

# Capstone project

## 1 Problem & background

Recently I visited Gent, one of the biggest and most visited cities in Belgium. I was wondering how similar or dissimilar this city is from the city I live in Antwerp. From visiting Gent, I felt it was a bit like Antwerp, but I want to check if this feeling is right.

The analysis of this problem can be of interest to those who want to choose between visiting either Antwerp or Gent. The **stakeholders** will typically be tourist that are visiting Belgium or Europe and do not have time to visit both cities.

## 2 Data

We can compare these cities by clustering their neighborhoods/areas by type of venues, by using the foursquare API, and comparing the resulting clusters. The API offers real-time access to Foursquare's global database of rich venue data and user content. We can also use the foursquare API to compare to most common venues in both cities.

To obtain the neighborhoods I used online sources and my own knowledge of the cities to make an Excel file that contains different neighborhoods/areas. I limited the scope to the more inner parts of both cities (see later in the result section).

## 3 Methodology

The main methodology that was being used was clustering and more specific: k-means clustering. K-means clustering aims to partition several observations into k clusters in which each observation belongs to the cluster with the nearest mean. K-means clustering tries to minimize the intra-cluster variances or the so-called inertia. The different observations are in this case the different neighborhoods or areas. Each observation contains a lot of features: relative amount of each type of venue within a certain radius of the 'center' of the neighborhood/area.

Obtaining the optimal number of clusters is a fundamental issue in partitioning clustering. The determination of the optimal amount is somewhat subjective.

The elbow method has been used to check if we can determine an amount that is somewhat optimal.

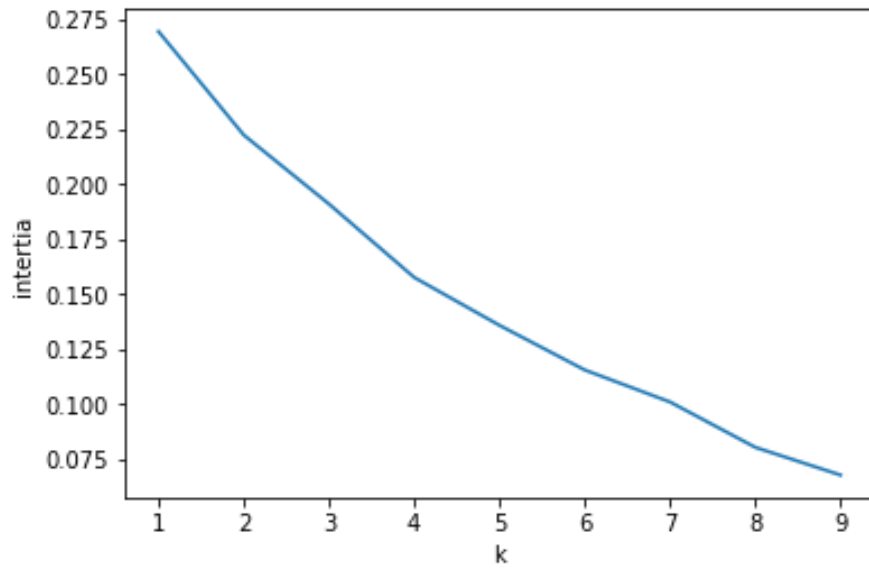
In the elbow method one should choose the number of clusters such that adding another cluster does not result in much better minimization of intra-cluster variation or inertia.

For both cities, Antwerp and Gent, the optimal number has been chosen this way.

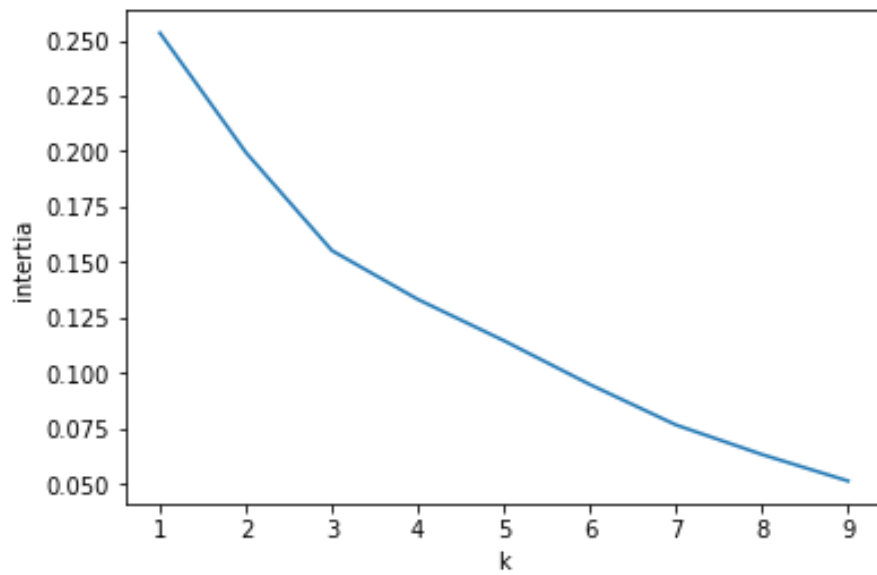
**Figure 1** shows the elbow graph for Antwerp. It is not so easy to determine the optimal number of clusters here: 2 as well as 4 clusters seem to be viable candidates. This is the reason why both options were considered and further explored.

