Background and Business Problem

In this project we will be looking at the dental care services supply in Prague.

Czech Republic is one of the Eastern European countries that went through a successful transformation from ex-communist to market economy. The country has a diversified economy that grows by 3-5% per annum compared to 1.5-2.5% on average for EU. The per capita GDP (nominal) is 22.6 kUSD, services sector accounts for about 60% of the economy.

Prague is a relatively large city with the population of 1.3 million people (13th largest city in the EU). It is located in the center of Europe, in a several hours' driving distance from such 'richer' countries as Germany and Austria. Prague is a quite popular tourist destination; annually it welcomes more than 8 million visitors.

Our analysis below covers the dental services supply in Prague. Our report is targeted at the stakeholders interested in opening a dental clinic in this city.

We will explore how developed is the dental services market in Prague. More specifically, how many dental clinics are there, where are they located? Are they spread evenly across the city or tend to concentrate in particular areas? Is the distribution pattern similar to other cities? Is the competition high or low compared to other cities?

Data

We will answer our questions using the Google Places location data (I was unable to set up a Foursquare developer account, so I had to use Google instead).

The Google API can provide us with the information about the venues of the type 'dentist' within certain distance from the location we specify. The data includes names of the venues and their geographical coordinates. The number of records returned by the API for each location is limited, and we cannot get all venues in a city with a single request. So we will need to split the area into a number of locations / district centers and make an API request for these individual points. This also implies that our research will be limited to the central parts of the cities which we will explore.

As our research question suggests some comparative analysis we will need to select several cities we can compare Prague with. In order to choose such cities we will collect data for population size and the relative countries' per capita GDP for several European cities.

Methodology

1. Select cities for comparison

As a first step we need to select the cities for comparison. We will limit our research to two other cities.

The information we collected from Wikipedia is laid out in the table below.

City	Population (thousand)	Country	GDP per capita (USD)
Prague	**1,305**	**Czech Republic**	**22,627**
Tallinn	446	Estonia	22,986
Porto	**1,313**	**Portugal**	**21,608**
Vilnius	539	Lithuania	19,883
Thessaloniki	812	Greece	18,168
Sofia	1,281	Bulgaria	9,826
Vienna	1,929	Austria	48,634
Budapest	1,768	Hungary	15,373
Munich	1,538	Germany	45,466
Cologne	**1,119**	**Germany**	**45,466**

Some of these cities are significantly larger or smaller than Prague, others are comparable in terms of size are but located in countries with much higher or lower GDP.

We will take the following approach:

- We choose one city of similar size (population) from a country with a similar income - **Porto** from **Portugal**
- We also choose another city of a comparable size from a 'richer' country - **Cologne** from **Germany**. Cologne also has another similarity with Prague- it's a cultural center and a popular tourist destination.
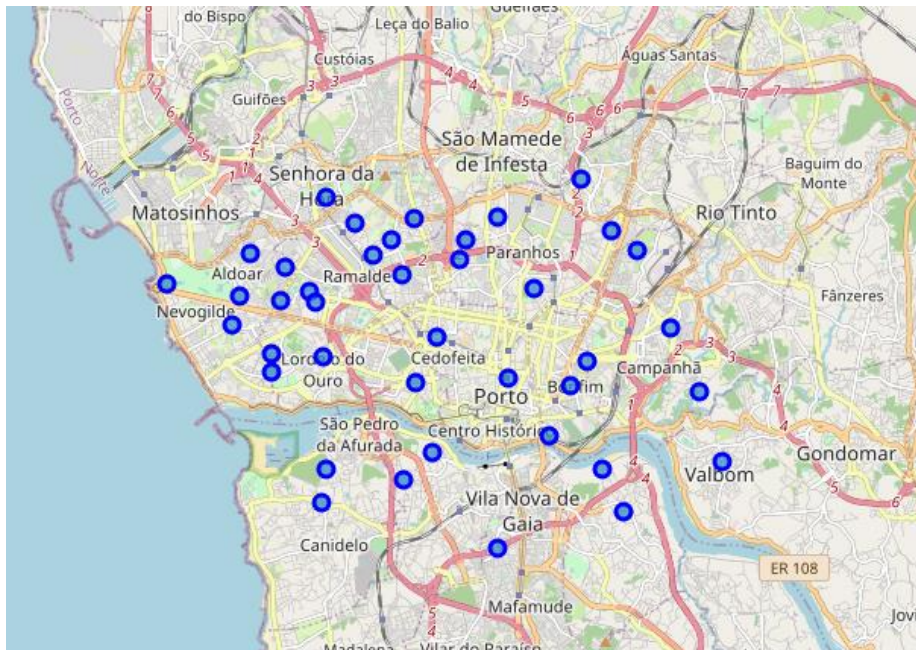
2. Select central locations / points for API requests

