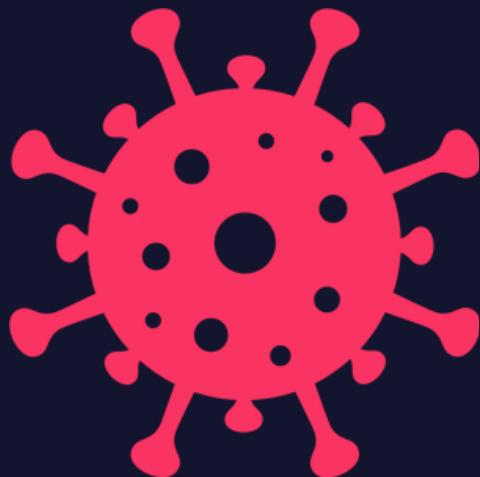


Data Visualization, COM-480



COVID-19 Impact through Data Visualization

Process Book

Vuk Vuković, Ioan Florin Cătălin Nițu, Mihai David

COVID-19 Impact Through Data Visualization aims to provide a comprehensive understanding of the pandemic's impact on society through three main aspects: COVID-19 cases and deaths, flights to assess travel in Europe, and the impact of COVID-19 on employment.

Datasets

We have selected three high-quality datasets for our project, which will serve as the foundation for our visualization and storytelling.

- [Data on COVID-19 \(coronavirus\) by Our World in Data](#)
- [European Flights by Eurocontrol](#)
- [Impact of Covid-19 on Employment by ILOSTAT](#)

We have conducted an initial exploratory data analysis of the datasets and found them to be of high quality. To achieve our visualization goals, such as obtaining airport latitude and longitude, map borders, and countries' flags, we had to enhance the datasets with two additional datasets:

- [IATA/ICAO List by IP2Location](#)
- [Countries' Borders on the Globe](#)

Finally, we also utilized the [CDC Museum COVID-19 Timeline](#) as a source of information for our storytelling.

In the beginning, we thought of using an [additional dataset](#) containing the yearly population and total deaths per country but due to its inconsistency with the population information in the COVID-19 dataset, we decided to leave it aside and therefore display COVID statistics that were not taking the number of deaths (due to any cause, not only COVID) into consideration.

Some of the data required cleaning and handling special values. For instance, in the Data on COVID-19 dataset by Our World, we encountered instances where daily new cases were reported as negative for certain countries. In such cases, we replaced the negative values with NA. Additionally, we found missing *ISO-ALPHA2* codes for countries, which we manually filled in to ensure data completeness.

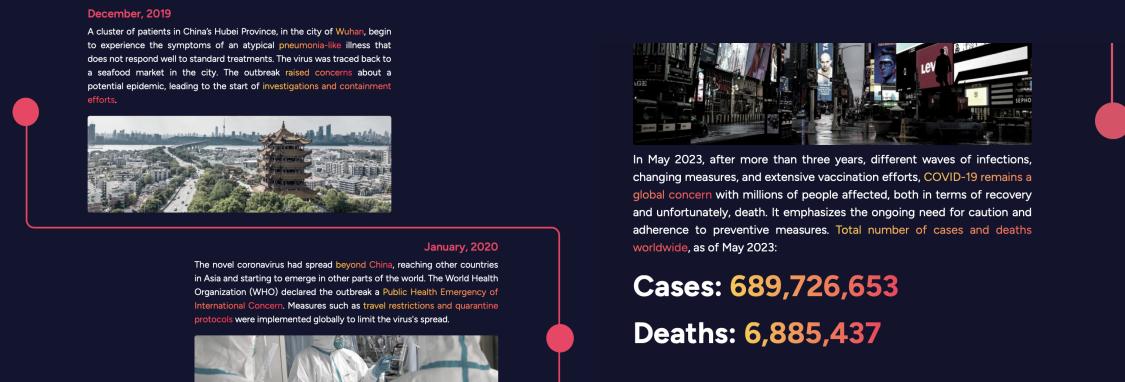
Visualizations

Our solution is built on a simple HTML and CSS backbone page with the Bootstrap framework, enhanced by several libraries that enable visualization and interactivity. To convey our message and tell the story through the available data, we employed various types of visualizations and techniques. The project can be divided into four distinct components, which will be discussed individually: a timeline and case summary, an interactive globe of cases, an employment impact infographic, and a flight map.

Timeline and cases summary

To introduce the storytelling aspect, we aimed to create a timeline depicting the emergence of the COVID-19 pandemic up until the present day. The timeline utilizes Bootstrap elements,

incorporating text and images. To enhance user interactivity, we added CSS animations: hovering over the timeline circles or images enlarges them and changes their color. Additionally, important phrases within the text were strategically highlighted to convey the message more effectively. The timeline is complemented by a counter that presents a summary of COVID-19 cases and deaths. The counter animation was achieved using jQuery, which updates the counter from the provided start value, with a given step, on a predefined timer until it reaches the final value.



