



Analysis of communes in Denmark: finding a new home

OLGA RODENKO

23-05-2020

<https://www.Google.Com/url?Sa=i&url=https%3a%2f%2fwww.Worldnomads.Com%2ftravel-safety%2fnorthern-europe%2fdenmark%2fdenmark-laws-on-substances-guns-natural-resources-and-more&psig=aovvaw2tpuwhzyzwugzapxuadaw&ust=1590388838970000&source=images&cd=vfe&ved=0caiqrqxqfwotcidjoqtyy-kcfqaaaaadaaaabad>

Contents

1. Introduction: business problem
2. Data description
3. Methodology
4. Results
5. Discussion
6. Conclusion
7. References

Introduction: Business Problem

- In these unprecedented times, many people are creating new ways to work.
- In Denmark, most of companies are located in and around Copenhagen. Not surprisingly, house prices are the highest in and around Copenhagen as well, ranging from 3 mio DKK to 10-15 mio DKK.
- Now, what if you are employed in a Copenhagen based company, but work from home and thus live in more affordable commune?

Introduction: Business Problem

- Our purpose is to provide guidelines to employees who would like to move out of Copenhagen without changing their lifestyle dramatically.
- Our target audience is the people, which have found a new degree of freedom in the time of the crisis: freedom to move.
- With this in mind, we try to find a commune (municipality) in Denmark that is similar to Copenhagen, and is not Copenhagen.
- The new commune should combine both, active business /entertainment and culture life.

Data description

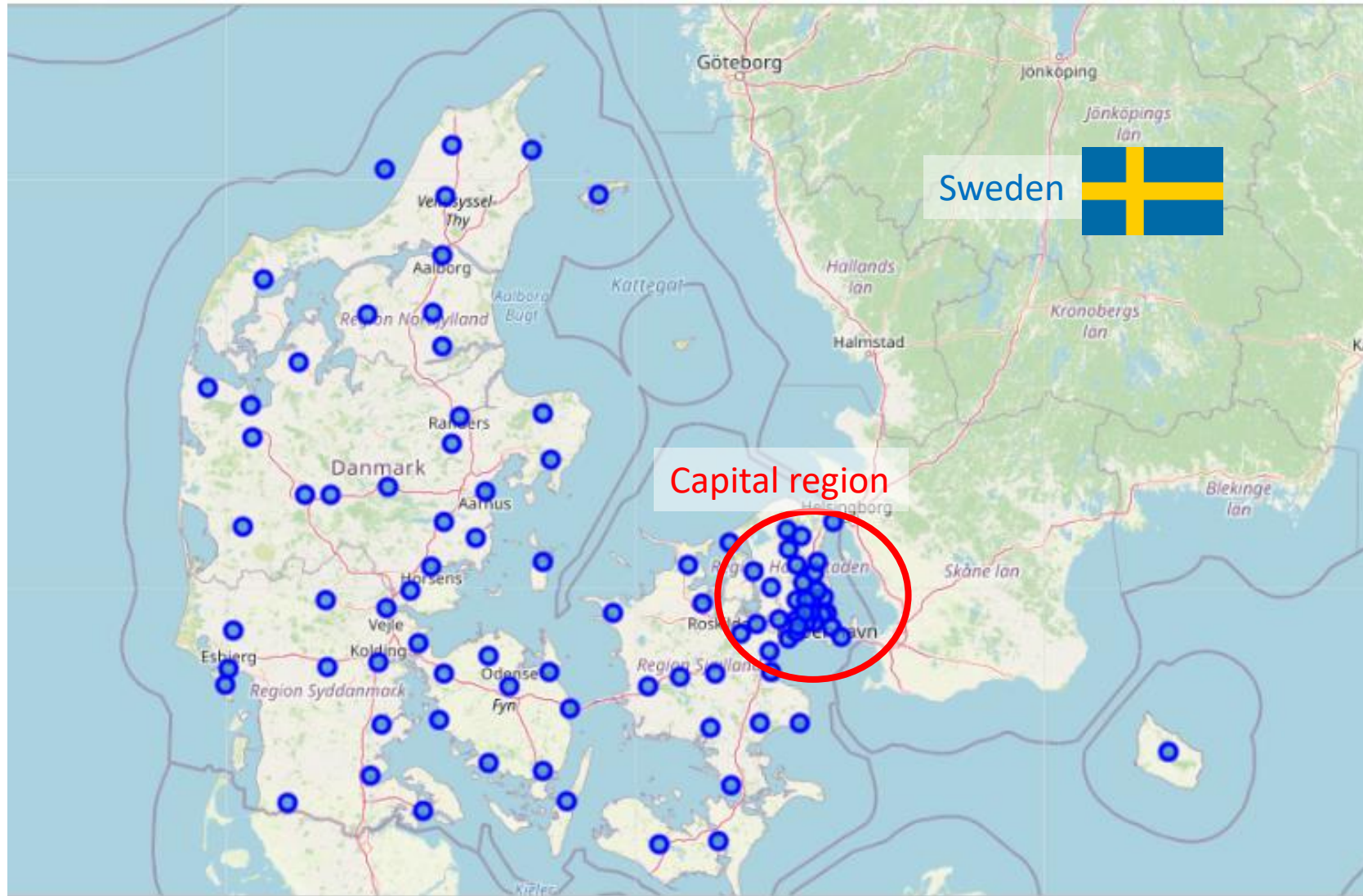
- There are 98 communes in Denmark. We use the list of communes (municipalities) in Denmark in [Wikipedia](#) [1].
- We use [Foursquare API](#) [2] to get most common venues in each commune. The data is used to cluster all communes and find those similar to Copenhagen.
- For each commune, we find geographical coordinates using [Geocoder](#) [3]. Then, using a JSON file of Denmark [4], we create a Choropleth map with the data for all communes.
- From statistical database [Statistikbanken](#), we find number of museums and private companies in each commune [5].

