COVID-19 ERTEs Impact Visualization in Barcelona

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1 | Introduction

1.1 | Background

Due to the Coronavirus disease (COVID-19) outbreak situation that the world has been suffering for the last months, on March 14, 2020, the Spanish government declared the so-called *Estado de Alarma*, imposing restrictions on the mobility of the population and the economic activity of different sectors, in order to control the spread of the virus across the country.

These measures have had, unfortunately, a big impact on the economy and employment. Companies and employers are losing thousands of millions of Euros and, as a consequence, many of them have had to drastically reduce their number of employees via a procedure called *Expediente de Regulación Temporal de Empleo*, or *ERTE* for short, which allows companies and business to temporarily fire one or more employees, during the time their economic activity is suspended.

1.2 | The problem

We are interested in visualizing the impact of such ERTEs from a geographical point of view in the Spanish city of *Barcelona*, which is one of the most important ones from an economic point of view. In particular, we want to examine and classify the different types of venues, shops and services of each of the neighborhoods of the city, and use data of the ERTEs in Catalonia in order to cluster neighborhoods in terms of the impact these ERTEs have had on each of them. After all the analysis, we want to produce a map of Barcelona that allows visualizing the results.

1.3 | Interest

This information could be useful for city governments or civil servants in order to have a clearer idea of the areas in the city that are suffering bigger economic consequences from the pandemic.

2 | Data

2.1 | Sources

We are going to use several data sources for this. First of all, we need a list of all the neighborhoods that we are examining. There is a Wikipedia page for that. Also, we are going to use the *Foursquare API* to obtain venues and services, as well as information about them, in each neighborhood. Moreover, we are using three datasets from the webpage *Dades Obertes Catalunya* that contain information on the number of ERTEs per economic sector, per county, and per day in Catalonia, and which will allow us to infer the effect of those ERTEs on each neighborhood:

- Number of ERTEs per economic sector

- Number of ERTEs per county

- Number of ERTEs per day

Finally, in order to examine the impact of ERTES in each economic sector (so that we can assign an impact to each venue category, and finally to each neighborhood), we will need to compare the number of ERTEs in Catalonia with the total number of companies in that region. We have obtained that data from this page of the *Instituto Nacional de Estadística*.

2.2 | Description of the data

2.2.1 | Neighborhoods of Barcelona

Barcelona consists of 10 districts, each of them divided into smaller neighborhoods. In total, there are 73 neighborhoods in the city. Figure 1 represents a complete list of all the neighborhoods and the districts they belong to.

ⓘ	**Districtes i barris de Barcelona**
Ciutat Vella	la Barceloneta · el Gòtic · el Raval · Sant Pere, Santa Caterina i la Ribera
Eixample	l'Antiga Esquerra de l'Eixample · la Nova Esquerra de l'Eixample · la Dreta de l'Eixample · el Fort Pienc · la Sagrada Família · Sant Antoni
Sants-Montjuïc	la Bordeta · la Font de la Guatlla · Hostafrancs · la Marina del Prat Vermell · la Marina de Port · el Poble-sec · Sants · Sants-Badal · Montjuïc¤ · la Zona Franca - el Port¤
les Corts	les Corts · la Maternitat i Sant Ramon · Pedralbes
Sarrià - Sant Gervasi	el Putget i Farró · Sant Gervasi - la Bonanova · Sant Gervasi - Galvany · Sarrià · les Tres Torres · Vallvidrera, el Tibidabo i les Planes
Gràcia	el Camp d'en Grassot i Gràcia Nova · el Coll · la Vila de Gràcia · la Salut · Vallcarca i els Penitents
Horta-Guinardó	el Baix Guinardó · Can Baró · el Carmel · la Font d'en Fargues · el Guinardó · Horta · la Clota · Montbau · Sant Genís dels Agudells · la Teixonera · la Vall d'Hebron
Nou Barris	Can Peguera · Canyelles · Ciutat Meridiana · la Guineueta · Porta · la Prosperitat · les Roquetes · Torre Baró · la Trinitat Nova · el Turó de la Peira · Vallbona · Verdum · Vilapicina i la Torre Llobeta
Sant Andreu	Baró de Viver · el Bon Pastor · el Congrés i els Indians · Navas · la Sagrera · Sant Andreu de Palomar · la Trinitat Vella
Sant Martí	el Besòs i el Maresme · el Camp de l'Arpa del Clot · el Clot · Diagonal Mar i el Front Marítim del Poblenou · el Parc i la Llacuna del Poblenou · el Poblenou · Provençals del Poblenou · Sant Martí de Provençals · la Verneda i la Pau · la Vila Olímpica del Poblenou

Figure 1: List of districts (left column) and neighborhoods (right column) of Barcelona.