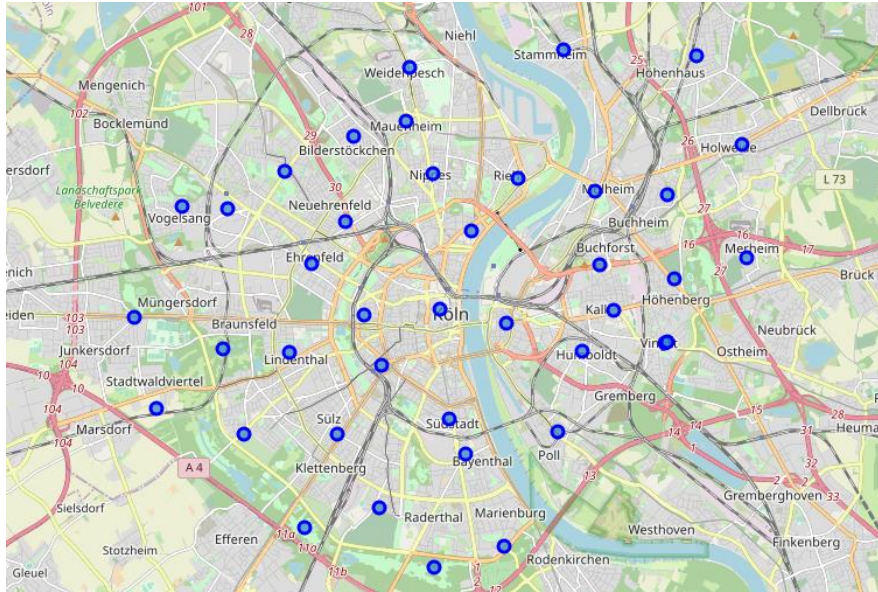After that we select points in 40 central districts in each city. This is how it looks on the map.

