### **Overview and Motivation**

The production of meat products—especially beef—is one of the largest contributing factors to global climate change. Meat production requires deforestation, and cows and other ruminant animals emit the harmful greenhouse gas methane as part of their digestive process. Dietary habits vary based on several cultural and economic factors, so meat consumption looks very different from one country to another. Additionally, different types of meat products have varying carbon footprints. We want to explore which areas of the world are committed towards decreasing meat consumption and lowering greenhouse emissions whether it is by decreasing meat consumption all together or decreasing the most harmful type of meat and increasing the least harmful type of meat. Because of the various cultural and economic factors that affect meat consumption habits across the globe, there is no “one-size-fits-all” solution to the environmental issues presented by meat production. However, taking a look at the data will help us identify the countries and regions making the greatest progress towards a more sustainable model of meat consumption and consider what the rest of the world can learn from their example. Additionally, identifying which countries are trending in the wrong direction away from sustainability will enable us to better understand the most problematic countries and better direct solutions to suit the needs of the people in these countries.

### **Related Work**

Formula 1 is a motorsport that travels all over the world for eight months out of the year to race at different venues and tracks. They travel and transport hundreds of individuals and over 20 cars, paddocks, pit crews, ect. I listen to a podcast following Formula 1 called Paddock Project which had a segment about sustainability in F1. Recently, on their race programs, they have discussed using analytics along with their partnered logistics company, DHL, to reduce the environmental impact of traveling all over the world to race. We thought that it was a great cause and implementation to use visualizations and analytics to find places where they can reduce greenhouse emissions. One of the biggest greenhouse emissions producers are agriculture and livestock. The motivation for this dashboard directly reflects the need to reduce greenhouse emissions from meat. The meat consumption habits dataset allows for us to draw insights into possible solutions and places where meat consumption can be reduced or the meat type consumption percentage can shift to have less environmental impact.

### **Questions**

One of the main questions we are trying to answer is what is the breakdown of meat consumption types that are consumed. What is the percentage of meat types consumed? This is an important question to be answered as meat type vastly influences the amount of greenhouse emissions. Additionally, we wanted to answer the question of how the type of meat consumption (kg\_cal) changes over time. This allows us to determine if we are trending in the right direction of consuming meats that have less of an environmental impact. Furthermore, we want to compare the meat consumption (kg\_cal) of countries around the world. We are then able to see which countries are ahead of the curve and others that need more resources to help them reduce meat consumption. Our questions have evolved to focus on what influences the environment impact the most. At the beginning of the project we were focused on questions like ““What is the median and spread of meat consumption per person worldwide?” and “What is the most consumed type of meat in each country in a given year?”. We found that these questions did not relate back or help us solve our goal: reducing greenhouse emissions caused by meat consumption. We had to pivot our questions and ask: How does this question and result help us reduce environmental impact? We found the most influential questions to be answered to influence our goal are the percentage of meat type consumed, trending meat consumption (by type) over time to determine the direction we are headed, and which countries have the most and least consumed meat per capita.

