M5 Final Document

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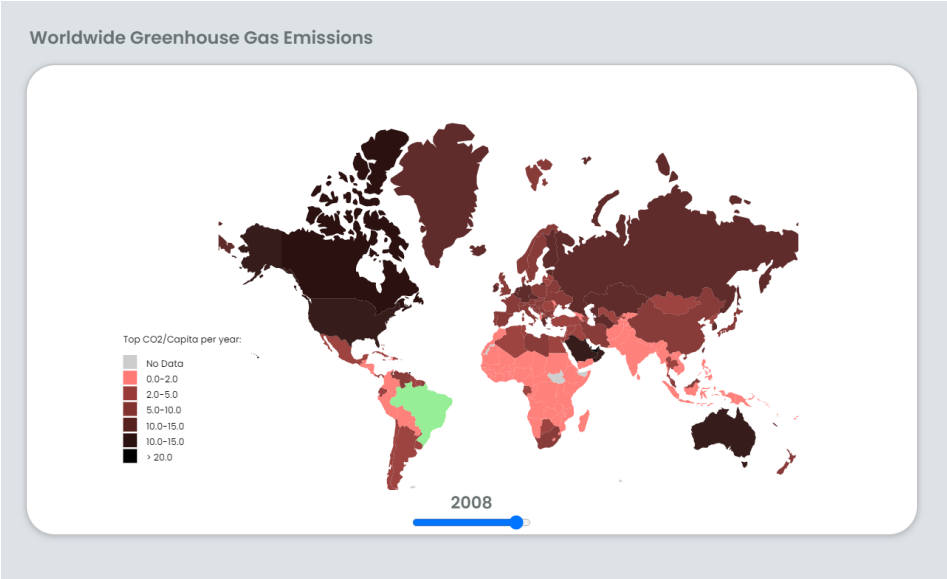
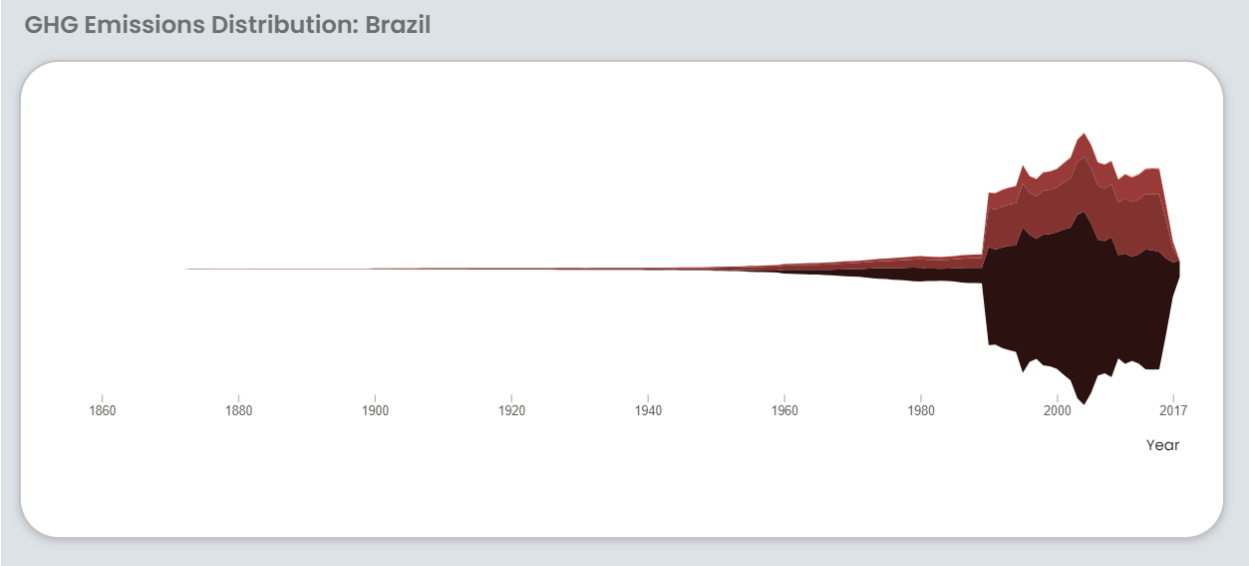
Summary of Dataset Characteristics

The dataset we used for this visualization was extracted from Kaggle. The data includes 174 variables that range from the years 1850 to 2018, country, sector, gas, unit, and source. The set had 217 entries. The sectors included agriculture, bunker field, energy, industrial processes, land-use change/forestry, and waste. For the earlier years and smaller countries, many of the data entries had null values. This made the processing and visualizing of the data difficult because with certain countries we did not have enough data to populate our charts and graphs.