2.2.2 | Foursquare API

Foursquare is a service that works with location data of hundreds of thousands of places all around the world. Their databases contain information of all kinds of venues and points of interest, such as their location, their type, or their opening hours. Moreover, since all this data is provided by the very same users of their mobile platform, there is also information such as pictures of each place, tips, or recommendations.

Foursquare provides a web API that allows developers to access to all that information by means of HTTP requests. One of the endpoints they provide is the **explore** endpoint:

https://api.foursquare.com/v2/venues/explore

By making a GET request to that endpoint, indicating several parameters such as the latitude and longitude coordinates of the location we want to explore, the radius around that location, and the number of results we want to get, the API returns a JSON file containing information about the venues that meet those parameters. All the relevant information about the use of that endpoint, as well as an example of the result JSON file, can be found in the documentaiton.

2.2.3 | Dades Obertes Catalunya

Dades Obertes Catalunya is a web page that provides open access data of different kinds related with the region of Catalonia. Recently, they have started to provide information related with the new COVID-19 disease. In particular, they also provide three datasets that gather information about the number ERTEs that have occurred in that region.

The first dataset provides the number of ERTEs that have occurred in each economic sector. Figure 2 shows the first 5 rows of this dataset, so we can have an idea of how it looks like.

	codi_divisi_econ_mica	divisi_econ_mica_ccae_2009	causa	n_mero_d_expedients	n_mero_d_afectats
0	01	Agricultura, ramaderia i caça	Força major	391	2400
1	02	Silvicultura i explotació forestal	Força major	39	436
2	03	Pesca i aqüicultura	Força major	215	921
3	05	Antracita, hulla i lignit	Força major	67	640
4	06	Petroli i gas natural	Força major	26	129

Figure 2: Example rows of the number of ERTEs per economic sector dataset.

We see that there are 5 columns in this dataset. The columns contain the following information:

- **codi_divisi_econ_mica**: unique numeric value that identifies each economic sector.

- **divisi_econ_mica_ccae_2009**: economic sector name.

- **causa**: why the ERTEs of that economic sector occurred. I can either be *Força major* (Force majeure) or *Altres causes* (other reasons).

- **n_mero_d_expedients**: number of ERTEs for a particular economic sector and cause.

- **n_mero_d_afectats**: number of people affected (since each ERTE can affect one or more employees).

The second dataset contains the information of the number of ERTEs occurred in each county of Catalonia. The following figure shows an example of its first rows.

	causa	codi_comarca	comarca	n_mero_d_expedients	n_mero_d_afectats
0	Força major	01	Alt Camp	433	3250
1	Força major	02	Alt Empordà	2246	12162
2	Força major	03	Alt Penedès	1140	7467
3	Força major	04	Alt Urgell	291	1406
4	Força major	05	Alta Ribagorça	60	168

Figure 3: Example rows of the number of ERTEs per county dataset.

This dataset also has columns named **causa**, **n_mero_d_expedients** and **n_mero_d_afectats**, which contain the same type of information as their homonymous columns in the ERTEs per economic sector dataset. The other two columns, named **comarca** and **codi_comarca**, contain the names of each Catalan county, as well as a unique number that identifies each of them, respectively.

The third dataset gathers the number of ERTEs occurred in Catalonia per day, starting on April 23, 2020. Figure 4 shows its first five rows.

	causa	data	n_mero_d_expedients	n_mero_d_afectats
0	Força major	2020-03-23T00:00:00.000	2.352	15.901
1	Força major	2020-03-24T00:00:00.000	4.402	25.067
2	Força major	2020-03-25T00:00:00.000	10.564	68.170
3	Força major	2020-03-26T00:00:00.000	9.511	59.460
4	Força major	2020-03-27T00:00:00.000	7.217	46.161

Figure 4: Example rows of the number of ERTEs per day dataset.

In this dataset, the columns **causa**, **n_mero_d_expedients** and **n_mero_d_afectats** appear once again. The extra column is **data**, which indicates the day in which the ERTEs of that row occurred.

2.2.4 | Instituto Nacional de Estadística

The *Instituto Nacional de Estadística* is the official agency in Spain in charge of all the statistical services related with demographic or economic data. They also provide open access datasets that gather some of the information they work with. One of the datasets available in their web page is the one pictured in Figure 5, which contains information of the amount of companies of each economic sector in each region of Spain.

	Comunidades y Ciudades Autónomas	Actividad principal	Estrato de asalariados	Periodo	Total
0	09 Cataluña	433 Acabado de edificios	Total	2019	13645
1	09 Cataluña	133 Acabado de textiles	Total	2019	327
2	09 Cataluña	82 Actividades administrativas de oficina y ot...	Total	2019	23657
3	09 Cataluña	821 Actividades administrativas y auxiliares d...	Total	2019	2112
4	09 Cataluña	522 Actividades anexas al transporte	Total	2019	3153

Figure 5: Example rows of the number of companies per economic sector dataset.