Data description

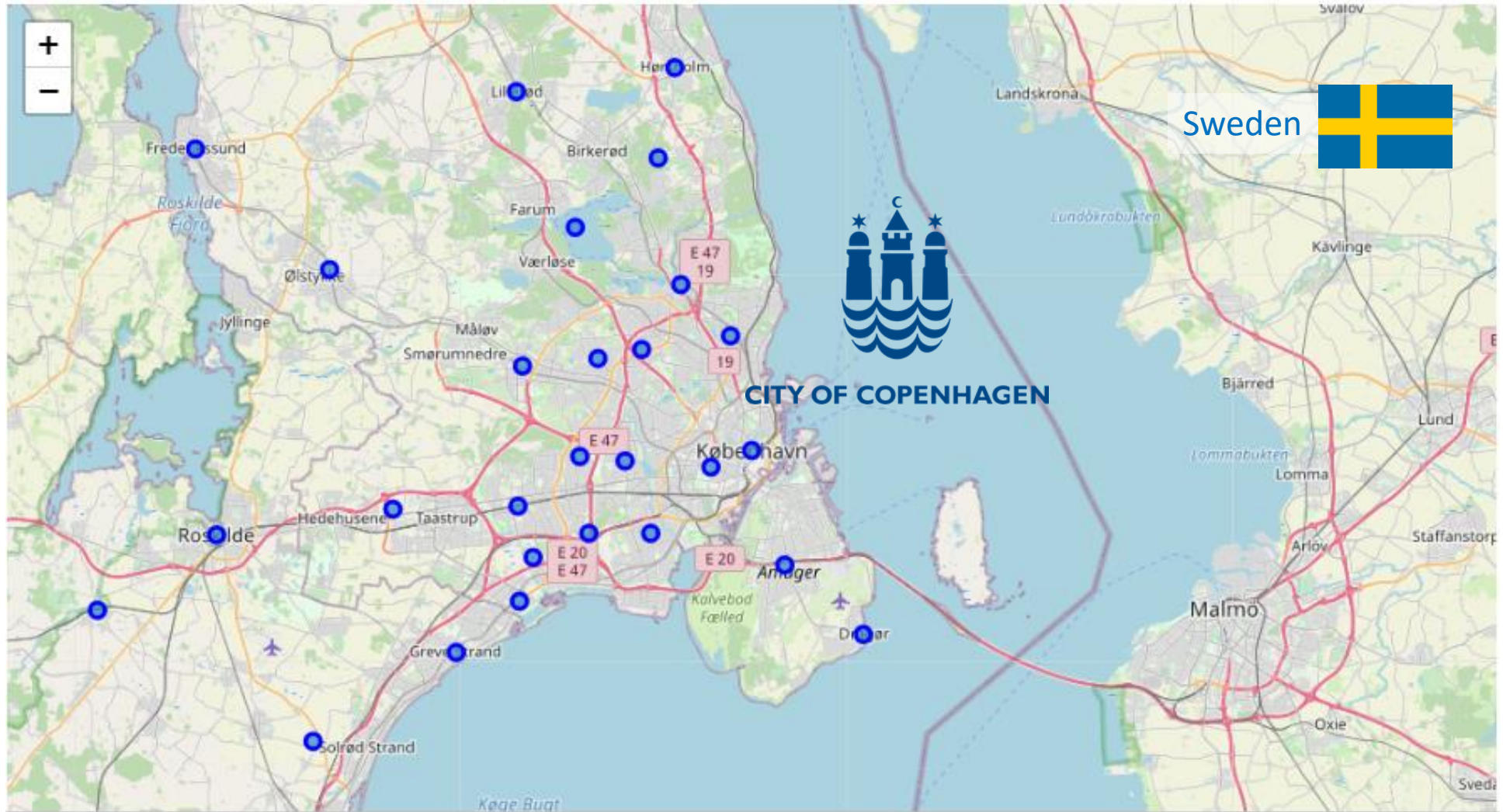
We consider the following factors when recommending a commune:

- Similarity to Copenhagen: clustering based on most common venues in each commune
- Number of museums
- Number of private companies

98 communes of Denmark



98 communes of Denmark: capital region



Methodology

- There are 98 communes in Denmark. The resulting dataframe contains for each commune: name, area, population, population density, and region
- We use Geocoder to find geographical coordinates of each commune

	Nr.	Navn	Km2	2019	indb/km2	Region	location	point	latitude	longitude	altitude
0	1.0	København	86.6	623404.0	7082.0	Hovedstaden	(København, Københavns Kommune, Region Hovedst...	(55.6867243, 12.5700724, 0.0)	55.686724	12.570072	0.0
1	2.0	Aarhus	467.9	345332.0	728000.0	Midtjylland	(Aarhus, Aarhus Kommune, Region Midtjylland, 8...	(56.1496278, 10.2134046, 0.0)	56.149628	10.213405	0.0
2	3.0	Aalborg	1137.4	215312.0	188000.0	Nordjylland	(Aalborg, Aalborg Kommune, Region Nordjylland, ...	(57.0482206, 9.9193939, 0.0)	57.048221	9.919394	0.0
3	4.0	Odense	305.6	204182.0	662000.0	Syddanmark	(Odense, Odense Kommune, Region Syddanmark, 50...	(55.3997225, 10.3852104, 0.0)	55.399723	10.385210	0.0
4	5.0	Esbjerg	795.1	115652.0	146000.0	Syddanmark	(Esbjerg, Esbjerg Kommune, Region Syddanmark, ...	(55.4664892, 8.4520751, 0.0)	55.466489	8.452075	0.0

Methodology

- We use Foursquare API to fetch venues in each commune in the radius of 10 km and with a limit of 100.
- There are 23 communes that have reached the limit of 100: Tårnby, Gentofte, Lyngby-Taarbæk, Frederiksberg, Hvidovre, Gladsaxe, Odense, Rødovre, Glostrup, København, Aarhus, Brøndby, Furesø, Ishøj, Albertslund, Ballerup, Dragør, Allerød, Vallensbæk, Rudersdal, Herlev, Hørsholm, Helsingør.
- Other communes have not reached the limit of 100. For one commune there were no venues found: Morsø.

Morsø commune: no venues found



https://www.google.com/url?sa=i&url=https%3A%2F%2Fda.wikipedia.org%2Fwiki%2FMors%25C3%25B8_Kommune&psig=AOvVaw0TMMYYad5b9ZtPLa7DcV_Y&ust=1590390465744000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCNDFjan4y-kCFQAAAAAdAAAAABAD

23-05-2020



https://www.google.com/url?sa=i&url=https%3A%2F%2Ffrealania.dk%2Fprojekter%2Fmorsoe-kommune&psig=AOvVaw0c6kM_WwmhSeKbVfhNtiyO&ust=1590390576159000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCKibt74y-kCFQAAAAAdAAAAABAD

Methodology

- In total, there are 4425 venues found for the 97 communes.
- Some communes have less than 10 venues found. We drop these 16 communes: Brønderslev, Jammerbugt, Lolland, Nordfyn, Kalundborg, Lemvig, Læsø, Langeland, Vesthimmerland, Ringkøbing-Skjern, Skive, Thisted, Tønder, Vejen, Mariagerfjord, Vordingborg.
- We now consider 81 communes now in our analysis, out of 98. There are 250 unique venue categories.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	København	55.686724	12.570072	Botanisk Have	55.686169	12.573246	Botanical Garden
1	København	55.686724	12.570072	Torvehallerne	55.683934	12.569244	Food Court
2	København	55.686724	12.570072	The Coffee Collective	55.683695	12.569790	Coffee Shop
3	København	55.686724	12.570072	Rosenborg Slot	55.685683	12.577482	Palace
4	København	55.686724	12.570072	Kongens Have	55.684361	12.580099	Park

