PROCESS BOOK

EARTHQUAKES UNEARTHED

50 years of earthquakes at a glance

Introduction

Our Team

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Abstract

This report presents a data visualization project focused on global earthquake patterns. Our aim was to create an engaging tool for both scientific and non-scientific audiences, providing an in-depth understanding of seismic activities. The earthquake dataset was chosen due to its unique patterns and potential unpredictability, highlighting that even lesser magnitude earthquakes can cause significant damage, particularly in countries lacking robust disaster response and prevention measures.

Our visualization uses geographical coordinates in the earthquake dataset to depict a comprehensive view of global seismic activities, emphasizing the ubiquity and varied magnitudes of these events. The tool incorporates interactive features like sliders, clickable elements, and animations, allowing users to explore specific earthquake details, distribution over time, and country-specific impacts.

To reinforce the real-life implications of earthquakes, we included descriptions and images of the two largest seismic events in our dataset. The project's overall goal is to enhance awareness of seismic activity worldwide and emphasize the importance of effective disaster response and prevention.

Project Journey

Initially, we sought a substantial dataset comprising geographical data that would enable us to discern patterns through our visualization. We contemplated utilizing a dataset delineating meat consumption by country; however, we elected to use an earthquake dataset. The rationale behind this decision was that instead of attributes associated with a country, the earthquake dataset offers attributes correlated with coordinates, which could subsequently be associated with a particular country. This feature provided us with more flexibility in devising innovative visualizations.

Our investigation revealed that our visualization could potentially enhance earthquake awareness. Earthquakes are conventionally conceived as data points on a map, but we endeavoured to exceed this superficial understanding. Our visualization accentuates the ubiquity of earthquakes worldwide, highlighting that the magnitude of these seismic events varies widely. While the most devastating earthquakes receive extensive coverage in the media, there are countless quakes with a magnitude of 5.5 that escape public attention. These lesser, yet still significant seismic events can cause considerable damage to buildings, particularly in countries where the infrastructure is not designed to withstand such forces. Furthermore, these countries often lack the necessary resources for effective disaster response and prevention, including the construction of earthquake-resistant buildings.

We selected the earthquake dataset over other potential datasets due to the intriguing patterns observed within the seismic activity. Earthquakes primarily occur near the boundaries of tectonic plates, and their magnitude can be unpredictable. High-magnitude earthquakes can trigger subsequent disasters, such as tsunamis in coastal regions and avalanches in mountainous areas, resulting in extensive destruction. Although patterns can be discerned in the location and magnitude of earthquakes, outliers exist, and their unpredictability often results in the most destructive outcomes.

Throughout our design process, we sought to engage a broad audience, encompassing both scientists and individuals without a scientific background, to maximize the impact of our visualization. We endeavoured to make our earthquake visualization as interactive as possible, enabling individuals with limited scientific knowledge to develop an intuitive understanding of seismic patterns. We believe that this interactive approach not only appeals to a wider audience but also enhances the educational value of the visualization.

We incorporated a number of features to augment the interactive nature of our visualization. For instance, we included sliders at the bottom of the initial map, enabling viewers to observe seismic patterns over time. Users can click on individual earthquakes to view details about the magnitude, location, and specific date of the event. We animated the appearance and disappearance of earthquakes as the user adjusts the slider, creating a sense of fluidity. A graph of the total earthquake distribution over time was included to facilitate the identification of periods with particularly high seismic activity.

In our visualization, we also sought to demonstrate the disproportionate impact of earthquakes on different countries. Users can click on individual countries to view a distribution of the number of earthquakes per year for that location. Our data visualization further illustrates that the distribution of earthquake magnitudes varies over time and differs between countries. On the fourth page of our visualization, we selected the countries with the highest number of earthquakes in our dataset to enhance the interest in the ridge chart. A timeline beneath the graph allows users to modify the year of the magnitude distribution for the displayed country, and an animation illustrates the change in magnitude distribution over time.

Finally, we aimed to convey that earthquakes are more than mere data points on a graph; they are harbingers of devastation and suffering. We incorporated brief descriptions and images of the two largest earthquakes in our dataset to underscore the havoc wrought by these natural disasters.

Challenges and Decisions

Datasets without explicit geographical location

One significant challenge revolved around the use of a dataset that only contained geographical coordinates with no explicit country information. To overcome this issue, we leveraged the geographical libraries to convert the lat-long coordinates to their corresponding country names. Although this wasn't a design-related problem, it influenced the design by adding an extra layer of complexity and processing. It made us consider performance implications, especially with large datasets, and thus the need to optimize our data processing and rendering code became evident.

