**Report**: *CO2 Output by State*

Motivation:

        With the media placing an increasing emphasis on global warming, carbon dioxide (CO_2) emissions has been a subject garnering a larger focus in recent years. The United States represents the largest CO_2 emissions output of any country in the world between 1970 and 2013 (EU EDGAR database). While the United States is a leader in CO_2 emissions, further exploration can be performed on a state level and by industry sectors. Additionally, as many reports show, the analysis can be conducted on a per capita level as well.

Tasks:

        Given a full dataset of CO_2 emissions within the United States from 1990 through 2010, the following inquiries arise: Which states have the largest annual CO_2 emissions? Is this consistent throughout the 21-year period? Which industry sectors account for the largest percentage of CO_2 emissions? Is this breakdown similar for every state?

Visualization:

        To effectively display the concept of ordered ranking of CO_2 emissions by state, the magnitude channels of size (length) and color hue are utilized on a common scale throughout multiple years in the following visualization:
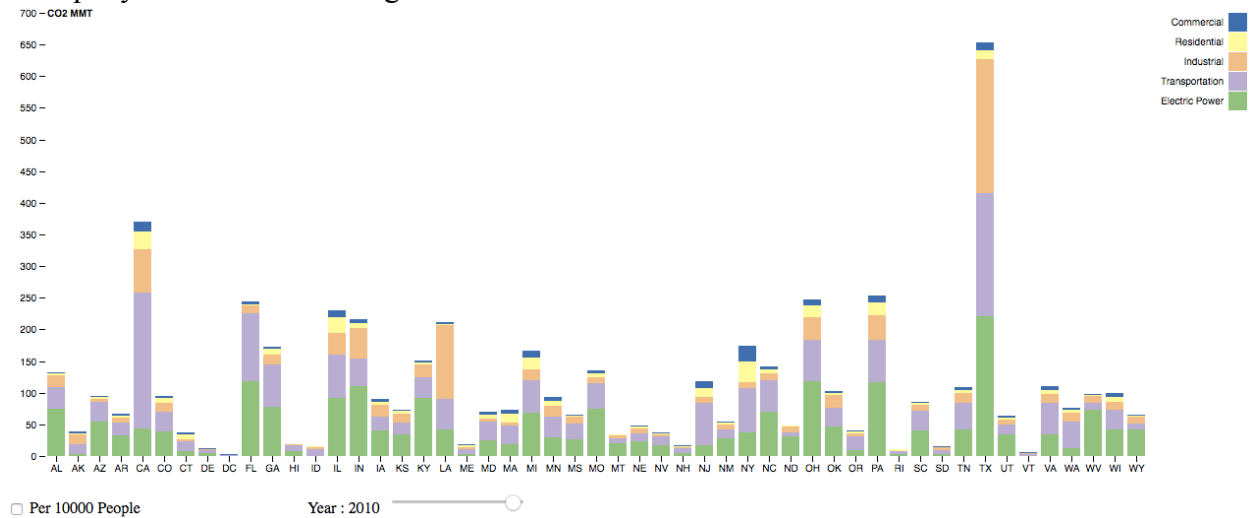

        The visualization is a stacked bar chart that displays the total CO_2 output for each state in a given year based on the total length of each bar. The slider below the chart enables the ability to adjust quickly for different years. The checkbox in the bottom left (unchecked by default) allows for a view of CO_2 emissions per capita, scaled to 10,000 people, for each state.

        Within the chart, each state is placed horizontally and sorted alphabetically by the state's two-letter abbreviation. The bars are placed on a common scale and the total length is used to express the CO_2 emissions. Within each stacked bar, there are five colors used to represent the CO_2 emissions for the five sectors provided by the dataset. The sectors are categorical and are represented with a qualitative scheme since it does not imply magnitude differences between the sectors. Using a qualitative scheme of five classes, colorbrewer2 serves as a useful tool for

determining the color hues for each category. The legend is located outside the edges of the chart to coordinate the colors with the sectors.

The interactivity of the slider in the chart allows for quick access to view changes in CO_2 emissions ranking and value by state throughout the years of 1990 to 2010. It shows the general trends of total CO_2 emissions throughout time, as well as if the ranking of states changes. While one of the aims is to identify the total CO_2 emissions by state, many sources feel as though reporting the emissions per capita would be a better representation of where the states truly rank relatively to each other. Thus, the check box labelled "Per 10,000 People" acts as a toggle to view the CO_2 emissions per capita, each state scaled to per 10,000 people. The scale adjusts accordingly to fit better the length of the bars. The changes in rank of the states per 10,000 people can be compared to the previous chart of total emissions by state:
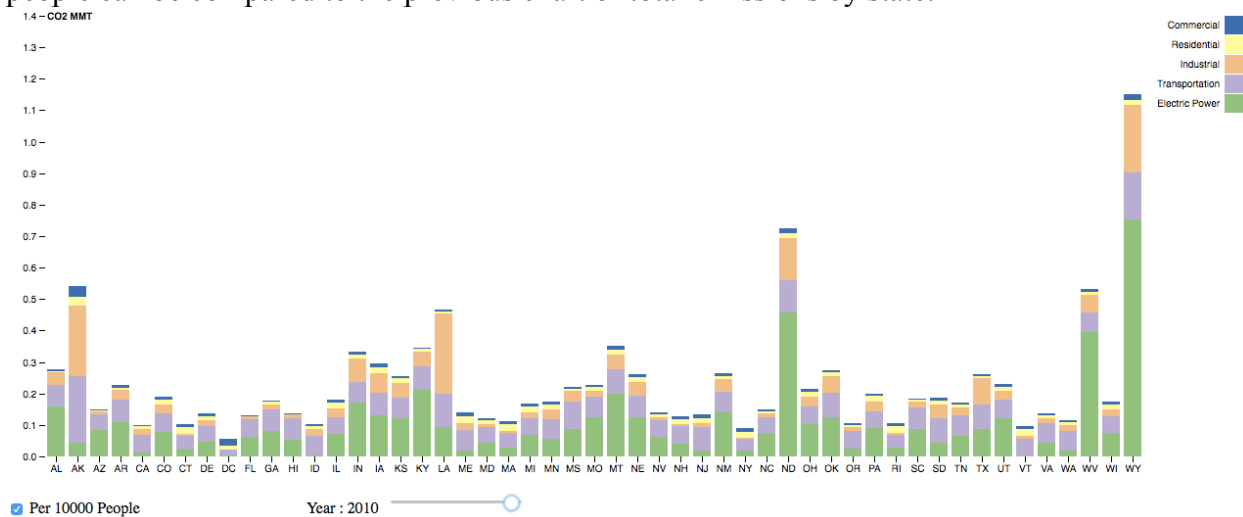
Omitted Data and Visualization:
          The data originally contained the full name of the states. For conciseness within the visualization, the state abbreviations are used. This requires knowledge of translating the abbreviations to the full state names to interpret the results properly. Location data of the states is provided, which could allow for the geographic mapping of where emissions are output. However, the primary aim of the visualization is to show the value and rank of CO_2 emission by state over the location of the emissions.

Improvements:
          There are potential improvements that could be added to the visualization to achieve additional goals. For example, while emissions by sector can be determined from the length of each color within the stacked bar, there is no functionality to view the value and rank of each sector individually or various sector combinations. Creating an interactive legend that could select/unselect sectors through clicking could accomplish that goal. Also, while the general value can be discovered from the stacked bar, the exact emissions by state is not displayed. Achieving this goal could be accomplished by adding an interactivity with hovering over the bars to show the full details of the state, which may include full state name, sector name, CO_2 emissions value, and rank out of 51.