Methodology

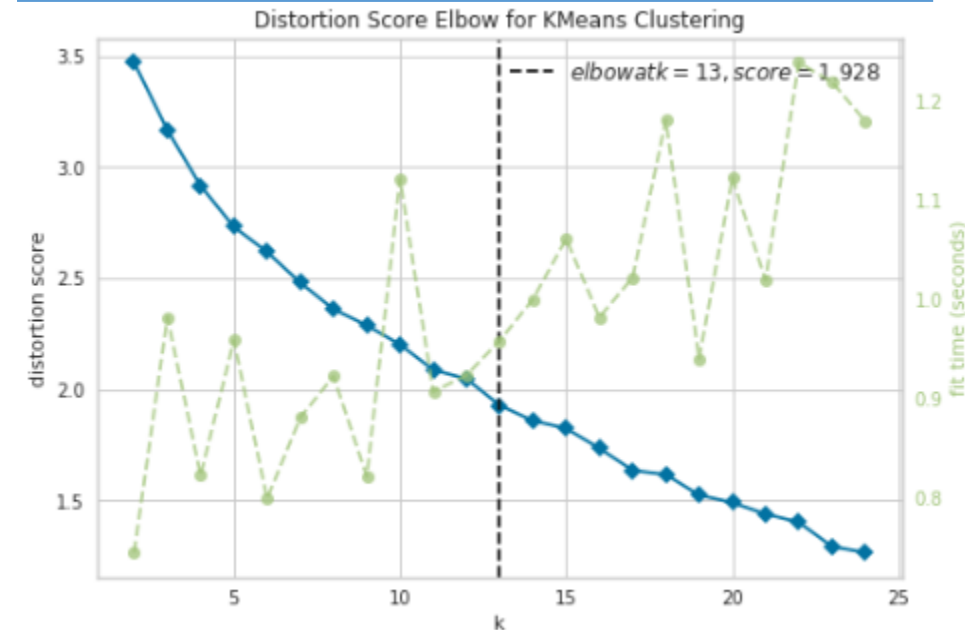
- Next, we find 10 most common venues in each commune

	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	Aabenraa	Fast Food Restaurant	Gas Station	Café	Harbor / Marina	Convenience Store	Gym / Fitness Center	Hotel	Pub	Bakery	Restaurant
1	Aalborg	Café	Grocery Store	Discount Store	Gym / Fitness Center	Italian Restaurant	Park	Scandinavian Restaurant	Pub	Bakery	Gas Station
2	Aarhus	Grocery Store	Café	Park	Scandinavian Restaurant	Gym / Fitness Center	Italian Restaurant	Discount Store	Hotel	Beach	Sandwich Place
3	Albertslund	Grocery Store	Gym / Fitness Center	Fast Food Restaurant	Furniture / Home Store	Market	Café	Supermarket	Restaurant	Music Venue	Hotel
4	Allerød	Grocery Store	Golf Course	Fast Food Restaurant	Café	Sushi Restaurant	Supermarket	Steakhouse	Music Venue	Park	Trail

Methodology

- We use unsupervised machine learning algorithm **k-means clustering**.
- For this, we transform the categorical variable 'Venue' using **one hot encoding**.
- We use the **elbow method [6]** to find the optimum number of clusters, k.
- However, we see that the curve does not have an elbow and is **a smooth curve**. This can be an indication that our data **is not very clustered**. Thus, the algorithm did not return an optimum k value.

The curve generated by the elbow algorithm



Methodology

By experimenting with the k-means clustering algorithm and using the domain knowledge, we find that **five clusters** seem to fit the data.

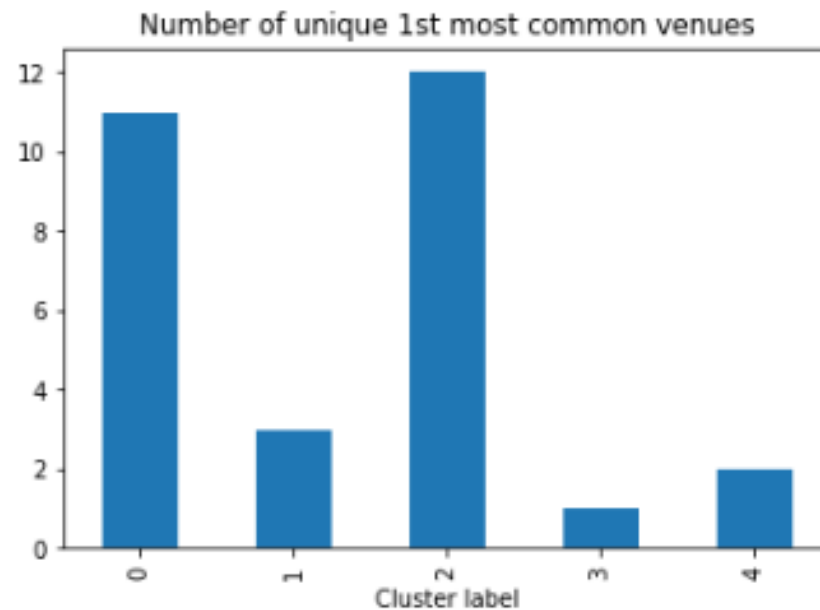


CITY OF COPENHAGEN

Navn	Region	latitude	longitude	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
København	Hovedstaden	55.686724	12.570072	0	Coffee Shop	Beer Bar	Park	Bakery	Movie Theater	Café	Ice Cream Shop	Theater	Burger Joint	Playground
Aarhus	Midtjylland	56.149628	10.213405	0	Beach	Café	Grocery Store	Park	Scandinavian Restaurant	Coffee Shop	Discount Store	Athletics & Sports	History Museum	Bar
Aalborg	Nordjylland	57.048221	9.919394	1	Grocery Store	Café	Italian Restaurant	Discount Store	Park	Tapas Restaurant	Sushi Restaurant	Gym / Fitness Center	French Restaurant	Cultural Center
Odense	Syddanmark	55.399723	10.385210	0	Café	Bar	Coffee Shop	Grocery Store	Supermarket	History Museum	Scandinavian Restaurant	Bakery	Concert Hall	Restaurant
Esbjerg	Syddanmark	55.466489	8.452075	1	Grocery Store	Café	Hotel	Beach	Restaurant	Steakhouse	Zoo	Bowling Alley	Sports Bar	Sporting Goods Shop