**Figure 2** shows the elbow graph for Gent. Here it is much easier to determine the optimal number of clusters. After k = 3 the graph seems to decrease much more slowly.

**Figure 1:** Inertia in function of the number of clusters  $k$  for **Antwerp**. Optimal number of clusters seems to be 2 or 4.



**Figure 2:** Inertia in function of the number of clusters  $k$  for **Gent**. Optimal number of clusters seems to be 3.



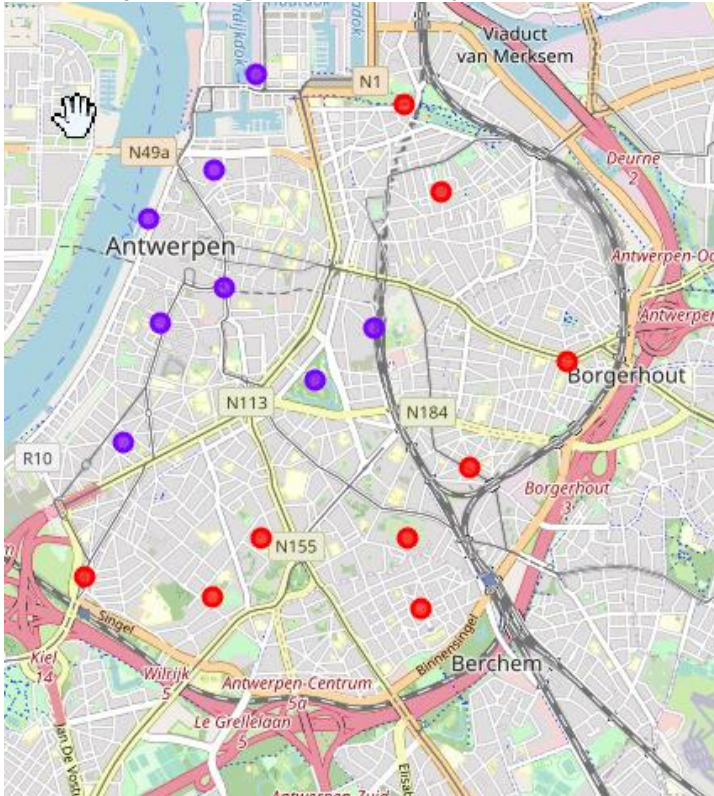
For further comparison, the 10 most common venues of Antwerp and Gent were obtained.

## 4 Results

### 4.1 Antwerp

First, we look at the results of Antwerp. Here we clustered neighborhoods/areas using 2 as well as 4 clusters (see also methodology). **Figure 3** shows the result of the clustering.

**Figure 3:** Results of clustering areas in Antwerp.  $K = 2$ .



It is not surprising that using 2 clusters, clustering the neighborhoods in Antwerp result in these two clusters. Since I am a resident of this city, I can use my "domain knowledge" here.

The second cluster (purple) is the most touristy part of the city there are the most diverse venues: zoo, coffee shop, cocktail bars, restaurants, shops, hotels, see **Figure 4**

The first cluster is a more residential part of the city. The diversification of venues is much less than the other cluster and there are also not as much clothing stores. In this cluster there are an especially large number of bakers and bars, see **Error! Reference source not found.**

