Q5 [25 points] Choropleth Map of Wildlife Trafficking Incidents

Goal	Create a choropleth map in D3 to explore the number of wildlife trafficking incidents per country by year.
Technology	D3 Version 5 (included in the lib folder) Chrome v131.0.0 (or higher): the browser for grading your code Python http server (for local testing)
Allowed Libraries	D3 library is provided to you in the **lib** folder. You must **NOT** use any D3 libraries (d3*.js) other than the ones provided. On Gradescope, these libraries are provided for you in the auto-grading environment.
Deliverables	[Gradescope] `Q5.(html/js/css)`: Modified file(s) containing all html, javascript, and any css code required to produce the plot. Do not include the D3 libraries or csv files.

Choropleth maps are a very common visualization in which different geographic areas are colored based on the value of a variable for each geographic area. You have most probably seen choropleth maps showing quantities like unemployment rates for each county in the US, or COVID-related maps and data at the county level in the US.

We have provided two files in the Q5 folder, **wildlife_trafficking.csv** and **world_countries.json**.

- Each row in *wildlife_trafficking.csv* represents the number of wildlife trafficking incidents per country in a given year, in the form of `<Year,Country,Number of Incidents,Average Fine,Average Imprisonment>`, where
  - o `Year:` the year in which the wildlife trafficking incidents occurred
  - o `Country:` a country in the world, e.g., United States of America.
  - o `Number of Incidents:` the number of wildlife trafficking incidents that occurred in `Country` in `Year`.
  - o `Average Fine:` the average fine in USD for wildlife traffickers caught for incidents occurring in `Country` in `Year`.
  - o `Average Imprisonment:` the average imprisonment term in years for wildlife traffickers caught for incidents occurring in `Country` in `Year.`
- The *world_countries.json* file is a geoJSON, containing a single geometry collection: *countries*. You can find examples of map generation using geoJSON here.

1. **[20 points]** Create a choropleth map using the provided data and use Figure 5.1 and 5.2 as references.
   a. **[5 points]** Dropdown lists are commonly used on dashboards to filter data. Create a dropdown list to allow users to select which year's data is displayed.
      - The list options should be obtained from the `Year` column of the csv file.
      - Sort the list options in increasing order. Set the default display value to the first option.
      - Selecting a different year from the dropdown list should update both the choropleth map (see part 2) and the legend (see part 3) accordingly.

      Hint: If failing to load map, you may try this method.

   b. **[10 points]** Load the data from *wildlife_trafficking.csv* and create a choropleth map such that the color of each country in the map corresponds to the **number of wildlife trafficking incidents for the year selected in the dropdown** in each country. Use a "Natural Earth" projection of the geoJSON file. **You MUST name the function for calculating path as 'path', to help the auto-grader locate it**. Create a projection first and use it as an input for the path.

Promise.all() is provided within the skeleton code and you can use it to read in both the world json file and game data csv file. Usage example: Making a Map in D3.js v.5.

Many countries have no incidents for some years — these should be **colored gray**. For countries that do have incidents in the selected year, use a quantile scale to generate the color scheme based on the average rating by country. Color them along a gradient of exactly 4 gradations from a single hue, with darker colors corresponding to higher rating values and lighter colors corresponding to lower values (see gradient examples at Color Brewer).

About Scaling Colormaps: In order to create effective visualizations that highlight patterns of interest, it is important to carefully think about the relationship between the range and distribution of values being displayed (the domain) and the color scale the values are mapped to (the range). Many types of mapping functions are possible, e.g., we could use a linear mapping where the lowest incident count is mapped to the first value in the color scheme, the highest incident count is mapped to the highest value in the color scheme, and intermediate incident counts are mapped to hues in the middle. This article illustrates the value of choosing appropriate endpoints for linear color maps, or log-scaling the domain so that large but relatively infrequent values do not cause differences between smaller values to be washed out. In our case, we can compute quantiles of the domain data into roughly equally sized groups. Here, we will get 4 groups, a special case of quantiles called "quartiles" since the data are divided into quarters.

Hint: You can verify the correctness of the quartiles generated by using the 'quartile' function in Excel. Open wildlife_trafficking.csv and filter the data for one year (say 2021). Then use the quartile function to get the 0th, 1st, 2nd, 3rd and 4th quartile values from the Incident Count column. Here [0th quartile, 1st quartile), [1st quartile, 2nd quartile), [2nd quartile, 3rd quartile), [3rd quartile, 4th quartile] will represent the 4 groups of values generated by the d3 quantile scale. Use all the countries listed in wildlife_trafficking.csv to generate your quartiles depending on the selection, including ones which may not appear in the geoJSON.

c. **[5 points]** Add a **vertical** legend showing how colors map to the average rating for a particular game. The legend must update for the quartiles of the selected game, and display values formatted to show precision up to 2 decimal places. You must use **exactly 4** color gradations in your submission. It is recommended, but not required, to use d3-legend.min.js (in the **lib** folder) to create the legend for the scale you use. The legend bars should be **rectangular** in shape. Also, **display your GT username** (e.g., gburdell3) beneath the map.