Prague
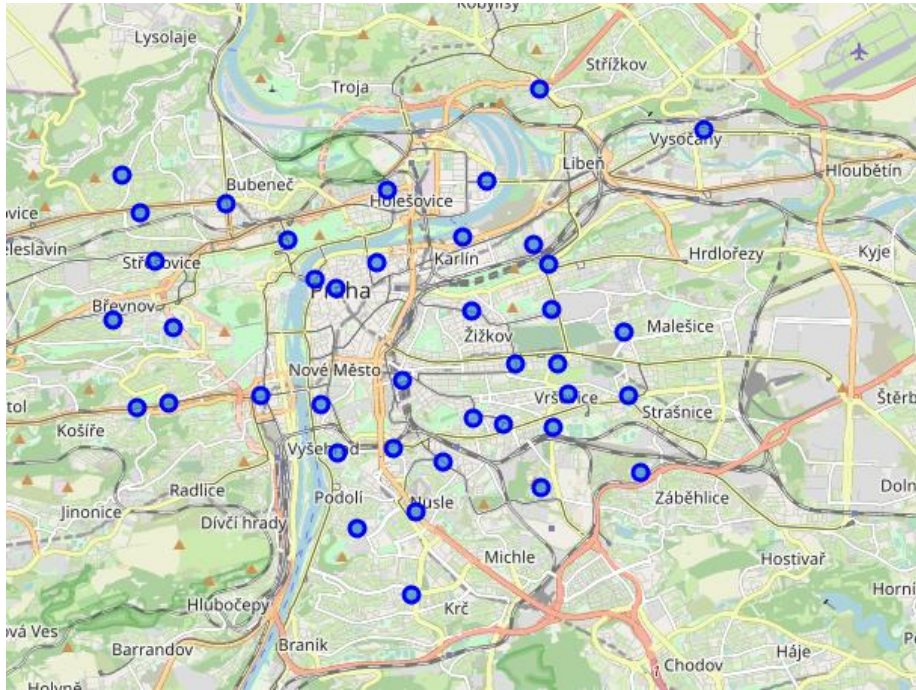
Porto

Cologne

3. Locate unique dental clinics in the area of the above points

Now we locate dental clinics within 1,000 meters from these points in each city using the Google API. After we eliminate duplicated entries (in case a venue is within 1,000 meters from more than one point) we get 449 unique dental clinics in the central part of Prague, 241 in Porto and 422 in Cologne.
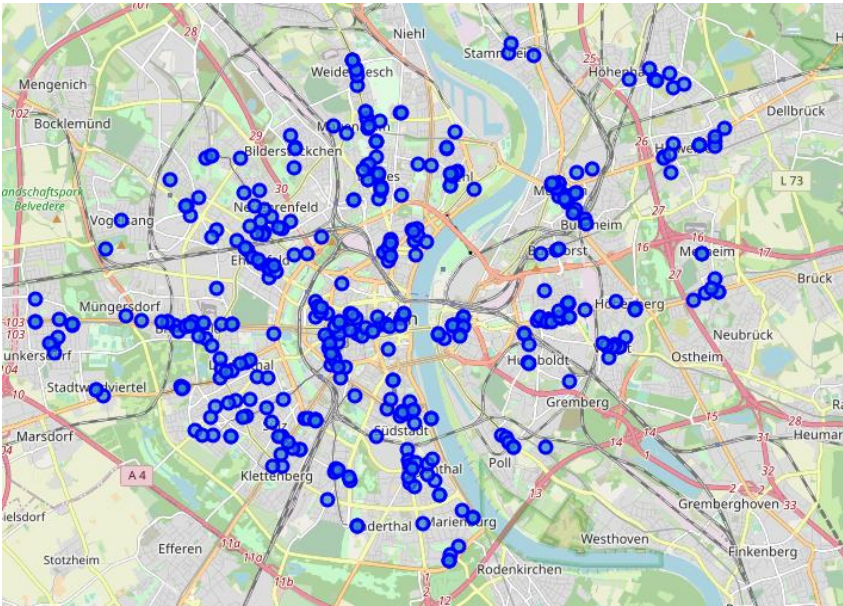
Dental Clinic Locations Prague
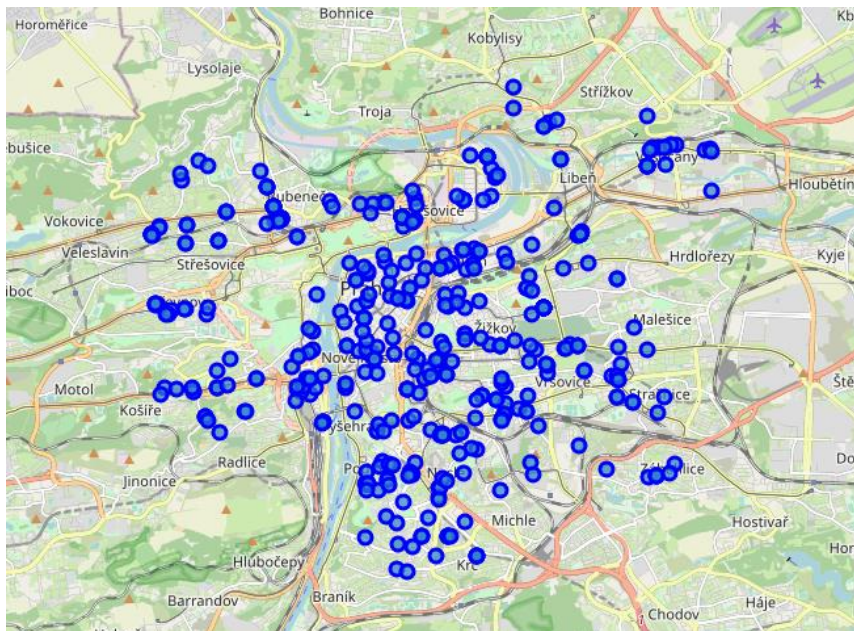
**Dental Clinic Locations Porto**
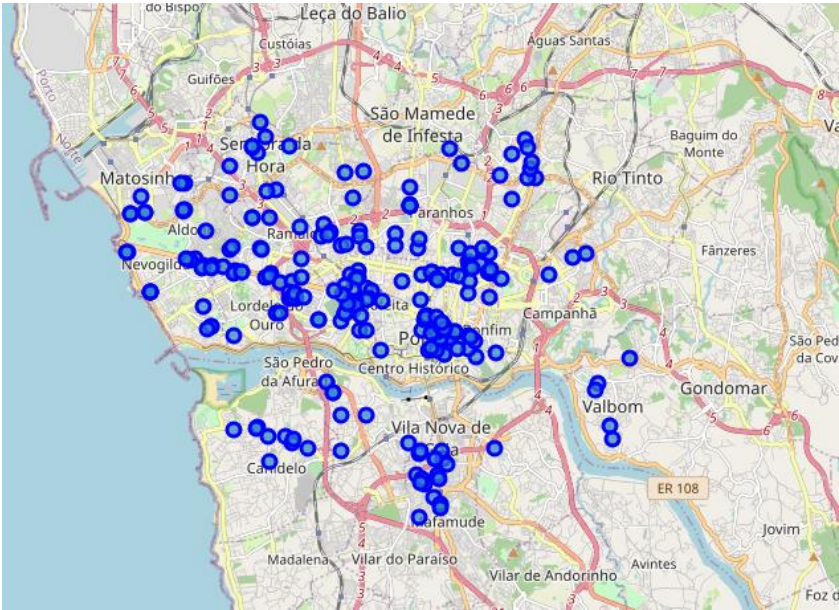
Dental Clinic Locations Cologne