The columns of the dataset describe the following data:

- **Comunidades y Ciudades Autónomas**: region of Spain.

- **Actividad principal**: code and name of each economic sector.

- **Estrato de asalariados**: number of employees.

- **Periodo**: year of the data.

- **Total**: number of companies.

2.3 │ Preprocessing

Since the data of the neighborhoods of Barcelona is available in a web page, we have parsed the table from the html code of the page and we have transformed it into a Pandas DataFrame.

For the data obtained from the JSON responses of the Foursquare API, we have explored each JSON file in order to construct a DataFrame that contains information of the name, latitude, longitude and type of each found venue, as well as the neighborhood it belongs to.

In the ERTEs datasets, we have dropped the columns **causa**, because it does not provide any useful information, and **n_mero_d_afectats**, since we are interested on the impact of the ERTEs on business and companies, not individuals.

Finally, for the dataset of total number of companies per economic sector, we have kept only the rows related to the region of Catalonia, and we have dropped the third and fourth columns. Also, we have separated the codes from the names of each economic sector of the second column. This is done so that this dataset can be matched easily with the one containing the number of ERTEs per economic sector.

3 | Exploratory data analysis

3.1 | ERTEs in Catalonia

Data from the number of ERTEs per economic sector reveals which are the sectors in Catalonia that have been most affected by the crisis. Figure 6 reveals the top 10 sectors where the incidence has been greater.
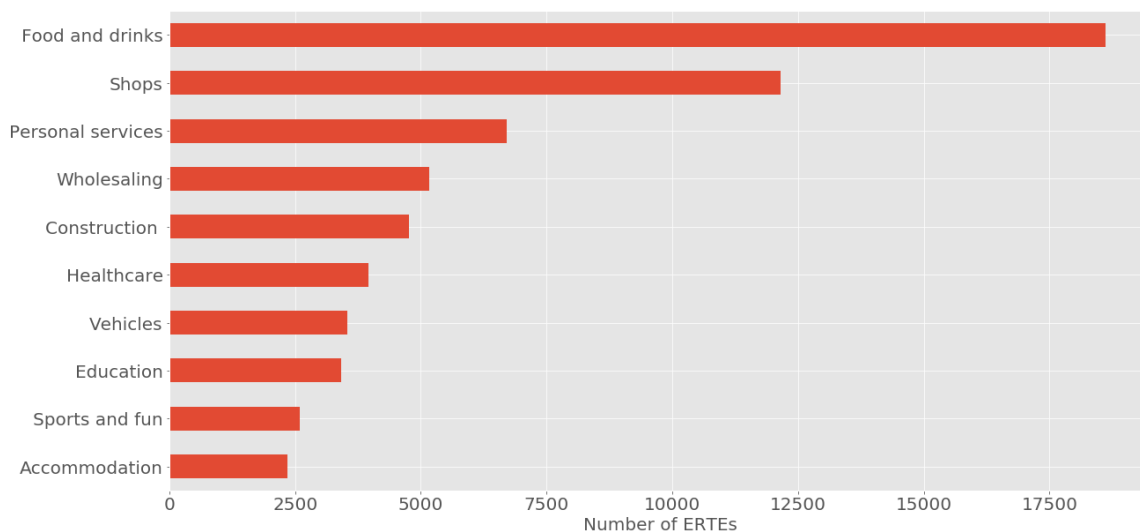

Figure 6: Top 10 sectors by number of ERTEs in Catalonia.

As we can see, the first one is *Food and drinks*, which includes business such as restaurants, bars, pubs, coffee shops, wine stores, night clubs and so on. The list also includes *Shops*, *Sports and fun* and *Accommodation*. This is reasonable because, in Spain, tourism is one of the major contributors to its GDP, and Catalonia is, in particular, one of the most touristic regions. Therefore, it is not surprising that tourism-related sectors should be the ones that have been most affected by ERTEs. Industry is also a very big part of the Spanish economy. In fact, Catalonia has one of the most important car factories in the country (SEAT Martorell). This partly explains why sectors like *Construction* and *Vehicles* appear in the list as well.