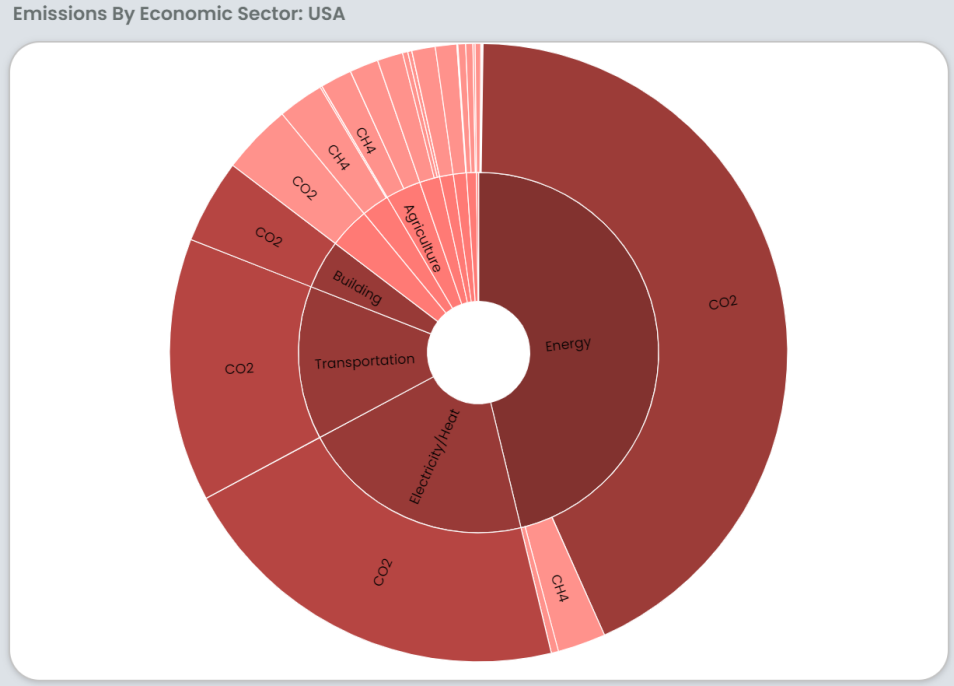
Images of the Visualization:



This is the dynamic map that shows the worldwide greenhouse gas emissions per country. We focused on Carbon dioxide (CO2) since it makes up the vast majority of greenhouse gas emissions. The slider was added to animate GHG emissions per country from 1900 to 2016. The country selected in green populates the two visualizations beneath it.



This is the streamgraph that represents the quantity of each greenhouse gas from 1850 to 2018 for the specified country. Each stream, differentiated by color, represents a different greenhouse gas, and the changing height of each stream encodes the quality for that year.



This is the sunburst diagram that breaks down a country's greenhouse gas emissions for a select year. The inner circle represents the specific sector and the outer circle is the type of greenhouse gas that that sector emits. When the user hovers over any of the specific areas of the visualization, more details about the sector/greenhouse gas emitted by that sector show up below the diagram.

Group Member Contributions:

Anna:

- Sunburst Diagram

Amin:

- World Map

Christina:

- Stream Graph Chart

We all worked together to piece the visualizations into the final static html page.

Discussion/Reflection:

Some interesting questions came up for our team about this visualization. We wondered if we should've combined our dataset with newer data in order to provide the most relevant information about climate change. This is a global issue that increases in severity every year; adding more recent years to the visuals could be a future addition.

Implementation mostly went according to plan. The map visualization had to use a different dataset as there was not enough data in our original dataset to populate it. Additionally, the sunburst diagram stayed about the same from the initial design. We lost a little bit of interaction with the sunburst diagram because there weren't as many levels in the data that would've justified further interaction. The design did diverge with our Stream Graph Chart. Initially it was going to be a visualization that would've required some more intense and expansive D3 knowledge. Instead of creating the scatterplot visual of the density of certain molecules, we decided to represent the density over time for specific countries with the stream graph.

The only substantial roadblocks were the preprocessing of data that each of us had to do for our parts. Luckily we planned ahead for this, so our data was preprocessed well before the visualization had to be presented.

The team worked well together. We all pulled our weight and we each were able to produce working visualizations.We understood that most of us were relatively new and unfamiliar with D3. In order to prepare for the presentation, we worked together to combine each of our parts. Overall, as a team we communicated and produced work we are proud of.

Introduction: compelling motivation for the project. What problem or deficit does your project address?

