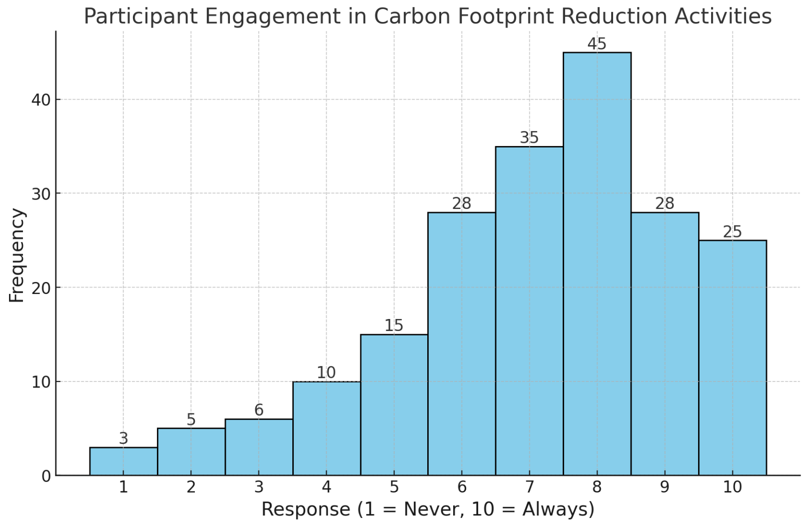
Assignment 3

This is the continuation of the sample statistical report from Assignment 2. Refer back to Assignment 2 if you want to look back at the previous content of this statistical report. Identify the statistical fallacies as discussed in class lecture, and explain how they could have been corrected. Upload a single PDF to canvas before the deadline.

Evaluating Public Understanding of Climate Change Part 2:

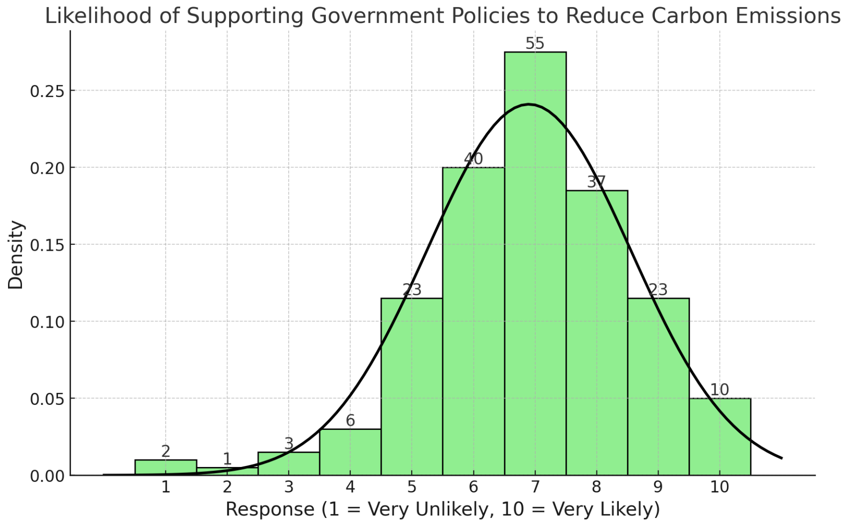
We start the second part of our analysis by examining the response to our survey question "On a scale of 1 to 10 with 1 being the lowest and 10 being the highest, how often do you take steps to reduce your carbon footprint, like recycling or using public transportation?" The participants answer any scale between 1 and 10, including decimal numbers. The results of the responses from the participants is summarized in the histogram below.



We can notice from the histogram that is clearly a right skew in the distribution of public participation in carbon footprint reduction activities.

- The calculated mean response was 6.47 which suggests that, on average, participants engage in carbon footprint reduction activities somewhat frequently, but not always.
- Similarly, the standard deviation was calculated to be 2.35 which suggests a fairly wide spread of responses as seen in histogram.
- This indicates variability in how participants approach reducing their carbon footprint—while some may be highly engaged, others may only take these actions occasionally or rarely.
- Thus we can conclude that there is a moderate level of carbon footprint reduction engagement among the participants, but there is also variability in how often participants engage in these actions.