The important numbers, though, to properly measure the impact of ERTEs on each economic sector would be, in fact, the proportion of companies and business on each sector that have suffered one or more ERTEs. This information is, a priori, unavailable for us, because the previous data refers to number of ERTEs, not number of companies affected, and each company could have suffered more than one ERTE. Nevertheless, we can justify a reasonable approximation with the data we have access too. Figure 7 is a representation of the number of ERTEs occurred in Catalonia per day. Notice how, the big majority of ERTEs occurred during the first week.
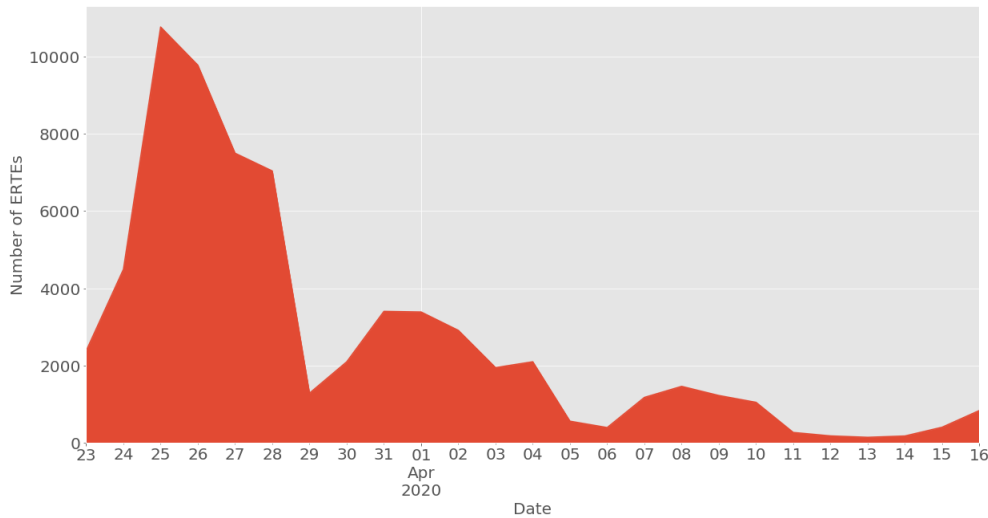
Figure 7: Evolution of the number of ERTEs in Catalonia per day.

Since it is unlikely that a company suffered two or more ERTEs on the same week (otherwise, they would have done them at once), we might think that the rest of ERTEs correspond to a minority of companies and business that either decided to wait a bit longer before doing one ERTE, or decided to do another one given the circumstances. In any case, as we are saying, this is not a big number of cases, so it is reasonable to think that each ERTE corresponds, in general, to one business or company, and thus, by computing the quotient between ERTEs and companies on each sector, we are basically computing an estimated probability that a company of a certain sector suffered an ERTE. This will be our measure of impact per sector. We will say more about it in Section 3.3.

There is another approximation we need to do before taking a look at the venues of the city of Barcelona. Figure 8 is based on the data of the number of ERTEs per county in Catalonia, and represents the proportion of ERTEs that have occurred in companies located in the county of *Barcelonès* with respect to the other 41 counties.
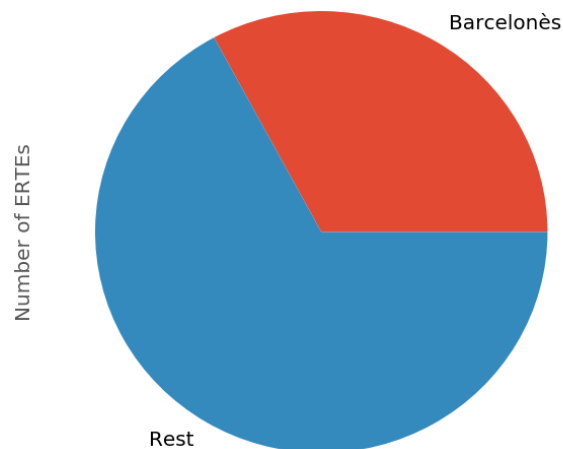

Figure 8: Proportion of ERTEs in Barcelonès.

We do not have any dataset containing the number of ERTEs per economic sector only in Barcelona, but as we can see, one third of all the ERTEs occurred in Barcelonès, which is the county where Barcelona belongs to. Being Barcelona the biggest city of that county, we will make the following simplification: we will assume that, for each economic sector, the proportion of companies that suffered and ERTE in Barcelona is the same as the proportion in Catalonia.

3.2 │ Venues in Barcelona

After getting the list of neighborhoods of Barcelona, we have obtained their corresponding geographical coordinates. Figure 9 allows to visualize the location of each of them.

For each neighborhood, we have used its location to perform an HTTP request to the Foursquare API *explore* endpoint and get a list of venues next to that location. In particular, we have asked for the top 50 venues in a radius of 600 meters from the position of each neighborhood.

In total, we have found 18676 venues, which can be categorized into 260 categories. Those categories are very specific (such as *Tapas Restaurant*, *Bakery*, *Plaza*, *Beer Bar*,...), so in order to relate that information with the number of ERTEs per economic sector, we have had to do some cleaning, and group these types into their corresponding sectors.