Interactive globe of cases

This section displays global COVID-19 statistics. It begins with a slider created using an SVG component and simple D3 slider tools. The slider ranges from 2020 to 2023, sampled monthly, with a play/pause button located on the left side of the slide bar. Users can either select a specific month and year by dragging the slider or let it run through all the time steps automatically. The slider will reset and run again when it reaches the end of the timeline.

The next element is an interactive 3D globe, created using Globe GL, which displays monthly COVID-19 statistics from 2020 to 2023, selected by the aforementioned slider. The monthly data selected by the slider is bound to the globe through a MutationObserver interface, which provides the ability to watch for changes being made to the slider.

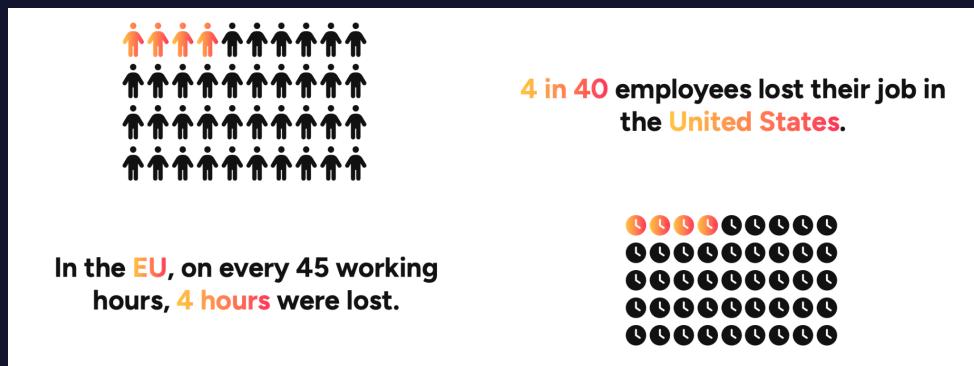
We compute the monthly number of new cases per capita per country. A heatmap with a suitable color palette and color domain for a specific month highlights the increase or decrease in this number. In this way, the visualization will provide the user with an idea of the monthly impact of COVID among multiple countries and across multiple months. Users can rotate and zoom in/out the globe (on a double-click enabling/disabling event) to better observe different parts of the world.

The globe displays the world's countries using predefined GeoJSON formatted data and the Polygons Layer from Globe GL to define each country's location and appearance. Hovering over a country, while a particular month is selected, displays a pop-up card with monthly information, including the country's flag, new monthly COVID-19 deaths and cases, and population. The country's borders will rise above the original surface of the earth to highlight it.



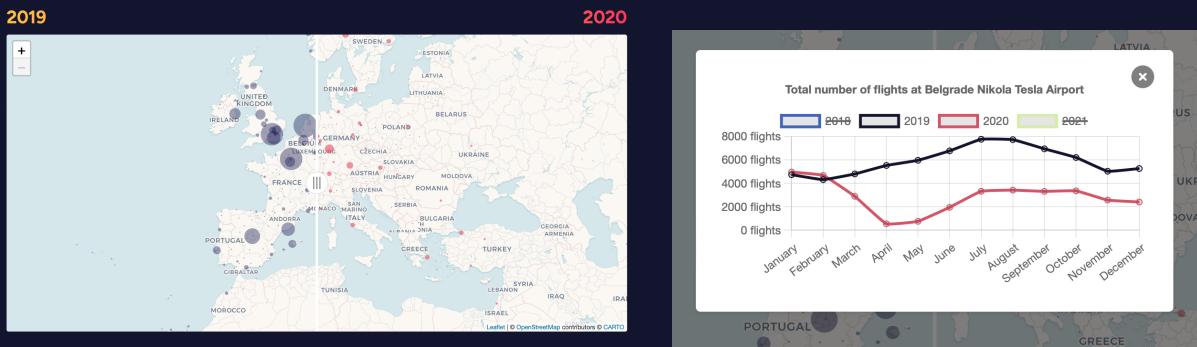
Employment impact infographic

Due to the simplicity of the dataset on the COVID-19 impact on employment, we decided to extract the most relevant data and present it in the form of an infographic. To achieve this, we utilized FontAwesome icons representing a man or woman and a clock, accompanied by carefully highlighted text. The infographic was created and animated using jQuery. We implemented an infographic class and utilized data fields (repeat number, highlight number) within an HTML tag to generate the infographic using jQuery. The animation gradually colors the relevant icons one by one. It is triggered when the user reaches the infographic section of the page. Additionally, to enhance interactivity, a CSS animation effect was applied to the icons upon hover.



Flights map

The impact of COVID on the travel sector is quite intriguing, as this sector probably suffered the most during the pandemic. Therefore, we show the difference in European air traffic before and during COVID, in the years 2019 and 2020, respectively. We use the Leaflet library to first load an OpenStreetMap raster-tiled map. Using the same library, we created two comparison panels for the two years. On each panel, we display the airports from our dataset as bubbles with an area proportional to the total number of flights departing and arriving at that airport. By clicking an airport bubble, a modal component from Bootstrap will pop up, showing additional information about the selected airport. In this pop-up, we show a chart, built with the Chart.js library, that incorporates the monthly number of flights, during four years (2018–2021), for that airport. In this way, a user would be able to see the difference between pre and post-pandemic number of flights and also the most affected months during the pandemic.



