

COVID-19 Government Measures Exploration

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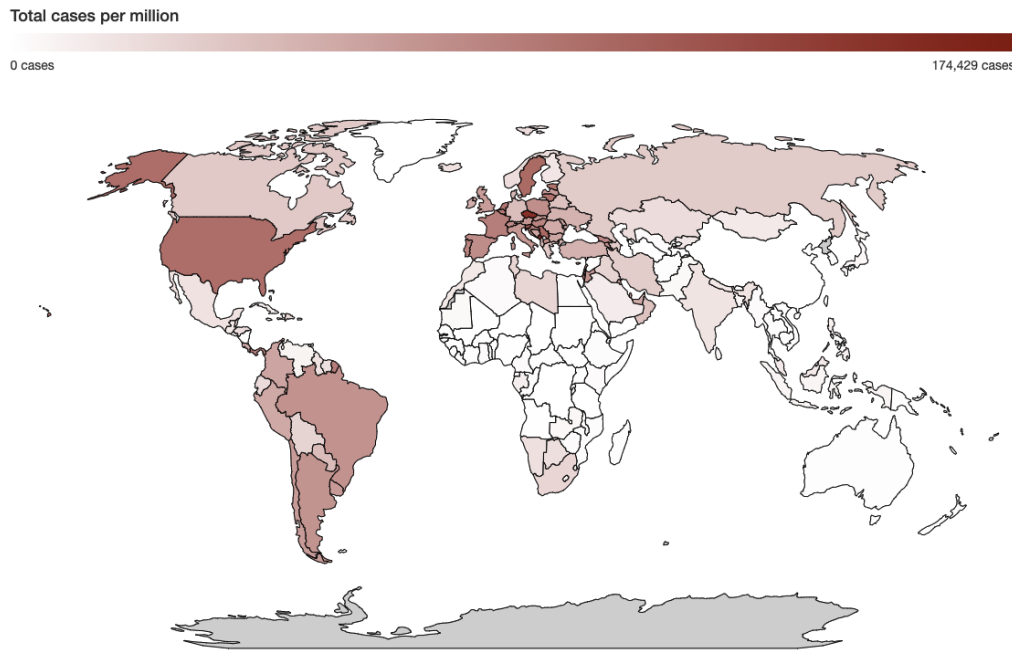


Figure 1: COVID-19 Cases Map: Visualization of total cases per million around the world throughout the pandemic.

ABSTRACT

As the COVID-19 pandemic spread around the world, many governments attempted a variety of mitigation strategies to curb the rise of cases and deaths in their countries. Some were more successful than others, but there exists no easy way of exploring these measures to investigate these important trends. We develop an interactive visualization to enable quick and simple exploration of pandemic-related measures by governments worldwide. This tool combines data on COVID-19 cases, deaths, and hospitalizations with detailed information about COVID-19 measures. Using the visualization, users can first browse the data at a high level on a world map and then narrow down to see more granular information about their country of interest. To avoid overloading the user with a multitude of confusing content and features, we emphasize simplicity as well as functionality. In particular, the tool targets policymakers to inform their decisions on future measures to implement. Indeed, we find that users can quickly and easily use our visualization to answer questions about COVID-19 measures. For example, a user can discover insights about measures the United States implemented around the second wave during summer 2020. The tool can be further improved and refined with more data, such as granular state-level measures.

Index Terms: Human-centered computing—Visualization—Visualization design and evaluation methods; Human-centered computing—Interaction design—Interaction design process and methods

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1 INTRODUCTION

The COVID-19 pandemic has disrupted everyone’s lives over the past year. As scientists continued to study the disease and to learn more about its spread and mitigation, cases and deaths fluctuated around the world. Governments attempted to curb the spread of COVID-19 with specific prevention measures and restrictions. The types and timing of implemented measures were critical in their effectiveness. Thus, some countries were more successful than others at effectively saving lives with these actions.

In order to respond with maximum effectiveness to this and future challenges, it is critical for governments and policymakers to easily see and understand their actions in context. There is currently no easy tool for users to intuitively explore COVID-19 data in conjunction with government measures. Therefore, we aim to create an easy-to-use interactive visualization that addresses these challenges. Our tool displays COVID-19 statistics together with data on worldwide government measures in a clear and clean fashion with additional functionalities for interaction. We aim to inform policymakers around the world on past actions by various governments, in order to help inform their future decisions.

2 RELATED WORK

There are existing solutions that separately visualize COVID-19 statistics, such as cases and deaths, and government measures, but these tools do not effectively combine the two elements. In addition, the current tools are not always complete and can be difficult to use.