**Figure 4:** Most common venues grouped by neighborhood/area in **Antwerp** for the purple cluster.

	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	9th Most Common Venue	10th Most Common Venue
0	Schipperskwartier	Coffee Shop	Bar	Restaurant	Italian Restaurant	French Restaurant	Cocktail Bar	Plaza	Ice Cream Shop	Gay Bar	Soup Place
3	Sint-Andries	Bar	Clothing Store	Coffee Shop	Spanish Restaurant	Cosmetics Shop	Bakery	Vegetarian / Vegan Restaurant	Italian Restaurant	Boutique	Cocktail Bar
9	Diamant	Zoo Exhibit	Coffee Shop	Thai Restaurant	Clothing Store	Hotel	Italian Restaurant	Asian Restaurant	Sandwich Place	Chinese Restaurant	Beer Bar
10	Eilandje	Bar	Restaurant	Nightclub	Italian Restaurant	Coffee Shop	Beach Bar	Spanish Restaurant	French Restaurant	Seafood Restaurant	Sandwich Place
13	Stadspark	Coffee Shop	Theater	Gastropub	Clothing Store	Italian Restaurant	Bar	Burger Joint	Hotel	Zoo Exhibit	Pub
14	Het steen	Coffee Shop	Cocktail Bar	Bar	Restaurant	Italian Restaurant	Plaza	Belgian Restaurant	Vegetarian / Vegan Restaurant	French Restaurant	Fish & Chips Shop
15	Meir	Clothing Store	Bar	Coffee Shop	Cocktail Bar	Boutique	Juice Bar	Cosmetics Shop	Gastropub	Bookstore	Bakery
16	Koninklijk museum voor schone kunsten	Coffee Shop	French Restaurant	Bar	Italian Restaurant	Breakfast Spot	Cocktail Bar	Japanese Restaurant	Asian Restaurant	Restaurant	Sushi Restaurant

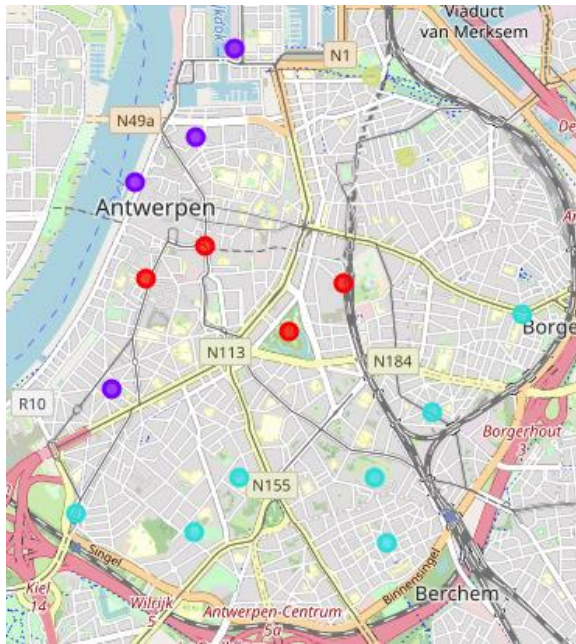
**Figure 5:** Most common venue grouped by neighborhood/area in **Antwerp** for the red cluster.

	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	9th Most Common Venue	10th Most Common Venue
1	Seefhoek	Supermarket	Steakhouse	Chinese Restaurant	Café	Bar	Friterie	Asian Restaurant	Clothing Store	Coffee Shop	Seafood Restaurant
2	Park Spoor Noord	Sandwich Place	Gay Bar	Bar	Plaza	Steakhouse	Restaurant	Breakfast Spot	French Restaurant	Athletics & Sports	Supermarket
4	Zuid	Bar	Coffee Shop	Snack Place	Supermarket	Bike Rental / Bike Share	Bakery	Pizza Place	Music Venue	Italian Restaurant	Restaurant
5	Markgrave	Sandwich Place	Restaurant	Bakery	Italian Restaurant	Coffee Shop	Supermarket	Belgian Restaurant	Theater	Bar	Park
6	Harmonie	Bar	Coffee Shop	Italian Restaurant	Sandwich Place	Restaurant	Friterie	Bike Rental / Bike Share	Supermarket	Park	Bakery
7	Oud-Berchem	Bar	Bakery	Friterie	Restaurant	Supermarket	Coffee Shop	Gastropub	Sandwich Place	Beer Bar	Platform
8	Zurenborg	Bar	Bakery	Restaurant	Bistro	Pizza Place	Indian Restaurant	Italian Restaurant	Pub	Plaza	Cocktail Bar
11	Groen Kwartier	Bar	Bakery	Friterie	Restaurant	Coffee Shop	Supermarket	Mediterranean Restaurant	Convenience Store	Pizza Place	Cocktail Bar
12	De Roma	Bar	Hostel	Hotel	Seafood Restaurant	Nightclub	Coffee Shop	Sandwich Place	Stadium	Breakfast Spot	Science Museum

It is remarkably interesting to see that if we increase the number of clusters from 2 to 4 clusters, we just get a subdivision of the first two clusters.