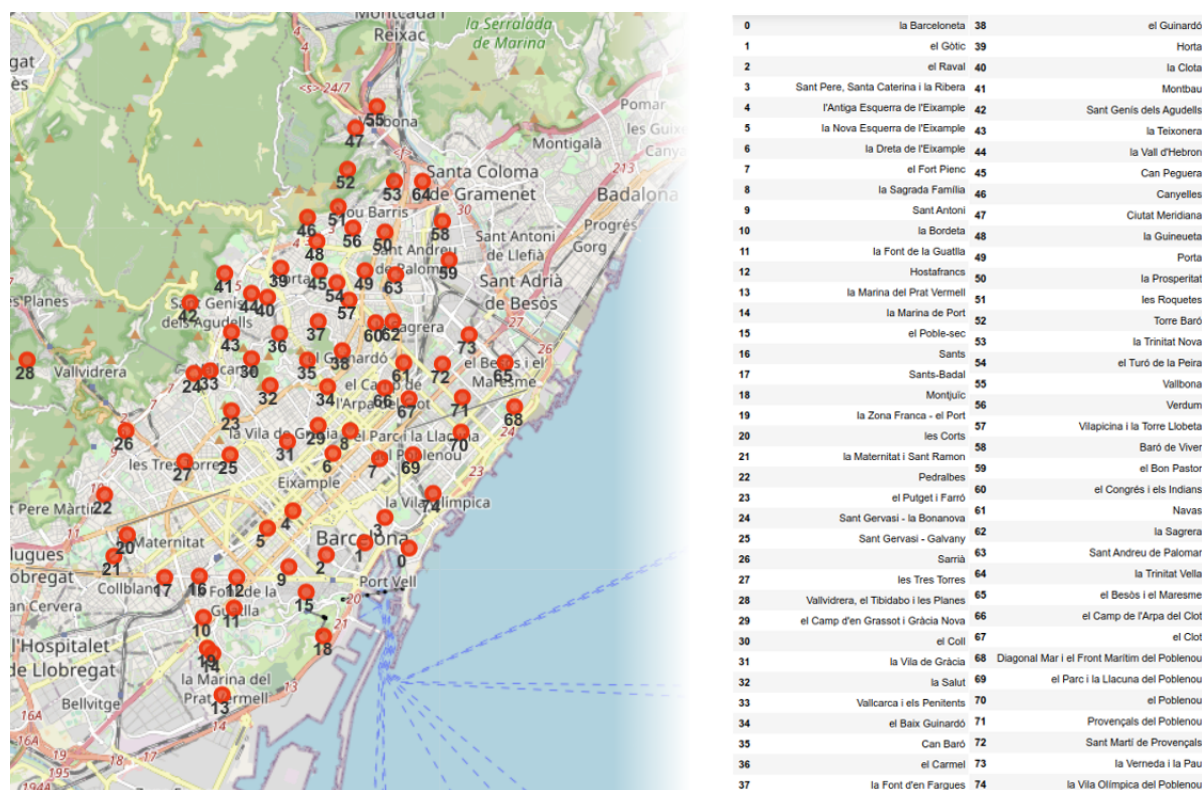|			
0	la Barceloneta	38	el Guinardó
1	el Gòtic	39	Horta
2	el Raval	40	la Clota
3	Sant Pere, Santa Caterina i la Ribera	41	Montbau
4	l'Antiga Esquerra de l'Eixample	42	Sant Genís dels Agudells
5	la Nova Esquerra de l'Eixample	43	la Teixonera
6	la Dreta de l'Eixample	44	la Vall d'Hebron
7	el Fort Pienc	45	Can Peguera
8	la Sagrada Família	46	Canyelles
9	Sant Antoni	47	Ciutat Meridiana
10	la Bordeta	48	la Guineueta
11	la Font de la Guatlla	49	Porta
12	Hostafrancs	50	la Prosperitat
13	la Marina del Prat Vermell	51	les Roquetes
14	la Marina de Port	52	Torre Baró
15	el Poble-sec	53	la Trinitat Nova
16	Sants	54	el Turó de la Peira
17	Sants-Badal	55	Vallbona
18	Montjuïc	56	Verdum
19	la Zona Franca - el Port	57	Vilapicina i la Torre Llobeta
20	les Corts	58	Baró de Viver
21	la Maternitat i Sant Ramon	59	el Bon Pastor
22	Pedralbes	60	el Congrés i els Indians
23	el Putget i Farró	61	Navas
24	Sant Gervasi - la Bonanova	62	la Sagrera
25	Sant Gervasi - Galvany	63	Sant Andreu de Palomar
26	Sarrià	64	la Trinitat Vella
27	les Tres Torres	65	el Besòs i el Maresme
28	Vallvidrera, el Tibidabo i les Planes	66	el Camp de l'Arpa del Clot
29	el Camp d'en Grassot i Gràcia Nova	67	el Clot
30	el Coll	68	Diagonal Mar i el Front Marítim del Poblenou
31	la Vila de Gràcia	69	el Parc i la Llacuna del Poblenou
32	la Salut	70	el Poblenou
33	Vallcarca i els Penitents	71	Provençals del Poblenou
34	el Baix Guinardó	72	Sant Martí de Provençals
35	Can Baró	73	la Verneda i la Pau
36	el Carmel	74	la Vila Olímpica del Poblenou
37	la Font d'en Fargues		

Figure 9: Location of the neighborhoods of Barcelona

First, we have erased supermarkets, grocery stores, pharmacies or gas stations. This is because they are places that have remained opened during the quarantine. We have erased as well plazas, parks, stations, transportation services, or any public place for that matter, for they do not count as business. All this categories represent already a big part of the total of venues found.