The New York Times effectively visualizes the trends in COVID-19 cases, deaths, and in some cases hospitalizations, around the world.¹ They show intuitive bar graphs that are easy to read for users

¹[nytimes.com/interactive/2020/world/coronavirus-maps.html](https://www.nytimes.com/interactive/2020/world/coronavirus-maps.html)

and interactive. Additionally, for the United States, data is available on the state and county levels, allowing users to narrow in on their specific area. However, The New York Times does not provide large, interactive plots for all countries, only some major ones. As a result, this significantly limits the tool's audience, and leaves many without an option to see data in their country. Additionally, this visualization does not include any information about government measures.

ACAPS, an independent humanitarian needs organization, provides the COVID-19 government measures dataset that we use in our tool. They also have their own dashboard that allows users to explore the data.² It provides some filters, and displays the information on a map and a bar chart by measure type. However, this tool does not present the information over time, only on aggregate. Additionally, the data is not overlaid on COVID-19 statistics, so users cannot easily interpret the relationships between the two trends over time. Finally, the tool is slow, taking a long time to load initially and when filters change. This could present challenges for usability, particularly for users without access to the latest and fastest computers.

Therefore, although currently existing solutions provide a baseline for our work, we expand on these visualizations to provide users with a novel and uniquely useful tool.

3 METHODS

The visualization is split into two distinct pages: a page with a world map to give users a general overview, and a page with information about a specific given country to allow for more granular exploration. Each page has some filters, as well as unique functionalities. The two levels of information were deliberately split between separate pages in order to avoid overwhelming users with excessive information in a single view. The visualizations were implemented in d3.js³.

3.1 Datasets

We utilize two separate datasets to create the visualization:

- **Our World in Data COVID-19 dataset⁴:** This dataset, obtained from OWID (Our World in Data), contains daily information about new COVID-19 cases, deaths, hospitalizations, and more since the start of the pandemic. These metrics are presented in a variety of formats, from overall totals to measures per million. Our tool uses the latter to scale by population.
- **ACAPS COVID-19 Government Measures dataset⁵:** This dataset, sourced from ACAPS, is a compilation of pandemic-related measures implemented by governments worldwide. This includes both introduced and phased-out policies. The measures are broken down into five categories: social distancing, movement restrictions, public health measures, social and economic measures, and lockdowns.

Data from the two datasets for a given country is joined by using the country's ISO, which is universal despite potential naming differences.

3.2 World Map Page

The first view that the user sees upon loading our tool is the general world map. Titled "COVID-19 Government Measures Exploration," the page begins with brief introductory text to help orient the user. This text explains the content of the page, as well as the interactive functionalities available. Interactions are bolded to highlight their importance.

²acaps.org/projects/covid19/data

³<https://d3js.org/>

⁴<https://github.com/owid/covid-19-data/tree/master/public/data>

⁵<https://www.acaps.org/covid-19-government-measures-dataset>

Hide notable dates

March 11, 2020: WHO Declares COVID-19 a Pandemic

May 28, 2020: US COVID-19 Deaths Pass the 100,000 Mark

July 14, 2020: Early Moderna Data Point to Vaccine Candidate's Efficacy

August 17, 2020: COVID-19 Now the Third-Leading Cause of Death in the US

September 14, 2020: Pfizer, BioNTech Expand Phase 3 Trial

September 23, 2020: A New, More Contagious Strain of COVID-19 Is Discovered

December 10, 2020: FDA Advisory Panel Recommends Pfizer, BioNTech COVID-19 Vaccine

April 2, 2021: US Surpasses 100 Million People Receiving 1 Vaccine Dose

Figure 2: The collapsible list of notable dates that serve as information scent.

The primary focus of the page is the world map (see Fig. 1). It depicts the total number of cases or deaths in each country during the selected date range. This was implemented by preprocessing the COVID-19 data from OWID to aggregate the desired statistic over the specified range. A color bar is placed above the map to indicate the spectrum of values for readability.

When the user hovers over a given country on the map, they see a tooltip that gives the country name and total number of implemented measures. This design decision allows the user to briefly glance at the COVID-19 measures data. They can then click on the country, which loads up the more detailed individual country page with more information about measures over time. The tooltip also informs the user if there is no measures data available for the given country, and thus clicking on that country is disabled.

Finally, the page includes two filters: a date range slider and COVID-19 statistic selector.

Date Range Slider This component, located above the map, allows the user to narrow the time range of the statistic displayed on the map. For instance, to visualize the cumulative number of cases per million in the middle of the pandemic, the user can select the middle of the date range slider. The map automatically updates when the slider moves – an intentional design decision to create a feeling of animation. Below the slider, there is a collapsible list of notable dates to provide information scent and help orient the user in time (see Fig. 2).