The cluster of the more touristy part of the city gets split in clusters 1 (red, **Figure 7**) and 2 (purple, **Figure 8**). The red clusters seem to be the area that is most suited for shopping. For the less touristy clusters it is harder to determine the meaning of the subdivision. Although if you want to get a drink, you are far better off in the third cluster (blue, **Figure 9**).

**Figure 6: Results of clustering areas in Antwerp.  $K = 4$ .**



**Figure 7: most common venues grouped by neighborhood/area in Antwerp for the red cluster.**

	Area	Cluster Labels	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
3	Sint-Andries	0	Bar	Clothing Store	Coffee Shop	Spanish Restaurant	Cosmetics Shop	Bakery	Vegetarian / Vegan Restaurant	Italian Restaurant	Boutique	Cocktail Bar
9	Diamant	0	Zoo Exhibit	Coffee Shop	Thai Restaurant	Clothing Store	Hotel	Italian Restaurant	Asian Restaurant	Sandwich Place	Chinese Restaurant	Beer Bar
13	Stadspark	0	Coffee Shop	Theater	Gastropub	Clothing Store	Italian Restaurant	Bar	Burger Joint	Hotel	Zoo Exhibit	Pub
15	Meir	0	Clothing Store	Bar	Coffee Shop	Cocktail Bar	Boutique	Juice Bar	Cosmetics Shop	Gastropub	Bookstore	Bakery

**Figure 8: most common venues grouped by neighborhood/area in Antwerp for the purple cluster.**

	Area	Cluster Labels	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	Schipperskwartier	1	Coffee Shop	Bar	Restaurant	Italian Restaurant	French Restaurant	Cocktail Bar	Plaza	Ice Cream Shop	Gay Bar	Soup Place
10	Eilandje	1	Bar	Restaurant	Nightclub	Italian Restaurant	Coffee Shop	Beach Bar	Spanish Restaurant	French Restaurant	Seafood Restaurant	Sandwich Place
14	Het steen	1	Coffee Shop	Cocktail Bar	Bar	Restaurant	Italian Restaurant	Plaza	Belgian Restaurant	Vegetarian / Vegan Restaurant	French Restaurant	Fish & Chips Shop
16	Koninklijk museum voor schone kunsten	1	Coffee Shop	French Restaurant	Bar	Italian Restaurant	Breakfast Spot	Cocktail Bar	Japanese Restaurant	Asian Restaurant	Restaurant	Sushi Restaurant



Figure 9: most common venues grouped by neighborhood/area in **Antwerp** for the **blue** cluster.

	Area	Cluster Labels	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
4	Zuid	2	Bar	Coffee Shop	Snack Place	Supermarket	Bike Rental / Bike Share	Bakery	Pizza Place	Music Venue	Italian Restaurant	Restaurant
5	Markgrave	2	Sandwich Place	Restaurant	Bakery	Italian Restaurant	Coffee Shop	Supermarket	Belgian Restaurant	Theater	Bar	Park
6	Harmonie	2	Bar	Coffee Shop	Italian Restaurant	Sandwich Place	Restaurant	Friterie	Bike Rental / Bike Share	Supermarket	Park	Bakery
7	Oud-Berchem	2	Bar	Bakery	Friterie	Restaurant	Supermarket	Coffee Shop	Gastropub	Sandwich Place	Beer Bar	Platform
8	Zurenborg	2	Bar	Bakery	Restaurant	Bistro	Pizza Place	Indian Restaurant	Italian Restaurant	Pub	Plaza	Cocktail Bar
11	Groen Kwartier	2	Bar	Bakery	Friterie	Restaurant	Coffee Shop	Supermarket	Mediterranean Restaurant	Convenience Store	Pizza Place	Cocktail Bar
12	De Roma	2	Bar	Hostel	Hotel	Seafood Restaurant	Nightclub	Coffee Shop	Sandwich Place	Stadium	Breakfast Spot	Science Museum