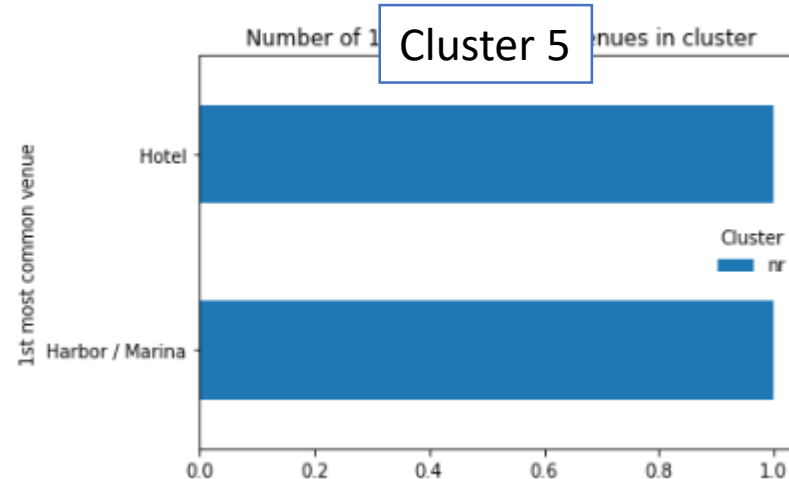
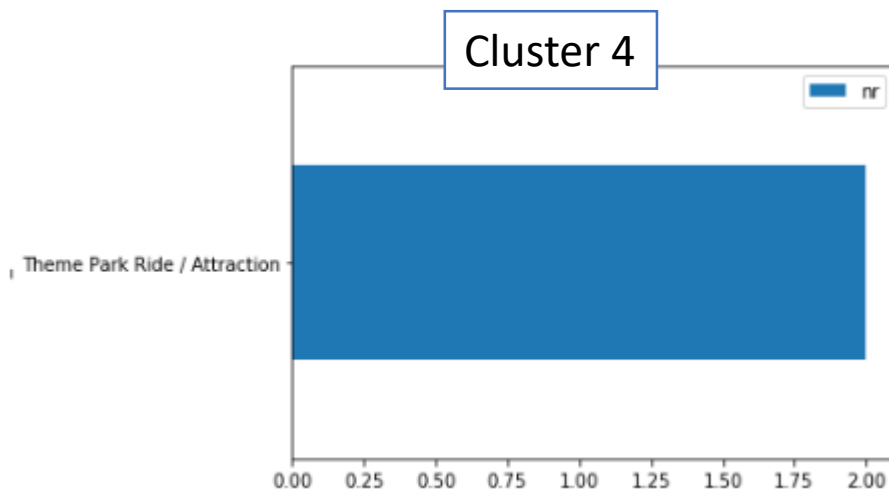
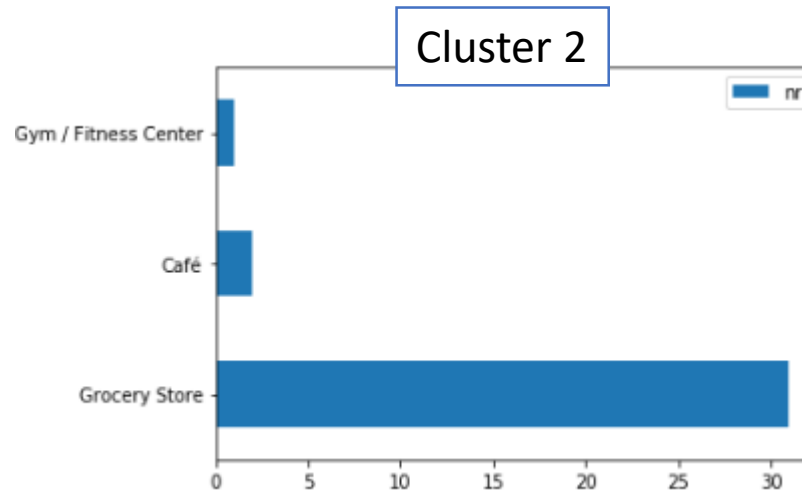
Methodology

- Number of unique 1st most common venues for each cluster



Methodology: five clusters

Unique 1st most common venues for each cluster



Methodology: five clusters

Cluster 1. Parks, bakeries, coffee shops

Cluster 2. Primarily grocery stores

Cluster 3. Hotel, cafe

Cluster 4. Theme park

Cluster 5. Harbor/marina

Cluster 1



https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.timeout.com%2Fcopenhagen%2Fthings-to-do%2Fvesterbro-copenhagen-guide&psig=AOvVaw2evkJbl6nqjctQxSCdeLPC&ust=1590392336050000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCJCPnKf_y-kCFQAAAAAdAAAAABAE

Cluster 3

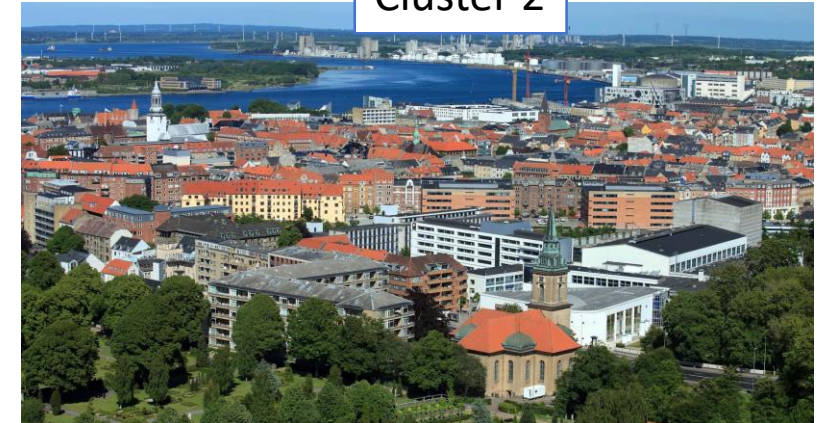


Cluster 4



<https://www.google.com/url?sa=i&url=http%3A%2F%2Fblog.ourworldheritage.be%2F2019%2F04%2F03%2Flegoland-billund-denmark%2F&psig=AOvVaw0JfJk0yyCmSSDcjOhJzWM&ust=1590392728035000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCLC7geaAzOkCFQAAAAAdAAAAABAD>

Cluster 2



https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.radissonhotels.com%2Fen-us%2Fdestination%2Fdenmark%2Faalborg&psig=AOvVaw2yIld5ds0vnE7Y_AFSSvEj&ust=1590392484255000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCMCdqbuAzOkCFQAAAAAdAAAAABAD

Analysis of communes in Denmark: finding a new home

Cluster 4: two
communes

Norddjurs, Billund

Results

So, which communes belong to each cluster?

Cluster 1: 23 communes.

København, Aarhus, Odense,
Frederiksberg, Viborg, Gentofte,
Gladsaxe, Helsingør, Rudersdal, Lyngby-
Taarbæk, Hvidovre, Ballerup, Tårnby,
Syddjurs, Furesø, Bornholm, Rødovre,
Brøndby, Herlev, Albertslund, Glostrup,
Vallensbæk, Dragør

Cluster 2: 34 communes.

Aalborg, Esbjerg, Horsens, Roskilde, Næstved,
Slagelse, Sønderborg, Holbæk, Hjørring, Køge,
Holstebro, Haderslev, Hillerød, Høje-Taastrup,
Varde, Greve, Frederikssund, Egedal, Gribskov, Ikast-
Brande, Fredensborg, Middelfart, Ringsted,
Odsherred, Halsnæs, Sorø, Lejre, Allerød, Hørsholm,
Kerteminde, Ishøj, Odder, Solrød, Fanø

