333	0.041667	0.083333	0.000000	0.000000	0.041667	
4	Köln-Lindenthal	0.041667	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.041667	0.333333	0.083333	0.041667	0.083333	0.041667	0.000000	0.000000	
5	Köln-Mülheim	0.000000	0.095238	0.000000	0.000000	0.047619	0.000000	0.000000	0.000000	0.000000	0.000000	0.047619	0.047619	0.000000	0.095238	0.000000	0.000000	0.000000	
6	Köln-Nippes	0.000000	0.000000	0.064516	0.000000	0.000000	0.032258	0.000000	0.000000	0.000000	0.096774	0.064516	0.064516	0.000000	0.193548	0.000000	0.032258	0.000000	
7	Köln-Porz	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.035714	0.071429	0.250000	0.071429	0.000000	0.178571	0.000000	0.000000	0.035714	
8	Köln-Rodenkirchen	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.333333	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	

I used this information to create a data frame in which you can see the most common restaurant venue types for each city district.

	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	Köln-Chorweiler	Fast Food Restaurant	Italian Restaurant	Sushi Restaurant	Vietnamese Restaurant	Japanese Restaurant	Indian Restaurant	Greek Restaurant	German Restaurant	French Restaurant	Falafel Restaurant
1	Köln-Ehrenfeld	Tapas Restaurant	Italian Restaurant	Restaurant	German Restaurant	Sushi Restaurant	Vietnamese Restaurant	Modern European Restaurant	Chinese Restaurant	French Restaurant	Greek Restaurant
2	Köln-Innenstadt	Italian Restaurant	Sushi Restaurant	Vietnamese Restaurant	German Restaurant	French Restaurant	Middle Eastern Restaurant	Modern European Restaurant	Restaurant	Schnitzel Restaurant	Falafel Restaurant
3	Köln-Kalk	Greek Restaurant	Turkish Restaurant	Italian Restaurant	Middle Eastern Restaurant	Restaurant	German Restaurant	Indian Restaurant	Kurdish Restaurant	Vegetarian / Vegan Restaurant	Mediterranean Restaurant
4	Köln-Lindenthal	German Restaurant	Sushi Restaurant	Italian Restaurant	Greek Restaurant	American Restaurant	Indian Restaurant	French Restaurant	Mexican Restaurant	Modern European Restaurant	Restaurant
5	Köln-Mülheim	Turkish Restaurant	Italian Restaurant	Asian Restaurant	Mediterranean Restaurant	German Restaurant	Vegetarian / Vegan Restaurant	Greek Restaurant	Middle Eastern Restaurant	Vietnamese Restaurant	Seafood Restaurant
6	Köln-Nippes	Italian Restaurant	French Restaurant	Vietnamese Restaurant	Austrian Restaurant	Modern European Restaurant	Greek Restaurant	Restaurant	Sushi Restaurant	German Restaurant	Spanish Restaurant
7	Köln-Porz	German Restaurant	Italian Restaurant	Restaurant	Greek Restaurant	Thai Restaurant	Seafood Restaurant	French Restaurant	Fast Food Restaurant	Turkish Restaurant	Kurdish Restaurant
8	Köln-Rodenkirchen	German Restaurant	Restaurant	Scandinavian Restaurant	Vietnamese Restaurant	Kebab Restaurant	Italian Restaurant	Indian Restaurant	Greek Restaurant	French Restaurant	Fast Food Restaurant

Now, with all this data, I could finally run an unsupervised machine learning algorithm, more specifically, a k-means clustering algorithm from the scikit-learn package. One could use the ellbow method to systematically define the k value, but I simply chose k to be 5, having been inspired by one of the coursera courses to do so.

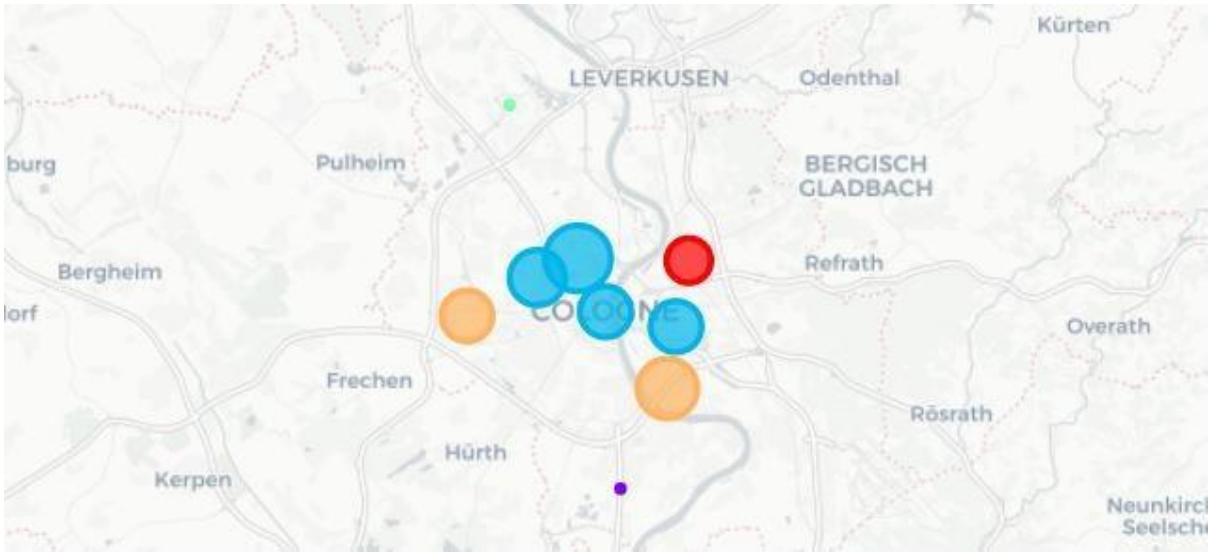
Results

And here already comes the result:

	Cluster Labels	City district	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
0	2	Köln-Chorweiler	Sushi Restaurant	Fast Food Restaurant	Vegetarian / Vegan Restaurant	Kebab Restaurant	Chinese Restaurant
1	3	Köln-Ehrenfeld	Italian Restaurant	Restaurant	Tapas Restaurant	Kebab Restaurant	Portuguese Restaurant
2	4	Köln-Innenstadt	Italian Restaurant	Indian Restaurant	Vegetarian / Vegan Restaurant	Mexican Restaurant	Chinese Restaurant
3	1	Köln-Kalk	Greek Restaurant	Vegetarian / Vegan Restaurant	Turkish Restaurant	Chinese Restaurant	Doner Restaurant
4	0	Köln-Lindenthal	Italian Restaurant	Vegetarian / Vegan Restaurant	Turkish Restaurant	Chinese Restaurant	Doner Restaurant

What we see in the table are the city districts and their most common venues, and they now have been assigned five different cluster labels from 0 to 4.

We can now use the cluster labels to show the city districts marked with a cluster-specific color on a map, again using folium:



You will see nine bubbles for the nine city districts, with five different colors for the five different clusters. If you have trouble counting to five here, look for a small green dot on the upper part of the picture and a small purple dot on the lower part of the picture.

Now, what is the final result of this exercise? We now can show five clusters of restaurant type concentrations for the city of Cologne, which I named according to the restaurant concentration the data shows.

Cluster 1 - the Italian Food(Lindenthal)

	City parts	District Councils	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
2	Braunsfeld, Junkersdorf, Klettenberg, Lindenth...	Bezirksamt Lindenthal Aachener Straße 220, 509...	6.871246	50.935935	0.0	Italian Restaurant	Vegetarian / Vegan Restaurant	Turkish Restaurant	Chinese Restaurant	Doner Restaurant

Cluster 2 - the Greek Food Cluster (Gremberg)

	City parts	District Councils	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
7	Brück, Höhenberg, Humboldt/Gremberg, Kalk, Mer...	Bezirksamt KalkKalker Hauptstraße 247–273,D-51...	7.005806	50.931923	1.0	Greek Restaurant	Vegetarian / Vegan Restaurant	Turkish Restaurant	Chinese Restaurant	Doner Restaurant

Cluster 3 - the Japnese Food Cluster (Fühling)

	City parts	District Councils	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
5	Blumenberg, Chorweiler, Esch/Auweiler, Fühling...	Bezirksamt Chorweiler Pariser Platz 1, D-50765...	6.898034	51.021167	2.0	Sushi Restaurant	Fast Food Restaurant	Vegetarian / Vegan Restaurant	Kebab Restaurant	Chinese Restaurant

Cluster 4 - the Italian Food Cluster (Ehrenfeld)

	City parts	District Councils	Longitude	Latitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue
3	Bickendorf, Bocklemünd/Mengenich, Ehrenfeld, N...	Bezirksamt Ehrenfeld Venloer Straße 419 – 421,...	6.916529	50.951502	3.0	Italian Restaurant	Restaurant	Tapas Restaurant	Kebab Restaurant	Portuguese Restaurant

Interestingly, it is really possible to define clusters of certain cuisines in Cologne city. People living in Cologne will probably agree that these clusters sound pretty reasonable and are not too far away from what you would have expected.

Discussion

If I reflect the work necessary to create these results, what comes to my mind is that for typical ways of scraping, cleaning, handling, transforming and visualizing data, all the tools are simply there. We just have to get to know the available open source packages and learn how to use them. What I find fantastic is that nearly all of them are free of charge. Also, a simple notebook computer is enough. All the rest is concentrated, creative, interesting, sometimes hard work and searching for hints, tips, examples, explanations etc. in the web. With these tools, many exciting data science use cases can be created, for all kinds of useful purposes.

Conclusion

We achieved the goal presented at the outset of this blogpost: tourists can see in the results which city districts best match their food desires. This is just one example of fantastic data science uses cases one can realize applying technology which is available for free today! What a time to be alive.

Acknowledgement & sources

A number of publications have inspired this piece of work and helped me develop the skills to run this analysis and the difficult coding behind. Also, when running into difficulties, it is common to borrow a few fragments of code, as long as you fully understand them, change and apply them to your needs, and name the source - at least if we are talking about non-commercial use for qualification purposes. Amongst these sources are:

The courses of the IBM Data Science Professional Certificate itself and the plethora of hours I spent with them: https://www.coursera.org/professional-certificates/ibm-data-science Especially, courses number 7 "Data Visualization with Python" and 8 "Machine Learning with Python" played an important role here.

Of course, also a number of cheat sheets I found on github (https://github.com/), stack overflow https://stackoverflow.com etc. helped.