Design decisions and challenges

One of the decisions we made right from the beginning was to strive for the creation of an aesthetically pleasing and consistent, fully responsive visualization that would be compatible with the majority of modern browsers and devices. However, we soon discovered that fulfilling this decision would be quite challenging.

To find the perfect color scheme, we explored multiple options from [Colors.co](#) before settling on the right one. From that point onward, our focus was on designing all other visualization elements in alignment with this chosen color scheme, ensuring a cohesive visual identity. We also made sure to maintain consistency in graphical elements such as rounded images and element borders.

Achieving full responsiveness and providing an exceptional user experience across various devices can be complex, especially when dealing with different types of data such as text, images, D3.js visualizations, Chart.js plots, and maps. For overall responsiveness, we utilized Bootstrap's grid system. While some elements were inherently responsive (Leaflet map), automatically adjusting their width according to their container, others presented more challenges. For example, we employed jQuery's window resize event and dynamic object width and height getters to ensure the interactive globe remained responsive.

During the development process, we encountered compatibility issues with certain libraries, such as Leaflet and leaflet-compare, due to conflicts with newer versions of their dependencies. On the other hand, we discovered a known bug in the older version of the Leaflet library specifically related to pop-ups in the Safari browser. After extensive research and experimentation, we managed to overcome this problem by substituting a Leaflet popup with a Bootstrap modal.

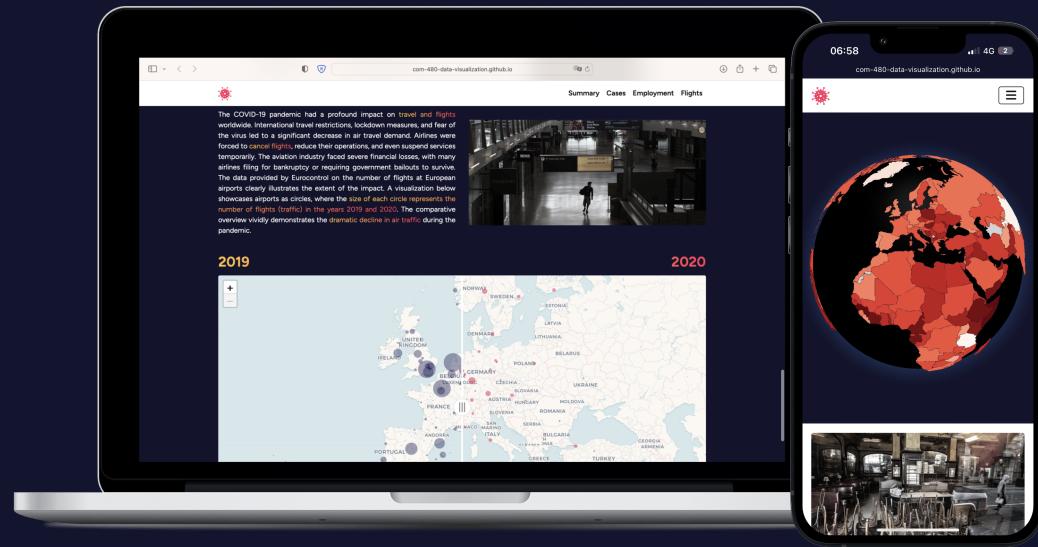
Another challenge was to carefully choose the color palette and color domains using the d3-scale-chromatic module, such that the countries with the highest number of new cases per capita are sticking out on each selected month. We chose a continuous palette of red shades, with a sequential scale transformed by a squared-root function. The domain of the red shades was limited to the minimum/maximum number of new cases among all countries, for a specific year and month.

Differentiating between the interactions with some elements in the website (zooming and dragging of the globe or flight map) versus the interaction with the web page itself (mainly scrolling), also

posed some challenges. For smooth scrolling of the website, we resized the globe canvas and the flight map so that they do not take up the whole width of the viewport. In addition, we give the user the possibility to disable/enable the zooming of the globe on a double-click event, so that globe interactions won't interfere with the page scrolling at all.

Designing a website for which the initial loading time is minimal was also a key point in our decision-making process. For this reason, we build the flight charts on demand, from a JSON formatted dataset, when a bubble is clicked. We also load the COVID-19 statistics on demand, from a GeoJSON formatted file, which was enriched with all the necessary information.

Although these challenges and design decisions were demanding and required significant time and effort, we are pleased with our ability to overcome them and acquire new skills in the process.



Contributions

Ioan Florin Cătălin Nițu

- Flights comparison map
- Flights charts
- Debugging and pair programming with Mihai
- Process book
- Screencast

Mihai David

- Interactive globe
- Slider
- Process book
- Screencast

Vuk Vuković

- Website design
- Timeline and counters
- Infographics
- Support with flights map
- Responsiveness of elements
- Process book
- Screencast