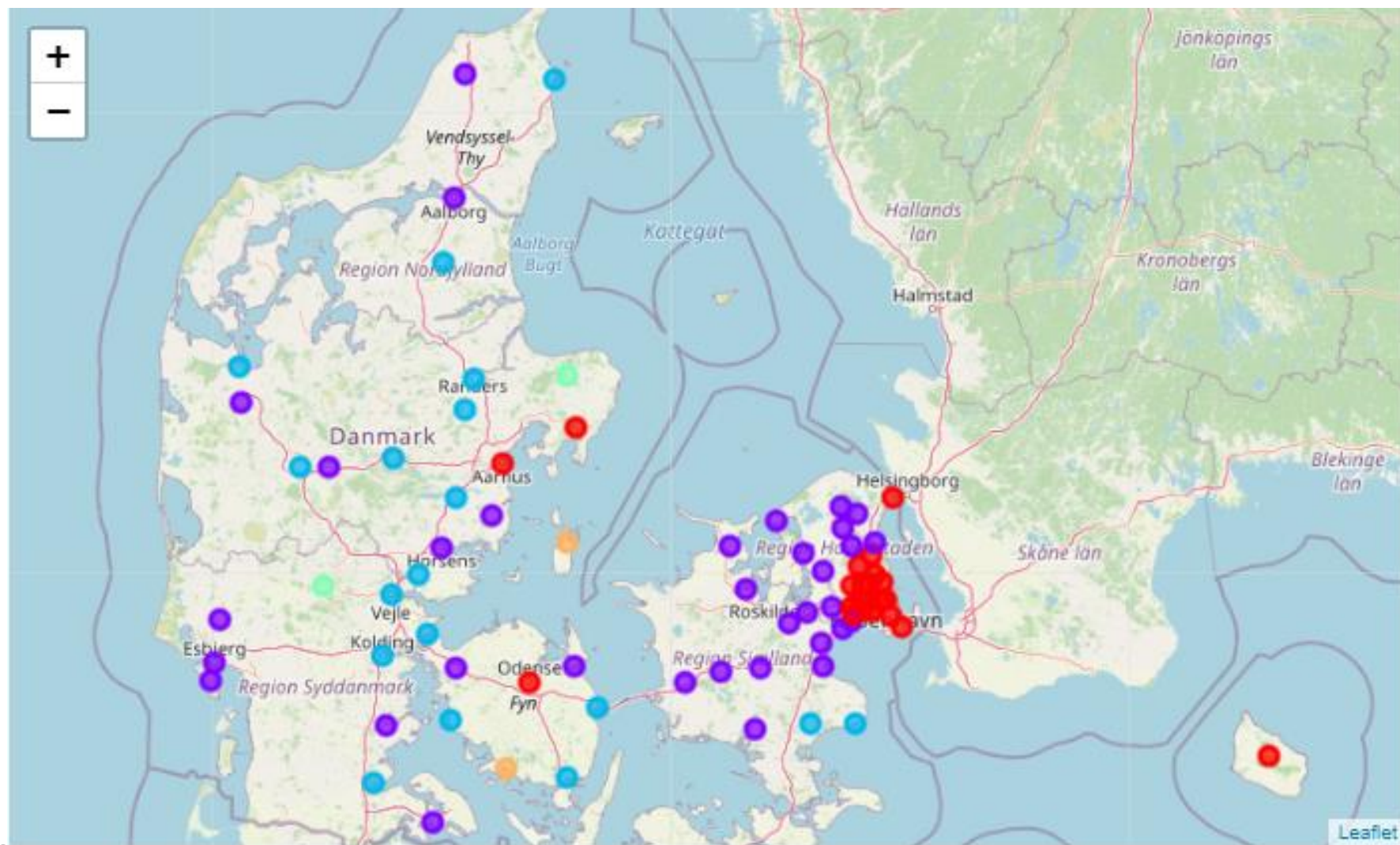
Cluster 3: 20 communes.

Vejle, Randers, Kolding, Silkeborg, Herning,
Guldborgsund, Skandeborg, Frederikshavn,
Aabenraa, Svendborg, Fredericia, Favrskov,
Hedensted, Assens, Faxe, Nyborg, Rebild,
Stevns, Struer, Ærø