COVID-19 Statistic Selector This filter, located right below the date range slider, allows the user to select which statistic is displayed on the map – total COVID-19 cases or deaths. This gives the user additional flexibility to quickly find countries depending on their desired metric. Like the date range slider, when this selector is changed, the map updates immediately. This decision was implemented to allow users to quickly use our tool without additional steps, such as clicking "Apply."

3.3 Individual Country Page

After the user clicks on a country on the map, they are taken to that country's detailed page titled "COVID-19 Government Measures in [Country]." While the page loads (which lasts a few seconds due to the required data processing), it displays a user-friendly "loading" message, so the user knows to wait. Like the map page, there is instructional text to help inform the user at the top.

The main visualization on the page is a bar plot showing COVID-19 measures over time, overlaid on a statistic, such as cases (see Fig. 3). The colors were deliberately chosen to maximize readability and emphasize the important elements of the chart. Since the measures are the main focus, days with introduced or phased-out policies are colored accordingly, while the remaining days are greyed out. This creates an outline of the visualized statistic, with the measures information on top of it.

Users can hover over an individual bar to see its date, as well as a summary of the number of measures introduced and phased out on that day, displayed on a tooltip (see Fig. 4). This design decision was implemented to give users a general idea of the information behind a

COVID-19 Measures Over Time

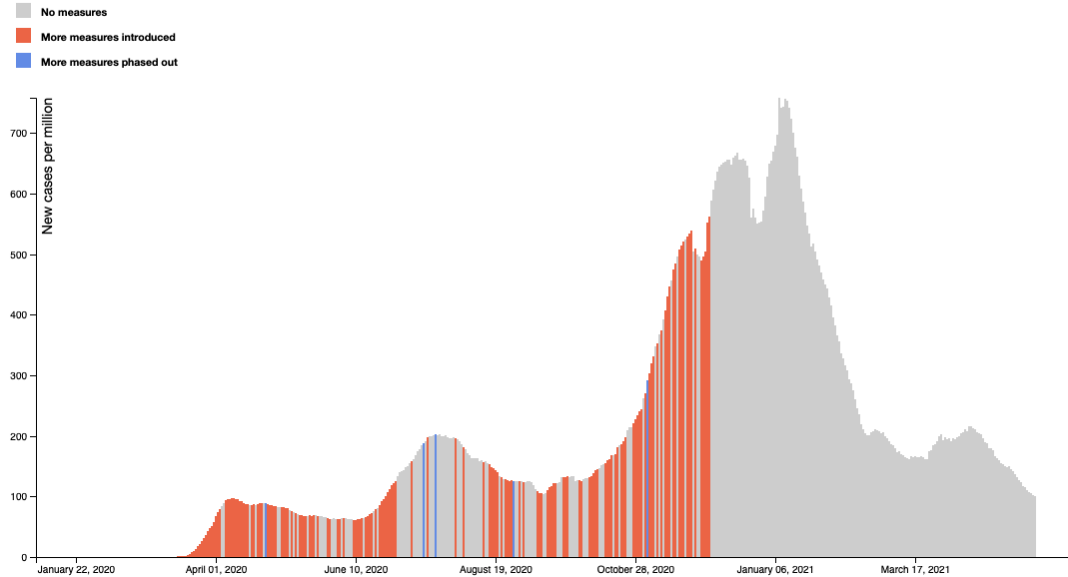


Figure 3: The bar plot visualizing COVID-19 cases and measures over time.

December 03, 2020: 6 introduced, 0 phased out

Figure 4: The tooltip that appears when hovering over a bar.

COVID-19 statistic

- ☒ Cases ☐ Deaths
☐ Hospitalizations

Figure 5: The COVID-19 Statistic Selector filter.

Measure categories

- ☒ Governance and socio-economic measures ☒ Public health measures
☒ Movement restrictions ☒ Social distancing

Figure 6: The Measure Categories Selector filter.

Measure search

[Clear](#)

Figure 7: The Measure Search filter.

bar. While the user is hovering over it, the bar changes color slightly, so the user clearly knows which bar they are choosing. They can then click the bar to see even more details about these measures, as well as hyperlinks to the original information source. These design decisions were all made in order to allow users to explore the data at any level of depth, without presenting an overwhelming amount of information immediately.

The page also has three filters: a COVID-19 statistic selector, a measure categories selector, and a measure search.