Finally, we will analyze the last survey question "Given that climate change is a serious threat to our planet, how likely are you to support government policies that reduce carbon emissions, even if it means higher taxes? (Response on a scale of 1-10 as above)". The result of the responses from the participants is summarized in the following histogram.



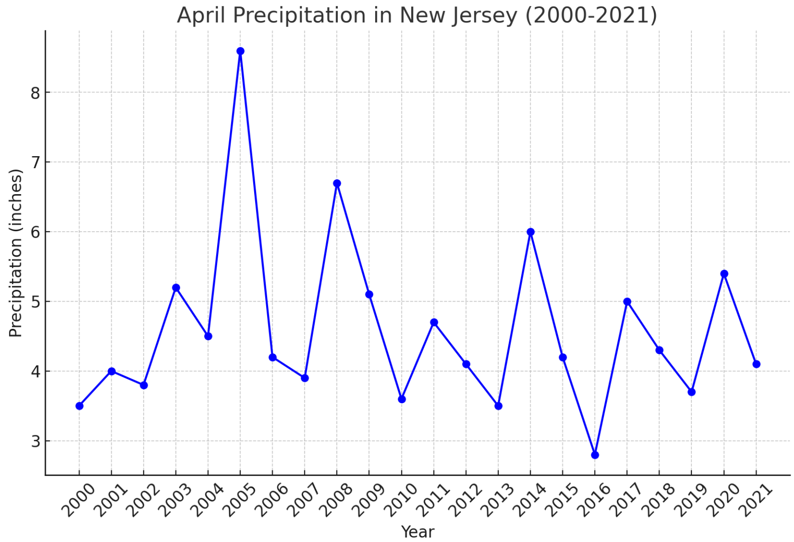
As we can see from the histogram above, that the responses are symmetrical. Hence, we will assume that the responses are normally distributed.

- The mean response was calculated to be 6.9 which suggests that, on average, participants are fairly likely to support government policies that reduce carbon emissions, even if it means higher taxes.
- Similarly, the standard deviation of 1.66 reflects a moderate spread around the mean, suggesting that while most participants tend to support these policies, there is a fair amount of variation in their level of support.

Since we have an approximately normal distribution, we can calculate the 25th percentile and 75th percentile from the dataset:

- The $z-$ score corresponding to 25th percentile is -0.64. The 25th percentile is then calculated as 25th Percentile $= 6.8 + (-0.674) \times 1.66 = 5.78$.
- Therefore we can conclude that only 25% of participants are likely to support government policies at a level below 5.78, suggesting that the vast majority are moderately to highly supportive.
- Similarly, the $z-$ score corresponding to $75th$ percentile is 0.674. The 75th percentile is then calculated as 75th Percentile $= 6.8 + (0.674) \times 1.66 = 8.01$
- Thus we can conclude that 75% of participants are likely to support government policies at a level below 8.01, indicating strong overall support among the participants.
- This result can be used by policy makers in New Jersey to help them in increasing taxes to reduce carbon emission.