Climate change and greenhouse gas emissions have been consistent and increasingly concerning issues facing society. As a society, we can only understand to a certain limit our impact on the environment, but we do know certain actions produce chemicals and gases that contribute to the overall rising of global temperatures and increase of sea levels. These gas are called greenhouse gases. As an overview of their impact, GHGs created a greenhouse effect for the globe. They create a boundary in our outermost layers of the ozone that allows heat to enter our atmosphere but does not allow it to leave, causing an imbalance. This imbalance contributes to the overall heat increase globally. Moreover, we understand the actions that cause and contribute to greenhouse production, like the burning of fossil fuels such as gas and coal. However, a lot of the blame has been put on individual people and their individualized actions when a majority of GHG emissions are coming from larger industries and corporations. The goal of our project and visualization is to allow people to better understand the large contributors to GHG emissions. Throughout the visualization, we allow users to explore how different industries, sectors, and countries contribute to the global emissions rates with a focus on one of the most prominent and easily reducible GHGs benign carbon dioxide. Additionally, this visualization is novel as the past works have highlighted GHG emissions by country or by sector but have not shown the intersection of these two aspects of the data. We found this essential to show because it explains how different countries' economic contributions and their industry have developed over time and how it has influenced their overall emissions.

Related Work: starting with your draft from Milestone 2, augmented with any additional related work you may have since identified.

Climate change and greenhouse gas emission have been very explored and heavily researched topics. Because of this, there exist many visualizations that attempt to share information related to certain aspects of the issue to highlight specific information to the user. However many of these visualizations are static or provide one layer of information. There are a handful of interactive visualizations that we found that have inspired and influenced our tool or have provided a novel outlook on their data. Climate Data UShas a climate condition interactive visualization that shows the changes and anticipated changes in temperature or precipitation in the United States from 1950 to 2090. Through this visualization, they highlight the uncertainty that the future holds for these estimates by accompanying the tool with a static visualization of predictions with their uncertainties for different models. We modeled our map

visualization from Climate Data US as it allowed users to take in order data around each year and witness the progression of populators over time through color. NASA's Climate Time Machine has a map visualization of the globe that features the change of levels over the years for the sea ice level, sea level, carbon dioxide levels, and global temperature. World Resources Institute published an interactive chart that displays changes in the world's top 10 countries by emission in 2020. They provide the data in a sunburst graph that highlights the top 10 contributors and a breakdown of the sectors for each of the countries. The hierarchical structure of the sunburst visual and the click for more detail inspired our sunburst visualization in which we focus on one country and expose the different greenhouse gases being produced in each economic sector. The remaining past works we reviewed were literature and papers that explained some of the major trends in greenhouse gas emissions or further educated us on how we should go about visualizing the data. In Thomas Nocke et al. paper entitled "Visualisation of Climate and Climate Change Data: An Overview", they shared the results of a questionnaire done by climate impact researchers around standard visualization techniques, tools, and systems as well as alternate approaches to better define how climate change data should be expressed to support the needs of possible users. From this paper, we considered the impact and use of interactivity in this visualization as well as the movement and change in data from the actions of the users.

System: starting with the images and system description from the group's document, expand the writing as if you were describing the system features and implementation in a paper. Image(s) of your interface, captioned or annotated to describe the visual representation and interaction design

The interface has three interconnected components. The first component is the map. The world map highlights each county's individual contribution of carbon dioxide per capita. The countries with darker colors have a larger contribution. COuntries that are grey don't have enough data to be visualized. The key on the lower left of the visualization describes the range of colors. On the bottom of the visualization is a slider. The slider controls what year the world map visualizes. The years range from 1900 to 2016. If a user clicks on a certain country, that country's data populates the other two components of the interface. The next component is the stream graph. The stream graph shows the breakdown between the different greenhouse gases for each stream and highlights the quantitative change in that specific greenhouse gas over the time range from 1850 to 2018. If you hover over a certain stream and at a year, in the top left-hand corner the year, gas, and quantity is MtCO2 units will appear. Additionally, the full stream for the greenhouse gas will be highlighted as the other streams will reduce in opacity. The third component is the sunburst graph. This graph displays the hierarchical relationships and components of the economic

sectors and greenhouse gas make up for the chosen country and year. When a user hovers over the innermost layer, which is at the top of the hierarchy, being the economic sector, they will see the percent out of total emissions that that sector produces. In the outermost circle, each sector has a breakdown of the composition of greenhouse gases. When you hover over one of the segments, it shows the quantity of that greenhouse gas for the specific sector, country, and year in MtC02.

Conclusion: a short paragraph summarizing what you built and why it's relevant.

The data visualization our team has built will help make energy decisions and account for GHG reductions. It is relevant because it will improve the precision and accuracy of GHG reporting and provide a more informed project decision-making.