4. Check for a pattern in venues location

We use DBSCAN clustering algorithm to detect if there is any clear pattern in the venues locations. This algorithm is based on density and can work with patterns / clusters of different shapes. Also, it does not require us to specify a number of clusters in advance, it detects the clusters automatically. As an output the algorithm produces cluster labels for the clusters it detects and marks unallocated points as 'noise'. Such 'noise' points represent "stand alone" clinics which are located in areas of low density / far from other dentists.
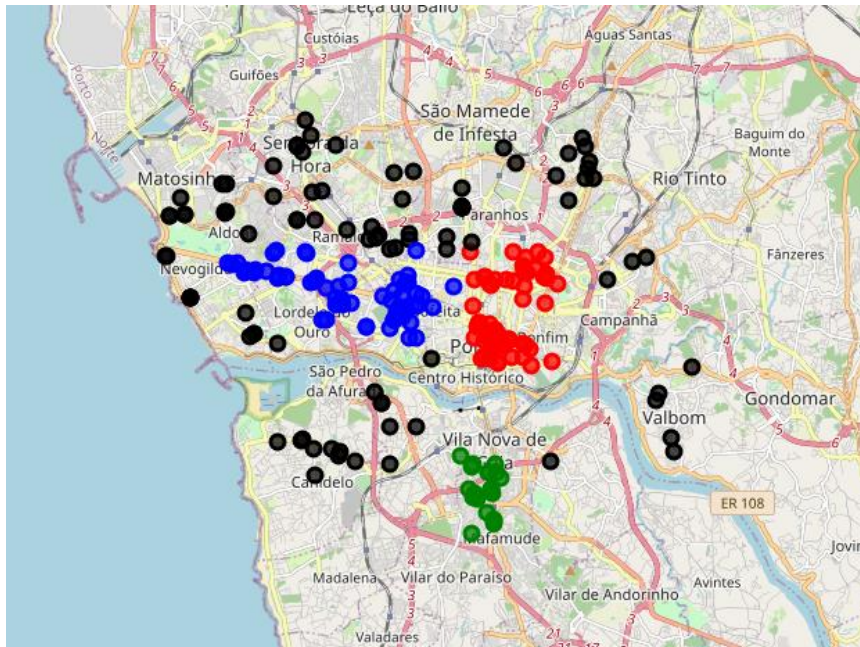
The clustering results are shown below