Range slider library

Regarding the range slider, we faced several challenges. The chosen library, DataDrivenRangeSlider, provided a robust starting point, but it lacked certain features that we deemed essential for our use case. For instance, it did not support initial values, which meant that we couldn't set a predefined time range when the page loaded. Also, the library didn't provide labels on the range, making it difficult for users to understand the selected time frame.
To address the slider's limitations, we made a couple of design decisions. First, we added an additional function getSliderValues to calculate the minimum and maximum years in our dataset, which we used to simulate an initial value setup. We also used these values to dynamically update HTML elements #time-map-year-min and #time-map-year-max to serve as labels for our range slider. This helped users understand the time frame they were looking at.

Performance issues when rendering the points of the first map

When attempting to remove data points from our first visualizations in d3 using the enter() and exit().remove() functions, we encountered an issue where the points were not being removed properly. The problem arose because there were a large number of points in the visualization. We tried removing all the points at once, but, consequently, the visualization was unresponsive, rendering it completely unusable.

To address this challenge, we decided to prioritize performance over precision. Our goal was to create a website that offered a smooth user experience, allowing users to fully appreciate the visualization. Instead of removing all the points at once, we opted for a tradeoff between performance and precision. By implementing a more optimized approach, we were able to maintain a fluid and responsive website while still ensuring a satisfactory visualization experience for users.

Finding dark theme tiles

Two of our visualizations rely on a map as the underlying framework, and for that purpose, we needed access to map tiles. Initially, we began implementing the design using tiles from OpenStreetMap, which is an open-source option. As we progressed with refining our design, we made the decision to use a dark theme on our website. However, we encountered challenges in finding free available dark theme tiles. Most of the options we came across either required a subscription or imposed limitations on the number of requests allowed.

In response to this, we made a design decision to apply a CSS filter to the tiles, inverting all the colours. Although it was not our original intention, the result of the visual appearance was aesthetically pleasing and aligned with our desired design objectives. While this solution deviated from our initial plan, it successfully fulfilled the design criteria for a dark-themed website.

Transition in d3 on plots containing multiple paths

We encountered some challenges when trying to add a transition animation between two states of the density plot. In the documentation, there were examples and explanations for animating a density plot with one line, but we had trouble finding how to achieve this with multiple lines on one plot. After looking at the documentation for the ridgeline plot we figured out that we had to add a class attribute to be able to select only the line and not the whole plot. We were then able to make a smooth transition between two states of the plot which can be changed by moving the slider to select a different year.

Changing from a sunburst area diagram to a density plot

In our third visualization, our initial plan was to create a sunburst diagram that would showcase the mean and maximum magnitudes of earthquakes for each country. However, when we looked at the data values, we realized that the variation in these values was not substantial enough to make the sunburst area diagram meaningful. We made the decision to not use this type of plot and instead opted for a density plot as our visualization method.

These solutions, though effective, added a layer of complexity to our implementation. But we believed that they were necessary to achieve a better user experience and make our visualization more intuitive and informative. Despite the challenges, our experiences allowed us to understand the need for a flexible design strategy that can adapt to unexpected issues and constraints.

Iterative Refinement

First sketch

Initially, our plan was to incorporate three different visualizations into a single map in order to present various types of information about the dataset. These visualizations included a map displaying locations, a choropleth map, and a heat map. We believed that condensing our design onto one page would be advantageous because it would help users maintain focus on the visualizations while minimizing distractions. However, during the implementation phase, we encountered a challenge in guiding users through the visualizations effectively. We realized that the experience and narrative of the design would vary for each user, potentially leading to the loss of important information. Moreover, our intention was to allow users to explore the data at their own pace. To achieve this, we made the decision to incorporate interactivity into our visualizations. For example, we implemented a slider that enables users to control the display of earthquake locations on the initial map by selecting a specific year. This approach empowers users to discover and engage with the data in a more personalized and interactive manner.