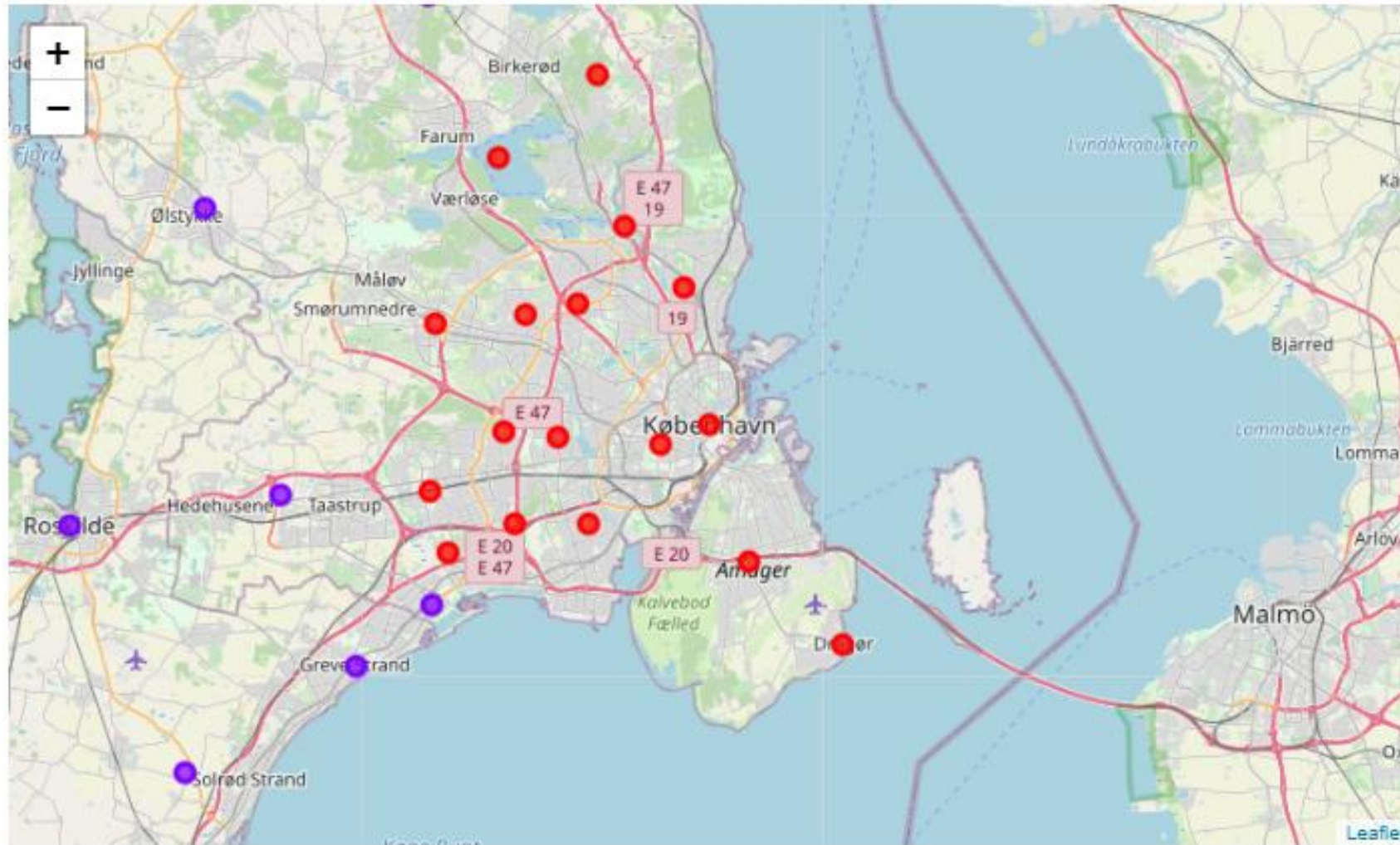
Cluster 5: two communes

Faaborg-Midtfyn, Samsø

Results: clusters labeled



Results: clusters labeled, capital region



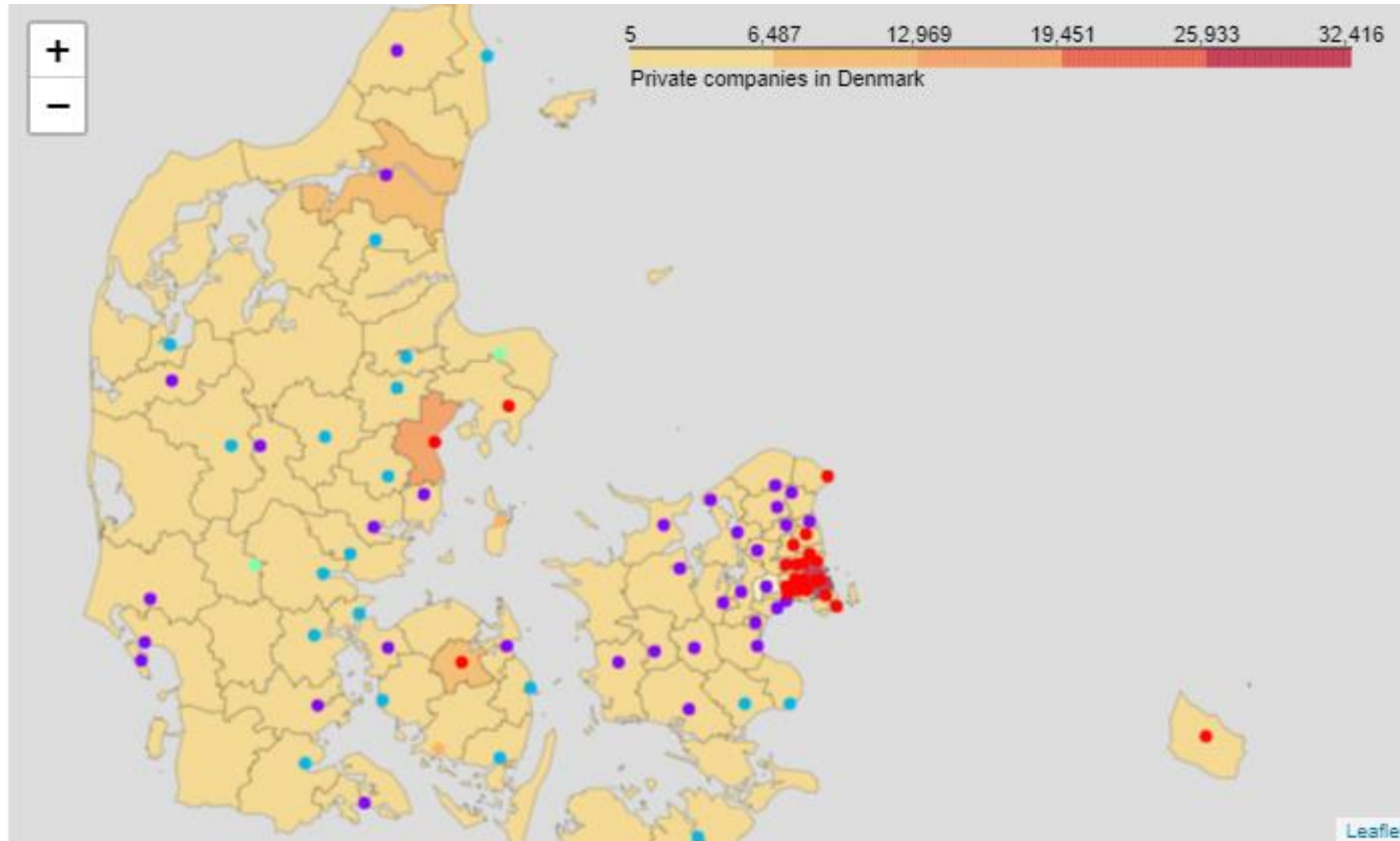
Results

Moreover, we use [data from Statistikbanken](#) to compare communes by the:

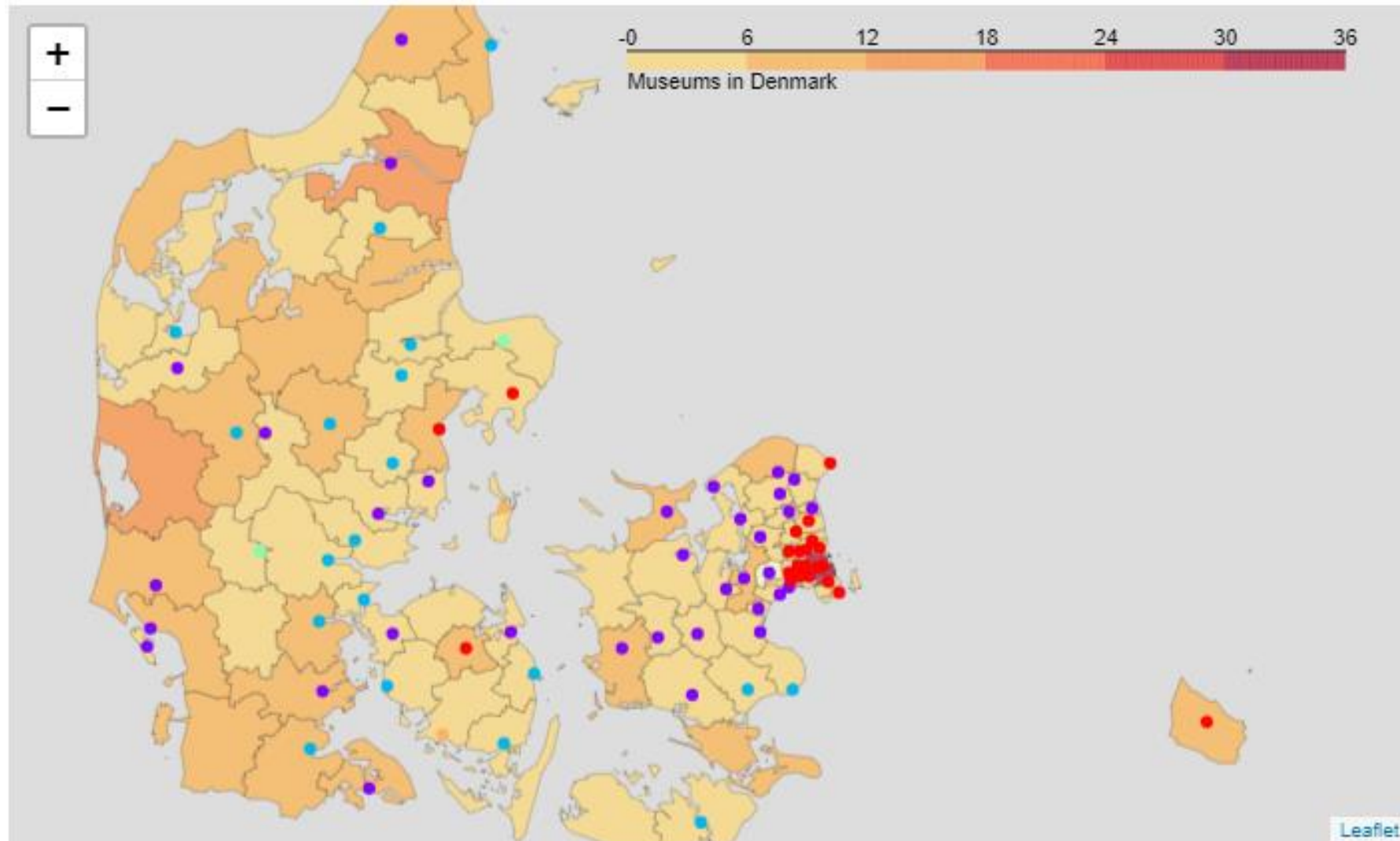
- Number of private companies
- Number of museums
- Income per family
- Percentage of women that have a job