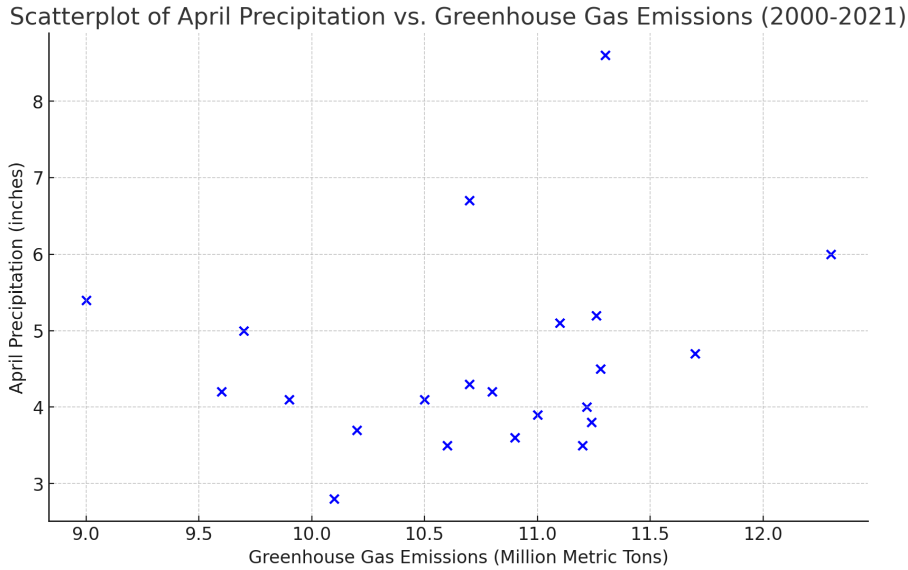
Case Study 1: For the final part of our research, it is essential to explore case studies that reveal how broader climate change trends manifest in specific local contexts. We'll begin by examining April precipitation patterns in New Jersey, one of the state's wettest months, over the period from 2000 to 2021. The line chart below shows the precipitation in April in New Jersey from 2000 to 2021.



- The median of April precipitation in New Jersey from 2000 to 2021 is calculated to be 4.2 inches and interquartile range (IQR) of 1.25 inches.
- This suggests that, in a typical year, New Jersey receives about 4.2 inches of rainfall in April and the variability is of 1.25 inches. The majority of years have rainfall amounts between approximately 3.07 and 5.32 inches.

To further explore the impact of climate change and its relationship to precipitation, we turn our attention to greenhouse gas (GHG) emissions from 2000 to 2021. New Jersey's statewide GHG emissions inventory includes estimates for carbon dioxide, methane, nitrous oxide, black carbon, and other high global warming potential gases. We specifically examine New Jersey's historical greenhouse gas emissions by the commercial sector, tracked in million metric tons.

- The data is available for 1990 and for 2005 to 2021, at the time of writing. Therefore, we performed linear interpolation to estimate the values for 2000 to 2004.
- The relationship between April precipitation in New Jersey (in inches) and greenhouse gas emissions (in million metric tons) from 200 to 2021 is illustrated in the scatterplot below.



As we can see from the scatterplot above, there appears to be a positive correlation between greenhouse gas emissions and April precipitation, suggesting that higher emissions may lead to increased rainfall.

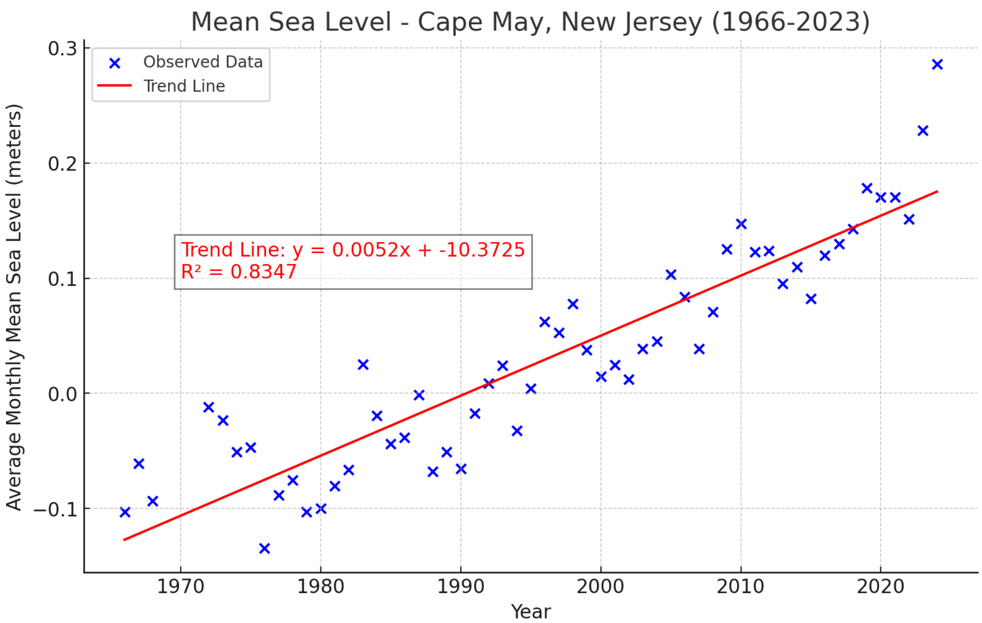
- The correlation coefficient is calculated as 0.21, indicating a positive correlation.
- The scatterplot illustrates that as greenhouse gas emissions increase, April precipitation also tends to increase, potentially highlighting an impact of emissions on New Jersey's climate patterns.