### **Data**

The data source is found on Kaggle detailing global meat consumption habits by

country and by year beginning in 1991 and extending to projected data up to 2026. The data was originally published by the Organization for Economic Co-operation and Development. At the time the dataset was published, the empirical data included years 1991 - 2020 and the projected data was the years 2021 - 2026. The items here will be countries, specifically a country in a given year. The attributes are the country’s consumption habits for meat products, which includes a breakdown for the kind of meat product: beef, pig, poultry, and sheep. The attribute ‘location’ describes the name of the region that consumes the meat product. There are forty-eight unique locations in the data. The twenty-eight European Union countries are grouped together as ‘EU28’and therefore cannot be distinguished from each other. Additionally, the ‘BRICS’ location represents the five countries in the BRICS organization in 2020: Brazil, Russia, India, China, and South Africa. This is important to note as Brazil, China, Russia, and India all have their own separate location codes (RUS, BRA, CHN, IND) in addition to being included in the ‘BRICS’ location. The attribute ‘measure’ describes how the meat consumption was measured: either in kilograms per capita (kg\_cap) of retail weight or in thousand tons of carcass weight (thnd\_tonne). The location ‘WLD’ represents the entire world. The location ‘OECD’ represents the 38 member countries in the Organization for Economic Co-operation and Development. The attribute ‘value’ describes the amount of meat the country has consumed. The attribute ‘subject’ describes the type of meat consumed: beef, pig, poultry, and sheep. Note that seafood is not included. The ‘value’ attribute provides a numeric value representing the meat consumption in a given country in the units specified in the ‘subject’ column. To clean up this data, we had to work around the location attributes including summary values. For example the location ‘world’ is an aggregated value of all countries and should not be included on visuals comparing countries. Additionally, the ‘world’ location should not show up on the map visual as not every country in the world is represented and it gives an inaccurate representation of the data. For the goal of this visual, we had to omit data where the measure was not kg/capita. We want to lower greenhouse emissions caused by meat consumption per person. Comparing the total meat consumption of a small country to that of a large country isn’t meaningful for identifying areas for improvement because it doesn’t account for differences in population size.

**Exploratory Data Analysis**

To begin our analysis, we used basic visualizations such as bar charts and scatterplots to understand the distribution and relationships within the data. These initial plots helped us identify key patterns, including the dominance of poultry consumption globally and the relatively smaller shares of sheep and pig meat. Additionally, we plotted time-series data to observe trends in meat consumption per capita over the years, which revealed a gradual increase in overall consumption with notable fluctuations in certain regions. These insights informed the final design by emphasizing comparisons between meat categories and the temporal dimension of consumption patterns.

**Design Evolution**

During the design process, we explored various visualization types, including stacked bar charts, maps, and bubble plots. After evaluating these options, we chose a pie chart for its intuitive representation of proportions, a line graph for its ability to depict temporal trends clearly, and an interactive map to allow geographical exploration. These decisions were rooted in perceptual principles, such as the effectiveness of area-based comparisons in pie charts and the use of spatial dimensions in maps to encode regional data. While our initial proposal included these visualizations, we refined the designs based on feedback and usability testing. For example, we adjusted the map's color scheme to improve contrast and readability and added percentage labels to the pie chart to enhance clarity. These iterative refinements ensured the visualizations adhered to design principles, such as maximizing data-ink ratio and minimizing cognitive load for users.

### **Implementation**

The project utilized D3.js for creating these interactive and dynamic visualizations. The implementation process began with data preparation, where our team filtered and aggregated the dataset to calculate global and regional totals for relevant measures, such as kilograms per capita. This preprocessing ensured that the data was clean and ready for visualization. The team then implemented the three visualizations: the pie chart, line graph, and interactive map. The pie chart used rollup functions to calculate total consumption by meat type and displayed proportions with visually appealing color-coded sectors. The line graph plotted year-over-year changes in per capita meat consumption, highlighting trends across time. The interactive map integrated geographic data to render a world map, overlaying meat consumption data for each region to create an engaging user experience. The team divided responsibilities evenly, with each member contributing to data preparation, coding, and documentation, ensuring efficient collaboration and a high-quality final product.

**Evaluation**

Using the visualizations, we gained deeper insights into global meat consumption trends. Poultry emerged as the dominant meat category, accounting for over 42% of global consumption, likely due to its affordability and cultural acceptance. The line graph revealed a steady increase in per capita meat consumption over the years, reflecting changing dietary preferences and economic development. The map highlighted significant regional differences, showing how cultural and economic factors influence meat consumption patterns. The visualizations answered our key questions effectively, providing both high-level overviews and granular insights. While the visualizations performed well in terms of clarity and engagement, there is room for improvement. Future enhancements could include integrating additional datasets, such as environmental impact metrics or population density, and allowing for deeper drill-down functionality in the map. These improvements would further enrich the narrative and broaden the project’s scope