COVID-19 Statistic Selector This filter, located above the plot, allows a user to choose which statistic is visualized as the grey outline on the plot (see Fig. 5). The user can choose between cases, deaths, and hospitalizations (where this data is available). Whenever this filter is updated, the plot smoothly transitions to the new data with an animation, which was a deliberate design decision to provide a pleasant user experience.

Measure Categories Selector This filter, located beside the COVID-19 statistic selector, allows users to choose which measure categories are shown on the plot (see Fig. 6). The available options sometimes change depending on the categories with policies for the given country. Since the information can be dense for countries with a lot of data, this enables users to simplify the plot and quickly find their intended information. So the user can clearly see which bars change, there is no animation when this filter changes.

Measure Search This search bar, located beside the measure categories selector, enables users to search for specific queries within all measures (see Fig. 6). The user can type any query, and the bar plot changes to only display measures that contain the string in their name, category, or description. The decision was made to automatically update the plot as the user types to prevent any unnecessary steps.

4 RESULTS

Ultimately, incorporating all of these techniques, our system produces two major visualizations. The first is a world map, showing a user-selected COVID-19 statistic within a filterable date range. The second is a country-specific bar chart, displaying a variety of categories of government measures, overlaid on a user-chosen COVID-19 statistic. The variety of filters allows users to customize the visualizations, and additional interactions, such as tooltips, provide much-needed additional context. The clean design avoids overloading viewers with unnecessary tools and information, only presenting relevant functionality to achieve our application's goals.

A specific case study could involve a policymaker looking to explore the measures implemented by countries with high levels of deaths at the beginning of the pandemic. On the first page, after switching the date range slider to roughly the first third of the pandemic and toggling the statistic to "Deaths," the user sees that

Belgium had many deaths during this time. Hovering over the country, the tooltip informs them that Belgium implemented 234 measures, and they click on it to explore further. They then filter the measure categories to only show lockdowns, and see that Belgium implemented two major lockdowns: one during the first wave on April 15, 2020, and another during the second on November 2, 2020. Shortly after the lockdowns, cases began to decrease, potentially indicating the effectiveness of these measures.

5 DISCUSSION

Our work helps our intended audience – primarily policymakers – to learn about COVID-19 measures implemented by governments worldwide throughout the pandemic. Users can explore the data at different levels of depth, from a world view to specific days in countries' COVID-19 response. They can learn about the number and type of measures implemented around the world and can investigate the specific timing of these measures' introduction and phasing out. Our tool provides the functionalities needed to discover such new insights. With previous solutions, there was no clear and intuitive way to explore COVID-19 cases, deaths, and measures together. With our visualization, the user is able to quickly discover connections between all of this information, using COVID-19 statistics as a basis for their government measures investigation.

We also ran an informal user study to evaluate our system under real circumstances. Three separate users tested the visualizations and provided specific thoughts on the system. Overall, they found the included functionalities extremely useful. The users really appreciated the two-page setup, highlighting that it was helpful to initially browse on a world map with COVID-19 statistics, and then click on individual countries to find out more information. The available actions were clear, and they easily discovered how to use the filters and interactions on the pages. For example, one user deliberately narrowed the date range on the most recent few weeks, and another filtered the measures to specifically look for lockdowns. The users also appreciated the overall simplicity of the layout, indicating that adding too much more functionality or information could start to be overwhelming. They expressed a desire to see more types of data, though, such as state-level information and vaccine development. Even though, unfortunately, this was out of scope for the project due to dataset limitations, it would certainly be a good addition in the future.

6 FUTURE WORK

There are several specific extensions to our system that could be implemented in the future.

1. **Additional data sources:** Users desired more types of data in the visualizations, including state-level granular information and statistics on vaccine development. Including more granular data could help personalize the experience for users looking to explore their specific area. Adding more statistics, such as on vaccines, could further contextualize the information. Due to limitations in our datasets, we were not able to include these features, but including more data sources in the future would be a useful improvement.
2. **More chart interactions:** We include a number of interactions on our visualizations for users, including tooltips and clicking. However, further additions, such as zooming and panning on the map and bar chart, could help users explore the data in more detail. Though this was out of scope for this version, as we prioritized more critical features, this would be a great addition to further enhance the user experience.
3. **More entry points:** Currently, in order to switch to a different country, the user has to go back to the map first. A future

improvement could be to include a searchable country dropdown directly on the country page, allowing the user to bypass the map if they choose. The current implementation's scope did not include such a feature, but it could be helpful as an additional refinement in the future.

ACKNOWLEDGMENTS

I wish to thank Professor Satyanarayan and the 6.859 TAs for providing the relevant instruction for this work, as well as supporting me throughout the process. I would also like to thank the 6.859 students for their insightful and helpful feedback to help refine this project.