In 2020, GHG emissions were 9.00 million metric tons, and the April precipitation was 4.1 inches. This data point may appear as an outlier in the scatterplot.

- By omitting the 2020 data point, the correlation between greenhouse gas emissions and April precipitation increases to 0.34, further suggesting a strong positive correlation between GHG emissions and precipitation rates in New Jersey.
- Similarly, this analysis could imply a causal relationship between GHG emissions and precipitation rates in New Jersey. If New Jersey residents wish to avoid extreme precipitation and the risk of flooding, it might seem logical to argue that GHG emissions should be reduced.
- We can also infer that an increase in GHG emissions causes more precipitation in New Jersey, while reductions lead to less precipitation.

Case Study 2: As we conclude our exploration of climate change impacts in New Jersey, we turn to a critical and visible consequence: sea level rise. Cape May, NJ, known for its coastal beauty, faces an increasing threat from rising waters. To explore the pressing issue of rising sea levels, we collected the monthly mean sea levels (without the regular seasonal fluctuations from coastal ocean temperatures, salinity, wind, atmospheric pressure, and ocean currents) data in Cape May, New Jersey from National Oceanic and Atmospheric Administration (NOAA) managed by the U.S. Department of Commerce.

The data is available from December 1965 to present, but we will take the data from 1965 to 2023. We have averaged the monthly mean sea level data and use yearly mean sea levels in our analysis. The linear regression between Mean Sea Level - Cape May, New Jersey (1966-2023) and year is shown in the figure below.



The explanatory variable is the average monthly mean sea level, and the response variable is the Year. The trend line is calculated as:

$$y = -10.3725 + 0.0052x$$
$$\text{Monthly Mean Sea Level (MSL)} = -10.3725 + 0.0052 \times \text{Year}.$$

The R^2 value is 0.7262, indicating that $1 - 0.7262 = 0.2738 = 27.38\%$ of the sea level variability is not accounted for by the linear model, making it a strong predictor of future sea levels in Cape May, New Jersey.
To illustrate the working of the linear regression equation, we can calculate the monthly sea level in June 2014:

$$\begin{aligned}\text{Monthly Mean Sea Level (MSL)} &= -10.3725 + 0.0052 \times \text{Year} \\ &= -10.3725 + 0.0052 \times 2014.5 \\ &= 0.1029 \text{ meters.}\end{aligned}$$

The result of 0.1029 meters is congruent with observations from the graph.

Similarly, we can use this linear regression to make future predictions. For example, the mean sea level in 2035 can be calculated as:

$$\begin{aligned}\text{Monthly Mean Sea Level (MSL)} &= -10.3725 + 0.0052 \times \text{Year} \\ &= -10.3725 + 0.0052 \times 2035 \\ &= 0.2095 \text{ meters.}\end{aligned}$$

This is a significant rise in mean sea level compared to what it was at the start of the century, approximately 0.050 meters.

- The slope of 0.0052 suggests that sea levels are increasing at a consistent rate of 0.0052 meters every five years.
- This analysis clearly indicates that action is needed now to preserve the natural beauty of Cape May.

Conclusion: Public opinion and two case studies in this research project have revealed the clear ways in which climate change is impacting New Jersey, from shifting precipitation patterns to rising sea levels. As Leonardo DiCaprio said in his Oscar-winning speech, "Let us not take this planet for granted. I do not take tonight for granted."