For the rest, as we have said, we have grouped them into bigger categories, similar to the economic sectors of the ERTEs dataset. After doing so, these are the top 5 sectors in the city of Barcelona by number of venues.
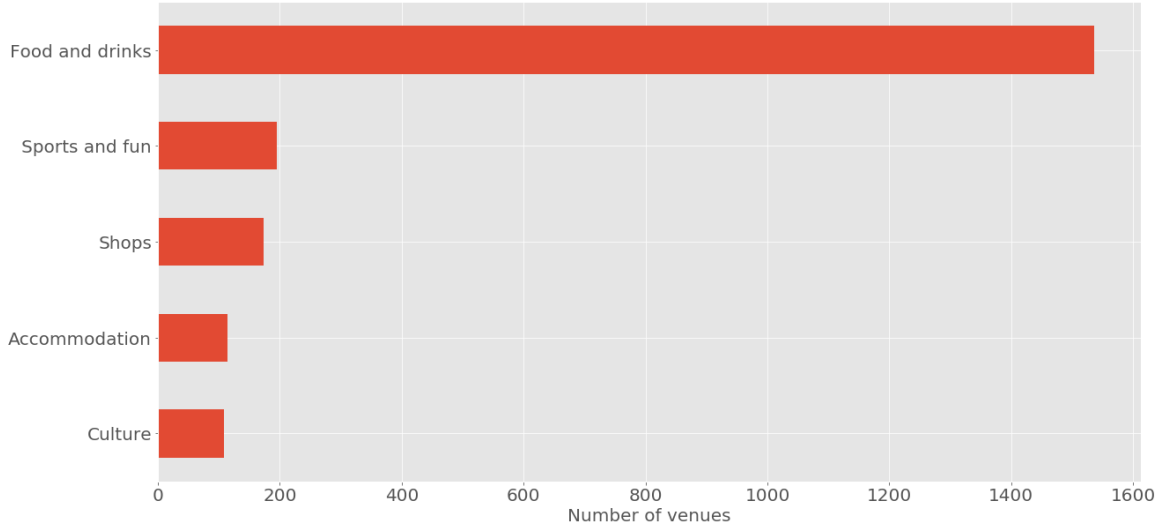
Figure 10: Top 5 economic sectors in Barcelona.

By far, the most common economic sector is *Food and drinks*, followed by *Sports and fun*, *Shops*, *Accommodation* and *Culture* (theaters, museums, galleries,...). Again, this is something reasonable to expect from a city with a very touristic profile.

3.3 | Impact measure

We define the *impact of ERTEs on an economic sector* e as the ratio between the number N_e of ERTEs occurred and the total number of companies T_e on that economic sector:

$$I_e = \frac{N_e}{T_e}. \tag{3.1}$$

As we have mentioned before, this impact is roughly the proportion of companies that have suffered an ERTE on an specific economic sector. In that sense, it can be though as the probability that a company of an economic sector suffered an ERTE.

Notice that the first four economic sectors in Barcelona belong to the list of Figure 6. Because of this, we have kept only the venues in Barcelona that belong to them. Then, using the information of the number of companies and the number of ERTEs per economic sector, we have computed the impacts for each of those four. The impacts we have found are presented in the following table.

Economic sector	Impact of ERTEs
Food and drinks	0.4700
Sports and fun	0.1735
Shops	0.3682
Accommodation	0.5370

Table 1: ERTEs impact on the most important economic sectors in Barcelona

These numbers are reasonable from an heuristic point of view. ERTEs are procedures that usually affect many employees at. Thus, sectors where each business employs several people are the ones where business are most prone to suffering ERTEs. This is clearly the case of *Accommodation*, *Food and drinks* and *Shops*, where each business can even employ dozens of people.