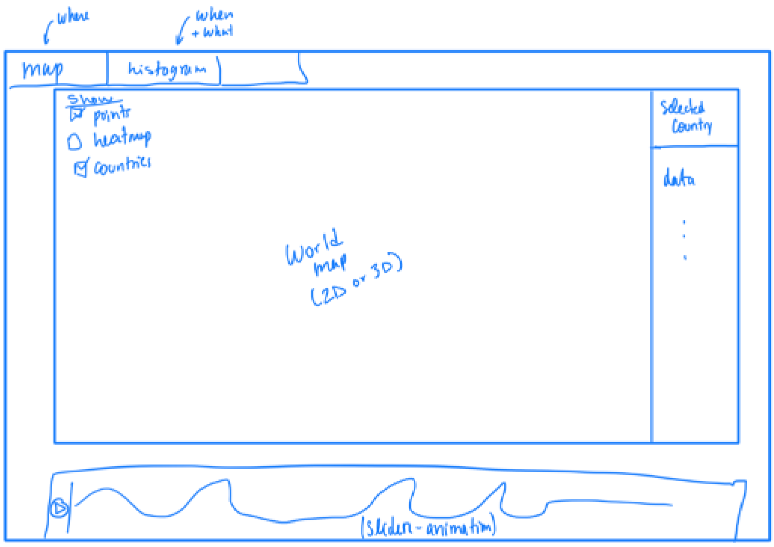

Fig. 1: Initial design of the website

Final design

The main modification between our original design and the final design involved separating the visualizations into distinct entities. This change enabled us to guide the user through a progression from a general view of the dataset to a more specific and focused view. Throughout this process, we remained committed to incorporating a significant amount of interactivity within the visualizations. One notable enhancement was made to the slider functionality of the first map. Instead of selecting a single year, we upgraded it to allow users to select a range of months and years. This improvement enables more comprehensive comparisons of the data within the dataset. Additionally, we introduced a histogram that displays the total number of earthquakes during the selected time period, providing users with an overview of the dataset's earthquake frequency.

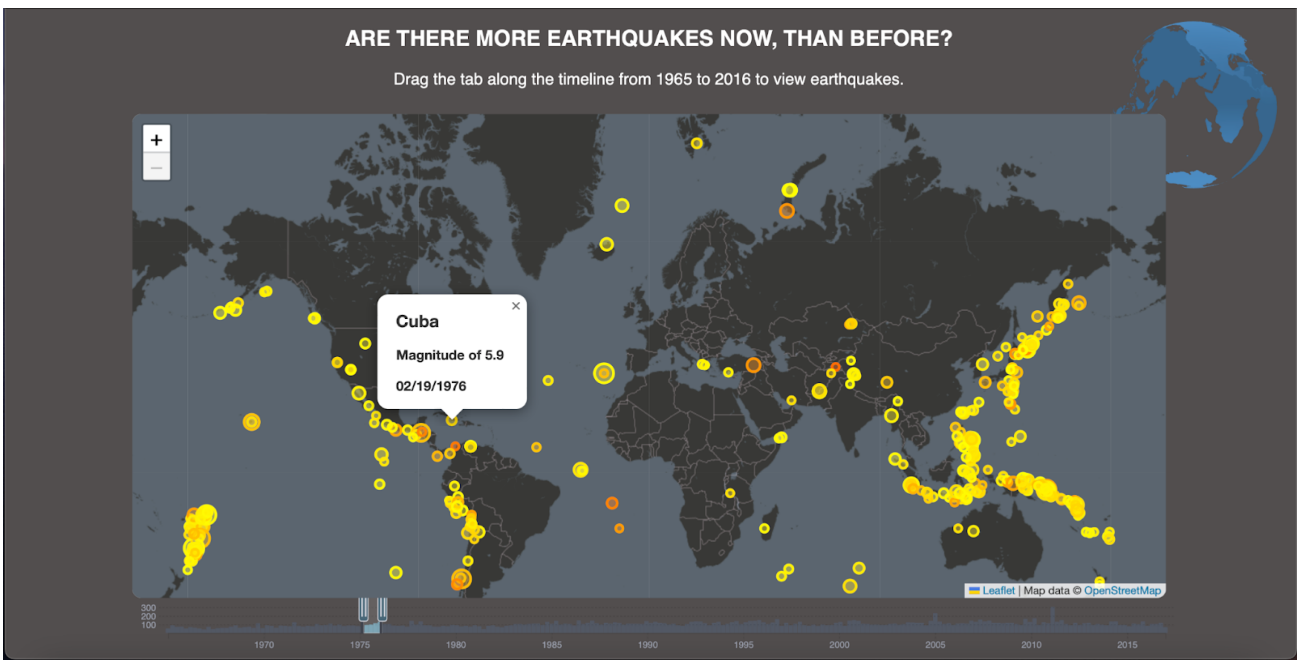

Fig 2. : Final design of the website (Visualization 1)

Another modification we made was transforming the third design from a heatmap to a density plot showcasing the magnitudes of countries with the highest occurrences of earthquakes over time. We believed this change would be more effective in conveying information.