Prague

DBSCAN detected 8 clusters and 28 noise points. Larger clusters are colored in blue and red, 'noise' points shown in black, other smaller clusters – in green.
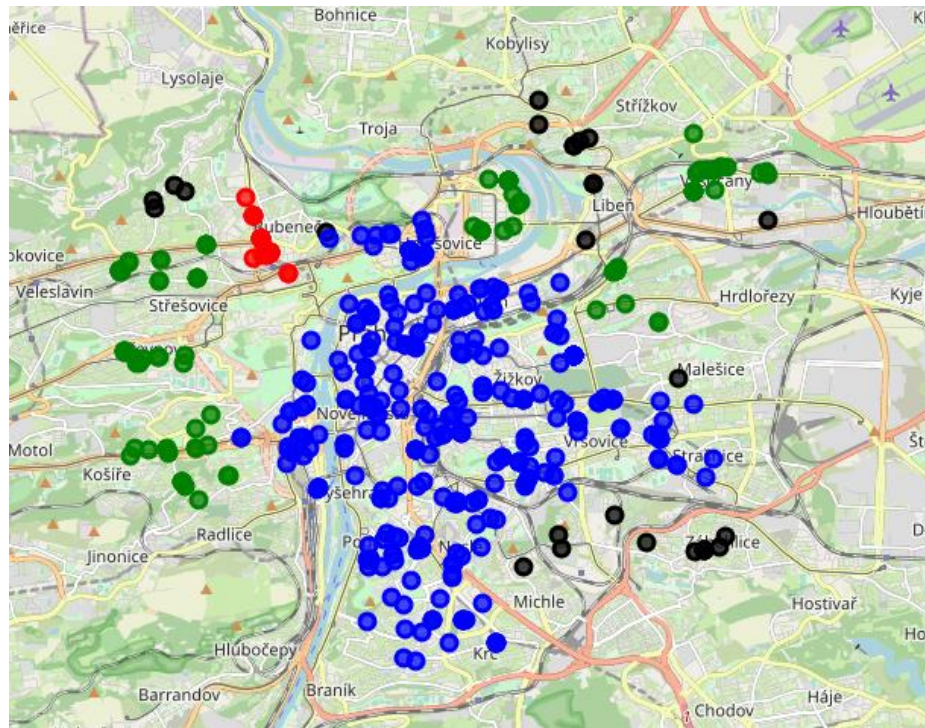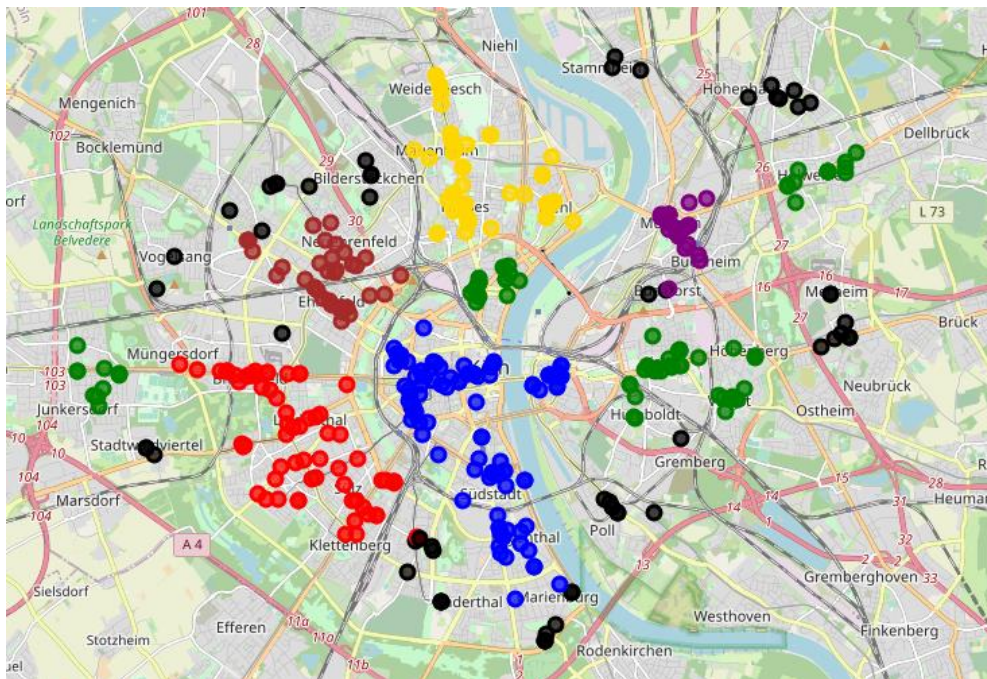
Porto