With these numbers, and the precise information of each venue in each neighborhood, we have been able to compute an estimate impact of ERTEs per neighborhood as follows. If I_{fd}, I_{sf}, I_s, and I_a are the impact of ERTEs for each of the previous sectors, respectively, then given a neighborhood n with N_{fd} venues of *Food and drinks*, N_{sf} venues of *Sports and fun*, N_s *Shops* and N_a venues of *Accommodation*, the *impact of ERTEs on the neighborhood* n is

$$I_n = \frac{I_{fd}N_{fd} + I_{sf}N_{sf} + I_sN_s + I_aN_a}{N_{fd} + N_{sf} + N_s + N_a}. \tag{3.2}$$

4 │ Results

Applying (3.2) to each neighborhood in Barcelona allow us to find the impact of ERTEs on each neighborhood. Figure 11 shows an histogram of the resulting impacts.
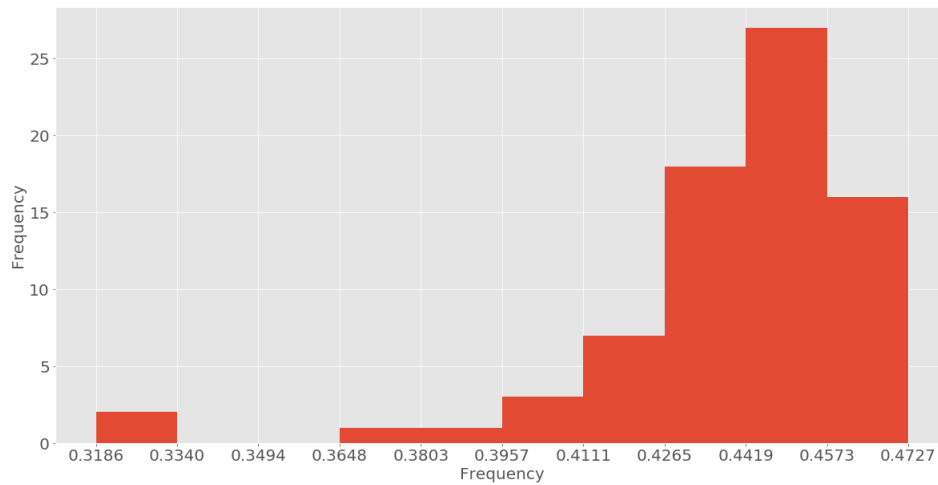

Figure 11: Histogram of ERTEs impact in each neighborhood.

We have further used these impacts to classify neighborhoods into three different categories: (0) *low impact*, (1) *medium impact* and (2) *high impact*. This has been done automatically using the
k-means clustering algorithm with $k = 3$ clusters. After assigning to each neighborhood its corresponding cluster, we have represented a colored map of the neighborhoods of Barcelona, where each color correspond to one type of impact. The resulting map is depicted in Figure 12.
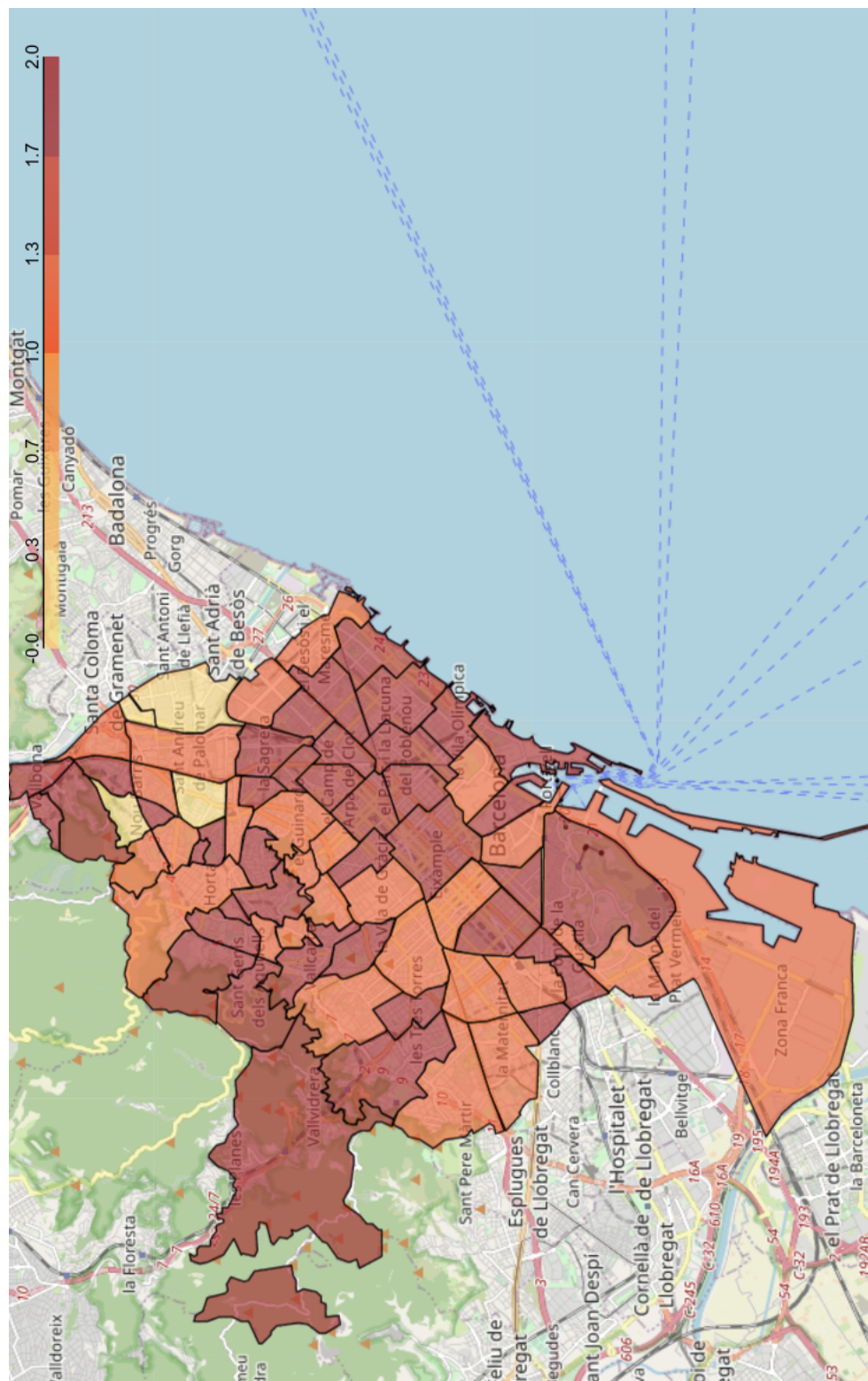
Figure 12: Neighborhoods in Barcelona colored in terms of the ERTEs impact in each of them.