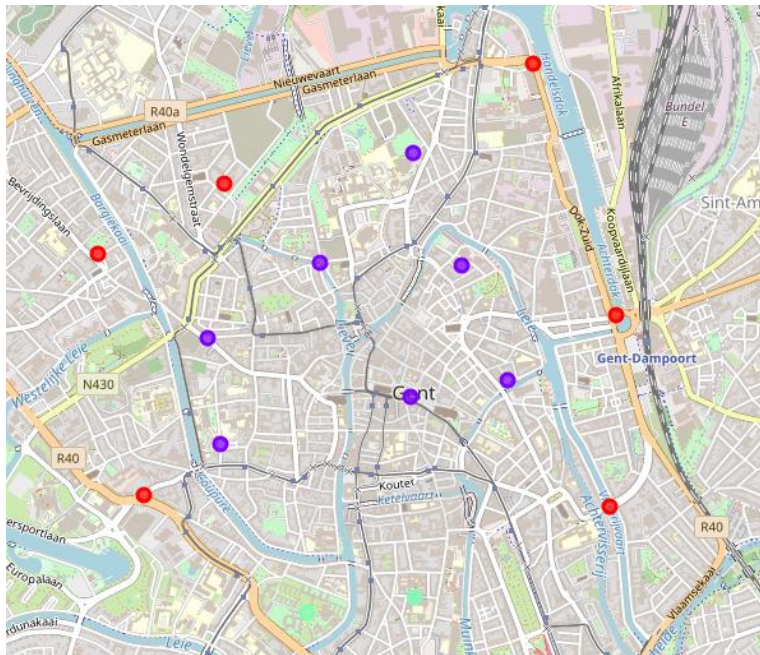
Figure 10: most common venues grouped by neighborhood/area in Antwerp for the **yellow** cluster.

	Area	Cluster Labels	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
1	Seefhoek	3	Supermarket	Steakhouse	Chinese Restaurant	Café	Bar	Friterie	Asian Restaurant	Clothing Store	Coffee Shop	Seafood Restaurant
2	Park Spoor Noord	3	Sandwich Place	Gay Bar	Bar	Plaza	Steakhouse	Restaurant	Breakfast Spot	French Restaurant	Athletics & Sports	Supermarket

#### 4.2 Gent

If we now repeat the same process for **Gent** with the optimal number of clusters ( $k = 3$ ) we find the clusters depicted in. **Figure 11**.

Figure 11: Results of clustering areas in **Gent**.  $K = 3$ .



A similar pattern as with the clustering for Antwerp arises: a more touristy part can be found around the center of the city: the purple cluster (see **Figure 12**) while other parts, the red (see **Figure 13**) and the green cluster (see **Figure 14**), are more residential: a lot of bakers and bars and less shopping venues. The difference between the red and the green cluster can be found in that the green cluster is dominated by pubs and sandwich places.

**Figure 12:** most common venues grouped by neighborhood/area in **Gent** for the **purple** cluster.

	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	9th Most Common Venue	10th Most Common Venue
0	Waterwijk	Bar	Turkish Restaurant	Belgian Restaurant	Italian Restaurant	Bistro	Wine Bar	Tapas Restaurant	Breakfast Spot	Cocktail Bar	Plaza
1	Het zuid	Bar	Italian Restaurant	Pub	Coffee Shop	French Restaurant	Cocktail Bar	Belgian Restaurant	Japanese Restaurant	Art Museum	Asian Restaurant
8	Casinoplein	Bar	Belgian Restaurant	Coffee Shop	Italian Restaurant	Bistro	Plaza	Clothing Store	Comfort Food Restaurant	Bakery	Gym / Fitness Center
9	Begijnengracht	Belgian Restaurant	Bar	Bistro	Park	Plaza	Italian Restaurant	Comfort Food Restaurant	Bakery	Coffee Shop	Pub
11	Belfort	Coffee Shop	Bistro	Plaza	Bar	Clothing Store	Hotel	Cosmetics Shop	Beer Bar	Vegetarian / Vegan Restaurant	Ice Cream Shop
12	Academiebrug	Bar	Plaza	Pub	Bistro	Belgian Restaurant	Turkish Restaurant	Italian Restaurant	Tapas Restaurant	Thai Restaurant	Cocktail Bar
15	Oude Beestenmarkt	Bar	Coffee Shop	Wine Bar	Plaza	Park	Bistro	Men's Store	Sushi Restaurant	Beer Bar	Jewelry Store
16	Tolhuispark	Turkish Restaurant	Bar	Bistro	Belgian Restaurant	Italian Restaurant	Tapas Restaurant	Pub	Art Gallery	Coffee Shop	Bakery