Just 3 clusters were detected, 92 points classified as 'noise' (shown in black)

Cologne

DBSCAN suggests that there are 10 clusters and 58 noise points. Larger clusters are shown in blue, red, purple, brown and yellow, other smaller clusters in green, noise points in black.

5. Calculate and compare distances between venues

Using the *numpy* libraries we can calculate the distance between venues based on their coordinates. For each city we create a matrix with distances between each two venues. After that for each dental clinic we find another 10 nearest dentists and the average distance to the closest 10 clinics nearby. As a summary, for each city we have the average distance between a dental clinic and its closest neighbor clinic, second closest clinic, etc, and an overall average distance from a dental clinic to the nearest 10 other clinics.

Results

We can summarize our results with the following plot.

Number of dental clinics and distance (in meters) between them in Prague, Porto and Cologne
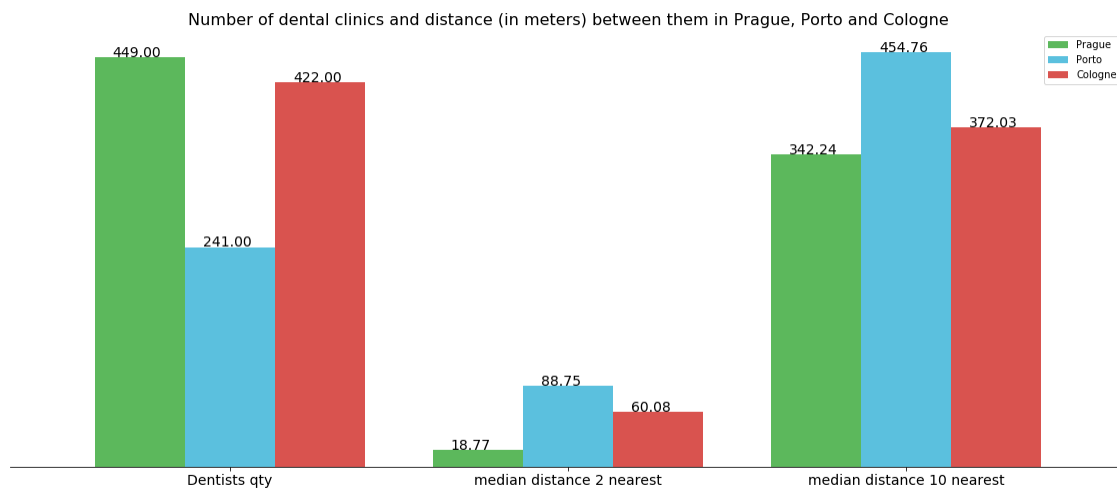
We've identified significantly more dental clinics in the center of Prague (449) than in Porto (241) – a city of a similar size from a country with a similar per capita income. The size and density of the dentists' network in Prague is even larger than in Cologne (422 dentists) – a city in Germany which has per capita income twice as large as Czech Republic.

In all cities that we've explored dental clinics tend to be located near each other and form certain clusters; although in Porto there are more "stand alone" venues. In the center of Prague ½ of the dentists are in just about 20 meters from each other, for Cologne and Porto this distance is larger but still less than 100 meters.