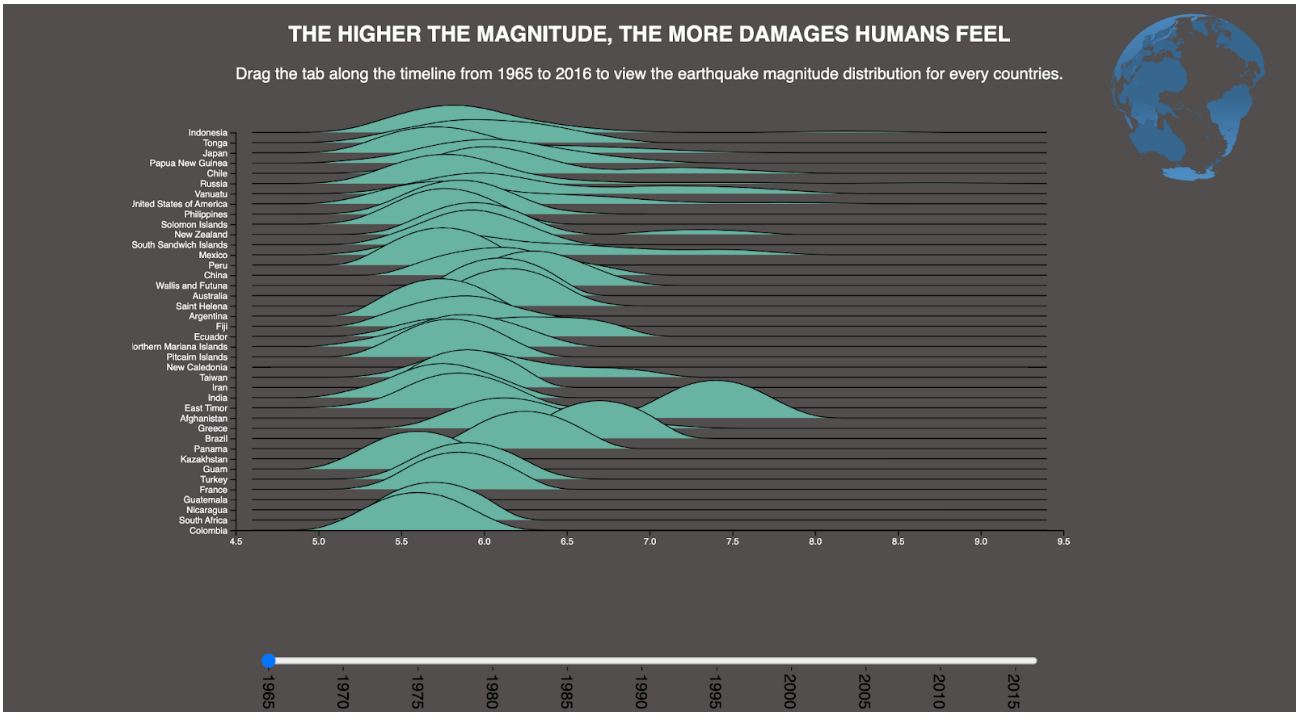

Fig 3. : Final design of the website (Visualization 3)

Overall, by refining the design and incorporating these changes, we aimed to enhance the user's experience and provide them with more insightful ways to interact with and understand the dataset.

Peer assessment

All members of the project team made valuable contributions to the overall success of the project. The work was divided in a way that leveraged each member's unique experience and strengths, ensuring that all team members were able to contribute their best to the project.

Julie-Anne worked on the processing of the data by updating the countries' names in the dataset to match the ones in the geojson. She used a python script that updates the dataset file by mapping the names to the wanted format. She also worked on transforming the data into a json file grouping the data by year and then by country. This was helpful for the performance of the application.

She made a basic prototype of the website's design based on the thoughts of all the members of the group to have a global view of the project. For the first visualization, she worked on the tooltip information that is displayed when clicking on a point in the map. For the second visualization, she implemented the superposition of the choropleth map, with the ability to interact with the map by clicking on the countries. She implemented the density plot feature of the 3rd visualization and a working slider. The slider's design was later refined by Olivier.

Olivier worked on the preprocessing of the data by mapping each coordinate point to a country. He used a python script to update the dataset with the addition of the country attribute of each earthquake. This preprocessing was useful for the second map of the number of earthquakes per year per country.

He also worked on the slider of the first map and improved the performance when changing the range value. He animated the ridge chart when the year slider value changes. He later worked on the pages describing the biggest earthquakes of our dataset.

An worked on the preliminary implementation of the slider, and his main contribution is in the writing/video deliverables. He wrote the script and filmed the screencast. For the final report, he is in charge of, writing, editing, proofreading and designing, adding visual flair to the process book.