5 | Discussion and conclusions

The histogram suggests that most impact values concentrate around 0.4 and 0.5. This means that, for most neighborhoods, around 40 to 50% of business have suffered an ERTE. These are very dramatic numbers. They suggest that, in general, **almost half of the business in the city have had to fire someone due to the Coronavirus outbreak**.

This fact is also visible form the map. Very few neighborhoods have had a low ERTE impact. **The vast majority of neighborhoods** have experienced either a **moderate impact** (around 40% of business have suffered an ERTE in them) or a **high impact** (around 45%). This might be due to the fact that the most common venue category in the city, which is *Foods and drinks*, is also one with a very high ERTE impact. This also makes sense from the geographical point of view: most of the neighborhoods with high impact are in the center of the city and in to the coastline, which is the location of most of the bars, pubs, restaurants, and night clubs of the city.

We should note, though, that we believe **these results should not be considered precise at all**, but rather as a rough, simple approximation of the actual situation. This is because we have done several simplifications during the whole analysis, being the use of equation (3.2) the biggest one. This is because this equation assumes that the probability that a certain business of a certain economic sector suffered an ERTE is uniform across the geographical distribution of business in the city. Thus, **the particular demographic and economic features of each neighborhood are not taken into account.**

For example, there are some neighborhoods in the city outskirts that also seem to have been very affected. In these neighborhoods, the most common venue category is, again, *Foods and Drinks*, but there are, in fact, very few venues of that type in them. This, combined with the fact that they are demographically and geographically different from any neighborhood in the center, makes it unlikely that the actual ERTE affectation had been so high in them.

6 | Further work

One of the biggest drawbacks of our model is that the data we have used for our analysis is not completely adequate for studying the affectation of ERTEs on a single city. This is due to the fact that it refers to larger scales, which are Catalonia and Spain. **In particular, using that data to infer properties on a smaller territory requires simplifications and approximations that make our results inaccurate**. Things such as assuming a uniform probability of suffering an ERTE on each economic sector across the city might not be the most precise way of tackling the problem.

Therefore, one possible improvement would be **using more precise ERTE information**, such as obtaining directly the companies that have suffered ERTEs and their locations to compute different proportions for each neighborhood.

Such data might be difficult to obtain, for it is rather sensitive. But even without having access to it, our analysis admits other refinements. One of them is related with the data obtained from Foursquare. As we have explained in section 3.2, we have looked, for each neighborhood, at the top 50 most popular venues located at less than 600 meters from the location of the neighborhood. This is a very imprecise way of proceeding. First of all, the location of the neighborhood might be rather arbitrary within its actual boundaries. Moreover, some neighborhoods are bigger than others, so 600 meters might be too much for some of them (which would imply that some venues appear duplicated in more than one neighborhood) and too less for some others. Finally, it is possible that many neighborhoods have more than 50 venues and business, and looking at the top 50 most popular might not be representative enough of the actual economy of the neighborhood. Thus, in short, **this data needs to be handled more carefully**. Ideally, we should be able to use Foursquare API to obtain, for each neighborhood, a complete list of all the venues, companies and business in it and without duplicates.