A more detailed table of distances (mean and median) from a dentist to its 1 to 10 neighbors is shown below:

|	praha_mean	praha_median	porto_mean	porto_median	cologne_mean	cologne_median
1	90.526270	18.771985	156.048124	88.751672	110.411709	60.077187
2	169.806203	118.689161	275.208635	204.433598	196.682020	147.268009
3	236.959789	231.483867	376.816923	296.586468	299.323626	233.523457
4	306.426581	287.705798	467.978101	382.022153	360.168983	285.028187
5	349.435633	333.579008	564.133760	445.990327	424.040933	330.476470
6	397.882282	395.501078	621.518782	512.053574	484.612311	371.213121
7	451.185572	432.243471	672.924837	563.520266	537.280842	433.173571
8	493.970978	477.151159	730.381733	599.432316	608.921239	511.435294
9	532.536586	506.725769	793.668539	638.518922	655.294585	542.946450
10	567.358455	541.533248	856.187240	672.551868	695.913712	586.039697
mean	359.608835	342.241096	551.486667	454.762276	437.264996	372.026399

Discussion

With reference to the questions we set out in the beginning of our analysis we've discovered that Prague has a very dense network of dental clinics; the competition is much stronger than one could expect given just the size of the city and per capita income of the country.
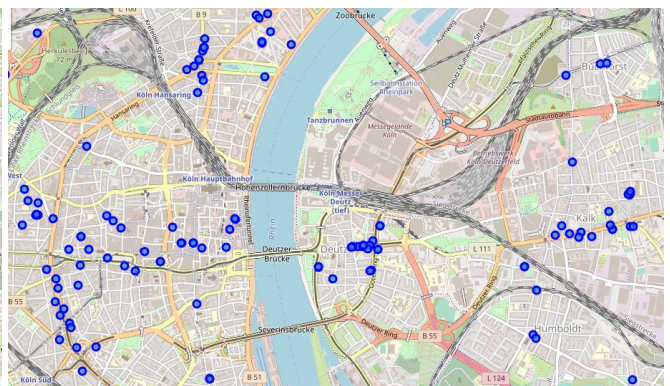
The central / historic part of Prague, in our opinion, looks overcrowded with dentists. We can illustrate this by comparing Prague with Cologne:

Dental clinics locations in the historic centers:
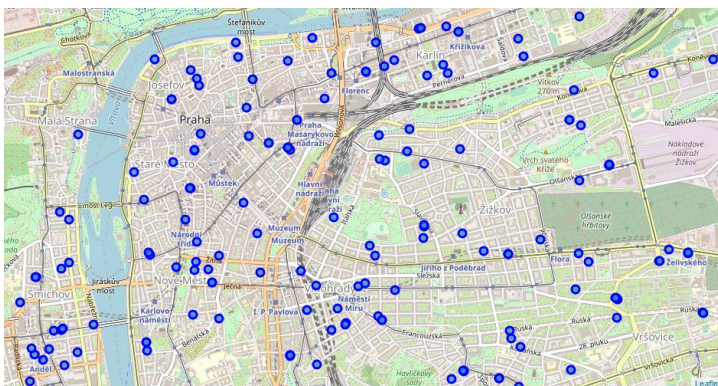
Prague: **Cologne:**

 A possible explanation for this situation could be that this network of clinics has developed to serve not only local customers, but also "medical tourists" from richer countries. With a fair quality of medical training in

Czech Republic and lower prices in local currency Prague clinics may successfully compete with dentists from German and Austrian cities nearby. An opportunity to spend a night in such a beautiful city as Prague "for free", taking into consideration the saving on dental care services, may constitute a sound marketing strategy. So, the stakeholders interested in setting up a dental clinic in Prague should be careful about what client segment they want to target and which medical procedures to specialize in (not all of them might be suitable / convenient for 'travelling' customers).

As for suitable locations, we may suggest that opening a clinic in a "clear space" far from other similar venues might not be a good idea. Empirical evidence from the data we've collected shows that if the location is attractive for some reason there will already be someone (probably more than one) who discovered it earlier. Although it may be worth looking at the popular locations in more detail in order to understand what makes them attractive (e.g. public places, transport hubs, or whatever), it would be too risky to bet on discovering a previously unknown golden spot.

Conclusion

We've looked at dental services supply in Prague in comparison with Porto and Cologne. We've discovered that the competition among dentists in Prague is much stronger than one could expect given just the size of the city and per capita income of the country.

We suppose that a significant share of the Prague dentists' customers are visitors from Germany and Austria, and stakeholders interested in opening a dental services business in Prague should take this into account when developing a marketing strategy.