Navn	PrivateCompanies	Museums	IncomeFamilies	IncomeCouples	IncomeSingles	Divorces	FemaleWork	Km2	2019	indb/km2	Region	latitude	longitude
København	32415.0	36.0	459997.0	807874.0	298018.0	927.0	72.5	86.6	623404.0	7082.0	Hovedstaden	55.686724	12.570072
Frederiksberg	4842.0	6.0	567083.0	971731.0	350841.0	149.0	75.5	8.7	103940.0	12001.0	Hovedstaden	55.678016	12.532619
Dragør	621.0	4.0	728628.0	1004900.0	377713.0	20.0	79.5	18.3	14270.0	780000.0	Hovedstaden	55.592487	12.671995
Tårnby	1758.0	1.0	540538.0	794094.0	312576.0	72.0	76.9	66.1	42984.0	651000.0	Hovedstaden	55.628184	12.599763
Albertslund	1465.0	0.0	465264.0	704773.0	287515.0	47.0	68.8	23.2	27877.0	1196.0	Hovedstaden	55.658602	12.356285

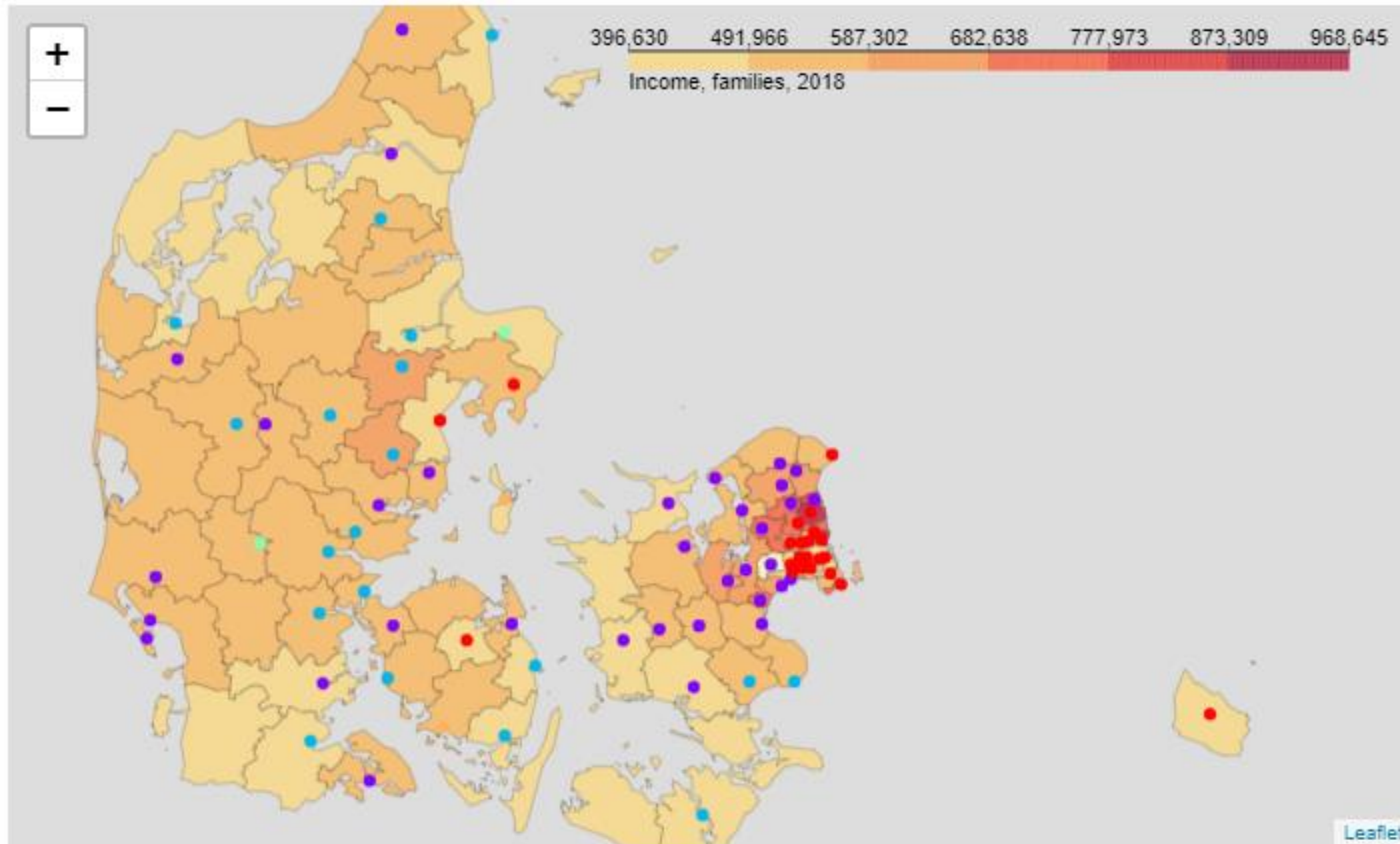
Number of private companies in Denmark, 2019, combined with the cluster labels