**Figure 13:** most common venues grouped by neighborhood/area in **Gent** for the **red** cluster.

	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	9th Most Common Venue	10th Most Common Venue
2	Dampoort	Bar	Gastropub	Doner Restaurant	Bakery	Park	Coffee Shop	Dance Studio	Theater	Italian Restaurant	Bus Stop
3	Dok-Noord	Bakery	Bistro	Park	Bar	Breakfast Spot	Convenience Store	Bus Stop	Coffee Shop	Bridge	Art Gallery
4	Rabot	Bakery	Doner Restaurant	Supermarket	Turkish Restaurant	Theater	Bar	Sandwich Place	Friterie	Park	Convenience Store
5	Brugse Poort	Bakery	Doner Restaurant	Turkish Restaurant	Park	Bar	Plaza	Supermarket	Sandwich Place	Cosmetics Shop	Friterie
6	Rozemarijnstraat	Bar	Friterie	Bus Stop	Gym / Fitness Center	Sports Bar	Sports Club	Bakery	Basketball Court	Pet Store	Furniture / Home Store
10	Lousbergsbrug	Park	Coffee Shop	Bistro	Bakery	Pub	Italian Restaurant	Convenience Store	Vegetarian / Vegan Restaurant	Sandwich Place	Historic Site

**Figure 14:** most common venues grouped by neighborhood/area in **Gent** for the **green** cluster.

	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	9th Most Common Venue	10th Most Common Venue
7	Kunstenkwartier	Bar	Italian Restaurant	Pub	Breakfast Spot	Sandwich Place	Friterie	Concert Hall	Vegetarian / Vegan Restaurant	Pizza Place	Bakery
13	De Bijloke	Bar	Italian Restaurant	Pub	Friterie	Sandwich Place	Bistro	Concert Hall	Breakfast Spot	Vegetarian / Vegan Restaurant	Bookstore
14	Arteveldehogeschool campus leeuwstraat	Bar	Sandwich Place	Italian Restaurant	Friterie	Burger Joint	Park	Pub	Print Shop	Supermarket	Pizza Place

### 4.3 Further comparison

For a final comparison let us look at the most common venues in Gent and Antwerp. Both have coffee shops as the most common venues. Gent seems to be more of a fashion city compared to Antwerp: clothing store is the second most common venue in Gent while in Antwerp it is not even in the top 10. Both cities seem to have a lot of diverse restaurants. Antwerp seems to have relatively more bars than Gent while Gent has more Cocktail bars.

Figure 15: most common venues in **Gent**.

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	9th Most Common Venue	10th Most Common Venue
0 Gent	Coffee Shop	Clothing Store	Italian Restaurant	Cocktail Bar	Plaza	French Restaurant	Spanish Restaurant	Restaurant	Sandwich Place	Juice Bar

Figure 16: most common venues in **Antwerp**.

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	9th Most Common Venue	10th Most Common Venue
Antwerp	Coffee Shop	Plaza	Bar	Italian Restaurant	Sushi Restaurant	Bistro	BBQ Joint	Belgian Restaurant	Pub	Cocktail Bar

## 5 Discussion

Antwerp and Gent indeed seem to have sort of the same pattern of type of neighborhoods/areas in terms of venues: more touristy areas in the center of the city vs more residential areas in the periphery. Based on the clustering I can recommend visiting the centers since these center areas are a lot more diverse.

The difference between the city in terms of venues are

- Relatively more clothing stores in Gent while relatively more plaza's and bars in Antwerp. For people that like the more small-scale shopping experience I would recommend Gent, while people that like the more shopping center experience I would recommend Antwerp.
- More bars in Antwerp: If you would like to hang out in the pub or bar, I would recommend Antwerp.
- A lot of sushi restaurants in Antwerp.
- Relatively more lunch opportunities in Gent.
- Relatively many juice bars in Gent
- Relatively more Spanish restaurants in Gent.

But overall, both cities are indeed remarkably similar.

## 6 Conclusion

We found a similar cluster pattern and quite a lot of similar venues in the top 10 for Antwerp and Gent. Some small differences can be found and may turn the decision of a potential reader towards a certain city. However just throwing a dice might also work if the differences are of no interest to the potential reader.

If we want to research further differences in experience it can be interesting to take other type of features in consideration, e.g. different types of surface areas, population, amount of tourists, ...

To make a recommendation for one or another city solely based on venues might not be enough for a lot of individuals.