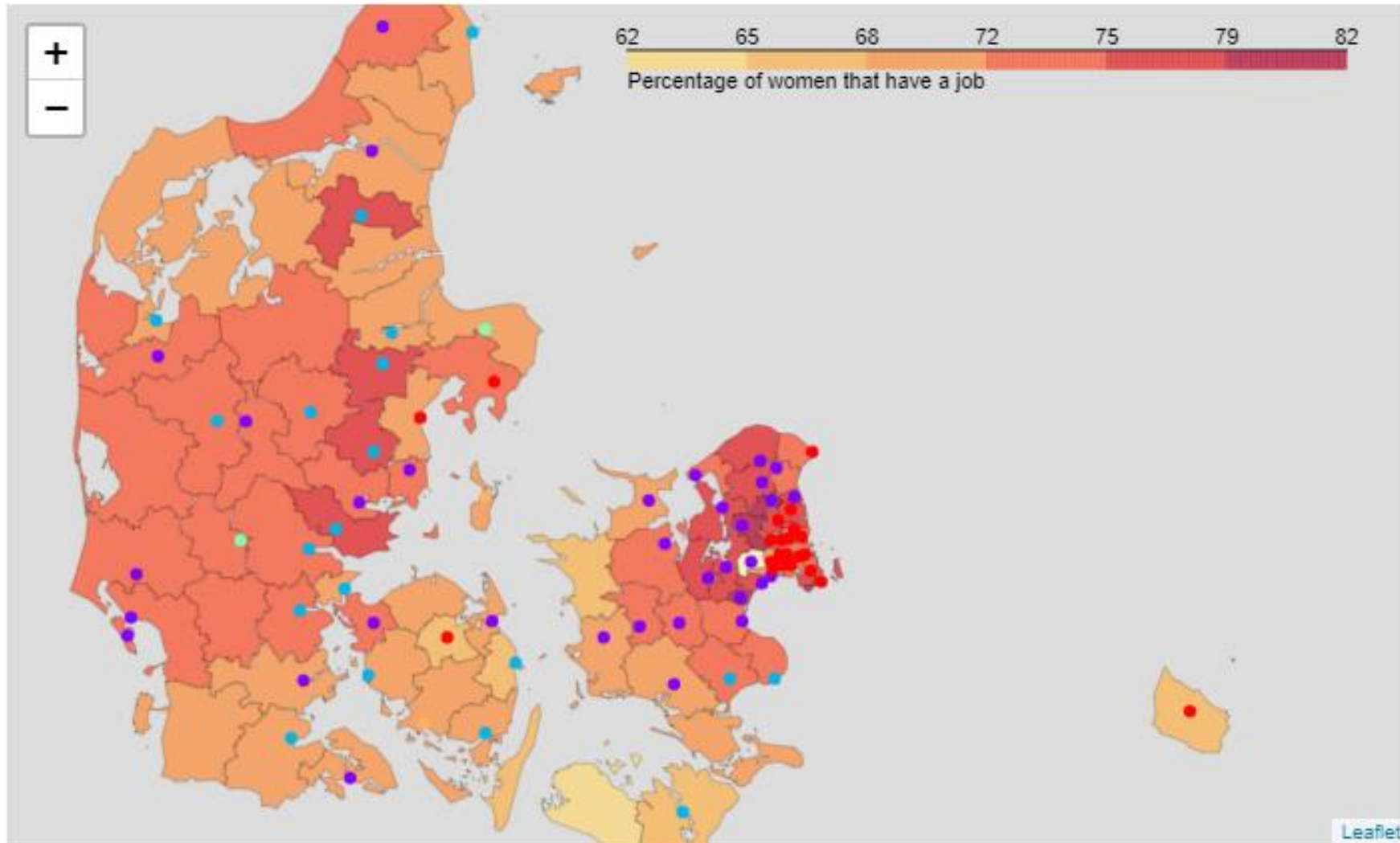
Number of museums in Denmark, 2019, combined with the cluster labels



Income, families, danish kroner DKK, 2018, combined with the cluster labels



Percentage of women that have a job, 2019, combined with the cluster labels



Discussion

- Denmark is a small country with surprisingly many communes. However, the population is **rather non-uniformly distributed**: many people live in the Copenhagen area. It's not possible to find a city/commune very close to Copenhagen, because Copenhagen is the only of its kind in Denmark.
- Still, according to Cluster 1, **22 communes are similar to Copenhagen**. The similarity is expressed in number the diversity of found venues and in the number of parks, bakeries, coffee shops.
- In the first cluster, **most of the communes are on Sealand**, the same island where Copenhagen is located. There are only **five communes** that are located elsewhere: **Aarhus, Odense, Viborg, Syddjurs, Bornholm**.

Discussion

- We only consider the communes in Cluster 1 that are not on Sealand.
- Aarhus and Odense are the biggest cities of Denmark after Copenhagen are somewhat an obvious alternative to the capital. However, Viborg and Syddjurs are communes in Jutland that are similar to Copenhagen according to the algorithm. Bornholm is an island, which can be accessed by ferry and plane. So, for now we have five candidates to the new home:
 - a. Aarhus
 - b. Odense
 - c. Viborg
 - d. Syddjurs
 - e. Bornholm

Bornholm is an island not far from Sweden



<https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.alt.dk%2Fartikel%2Fferieguide-til-bornholm--7-ting-du-skal-opleve-paa-solskinsoeen&psig=AOvVaw38l2RCCJNgjcm624u5g3TR&ust=1590393796873000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCLDvqOOEzOkCFQAAAAAdAAAAABAD>

Discussion

- Let's examine the Choropleth maps which help us to decide.
- Both **Viborg** and **Syddjurs** are not so far from Aarhus, where **many private companies** are located.
- The same goes for the **number of museums**. In **Aarhus, Odense, and Syddjurs** the number of museums is lower than in Copenhagen area but not too low.
- Interestingly, the map of **family income** suggests a rather **high-income level in Syddjurs**, compared to Aarhus and Odense.
- Moreover, for the sake of curiosity, we have plotted a percentage of women that have a job in each commune. Again, the numbers are in favor of the Syddjurs commune!

To conclude, we recommend to all people that are considering moving from the capital area, to investigate the following communes: Aarhus, Odense, Syddjurs, Viborg.

Conclusion

- The purpose of this study was to recommend an alternative commune to Copenhagen, for all people who have discovered the opportunity of working from home. Thus, all communes in Denmark are under the magnifying glass!
- We used Wikipedia, Geocoder, and Foursquare to gather data about communes.
- Then, we have used the [Kmeans algorithm](#) to cluster the communes of Denmark based on the venues data from Foursquare. The communes have been divided into five clusters. The first cluster contained [23 communes including Copenhagen](#).
- Finally, we used the data from Statistikbanken to investigate the communes by the number of private companies and museums.
- The data and the clusters have been visualized using Folium and Cloropleth maps.

References

- Wikipedia page:
https://da.wikipedia.org/wiki/Kommuner_i_Danmark_efter_indbyggertal
- Foursquare API
<https://developer.foursquare.com/>
- Geocoder
<https://geocoder.readthedocs.io/>
- JSON file
<https://github.com/Neogeografen/dagi/blob/master/geojson/kommuner.geojson>
- Danmarks statistik
<https://www.dst.dk/da/Statistik/statistikbanken>
- Elbow method
<https://www.scikit-yb.org/en/latest/api/cluster/elbow.html>



Thank you!

OLGA RODENKO

23-05-2020

<https://www.Google.Com/url?Sa=i&url=https%3a%2f%2fwww.Worldnomads.Com%2ftravel-safety%2fnorthern-europe%2fdenmark%2fdenmark-laws-on-substances-guns-natural-resources-and-more&psig=aovvaw2tpuwhzyzwugzapxuadaw&ust=1590388838970000&source=images&cd=vfe&ved=0caiqrqxqfwotcidjoqtyy-kcfqaaaaadad>