2. **[5 points]** Add a tooltip using the d3-tip.min library (in the **lib** folder). On hovering over a country, the tooltip should show the following information on separate lines:
   - *Country* name
   - *Year*
   - *Number of Incidents* in that year in that country
   - *Average Fine* in USD for wildlife traffickers for incidents in that year in that country
   - *Average Imprisonment* in years for wildlife traffickers for incidents in that year in that country

For countries with no data, the tooltip should display "N/A" for *Number of Incidents*, *Average Fine*, and *Average Imprisonment.*

Note: The tooltip should appear when the **mouse** hovers over the country. Figure 5.2 demonstrates this for 2021. On mouseout, the tooltip should disappear. You can position the tooltip a small distance away from the **mouse cursor** (e.g., add margin to the tooltip via CSS) **and have it followed the cursor**, which will prevent the tooltip from "flickering" as you move the mouse around quickly (the tooltip disappears when your mouse leaves a state and enters the tooltip's bounding box). **You must prevent such "flickering"** because rapid appearance and disappearance prevent the autograder from detecting the tooltip's content (since the tooltip can no longer be found) and adversely affect the usability of your visualization in practice. Alternatively, you may position the tooltip at a location (picked by you) such that it is close to the country the cursor is currently at. Please ensure the tooltip is fully visible (i.e., not clipped, especially near the page edges). If the tooltip becomes clipped, you may lose points.

Note: Please ensure that you **only** have **a single tooltip element** defined in your code. You should not create new tooltip elements for different countries; rather, update the contents, position, and visibility of a single tooltip.
Note: You **must** create the tooltip by **only** using **d3-tip.min.js** in the **lib** folder.

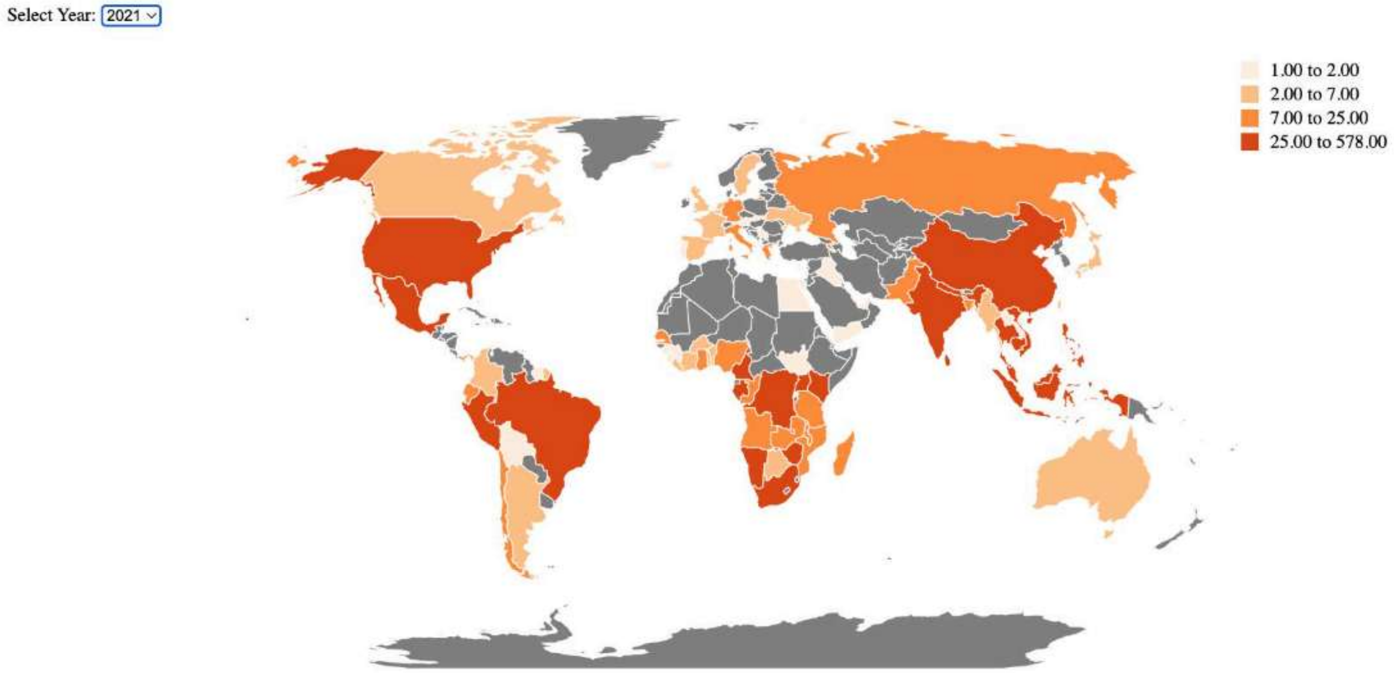
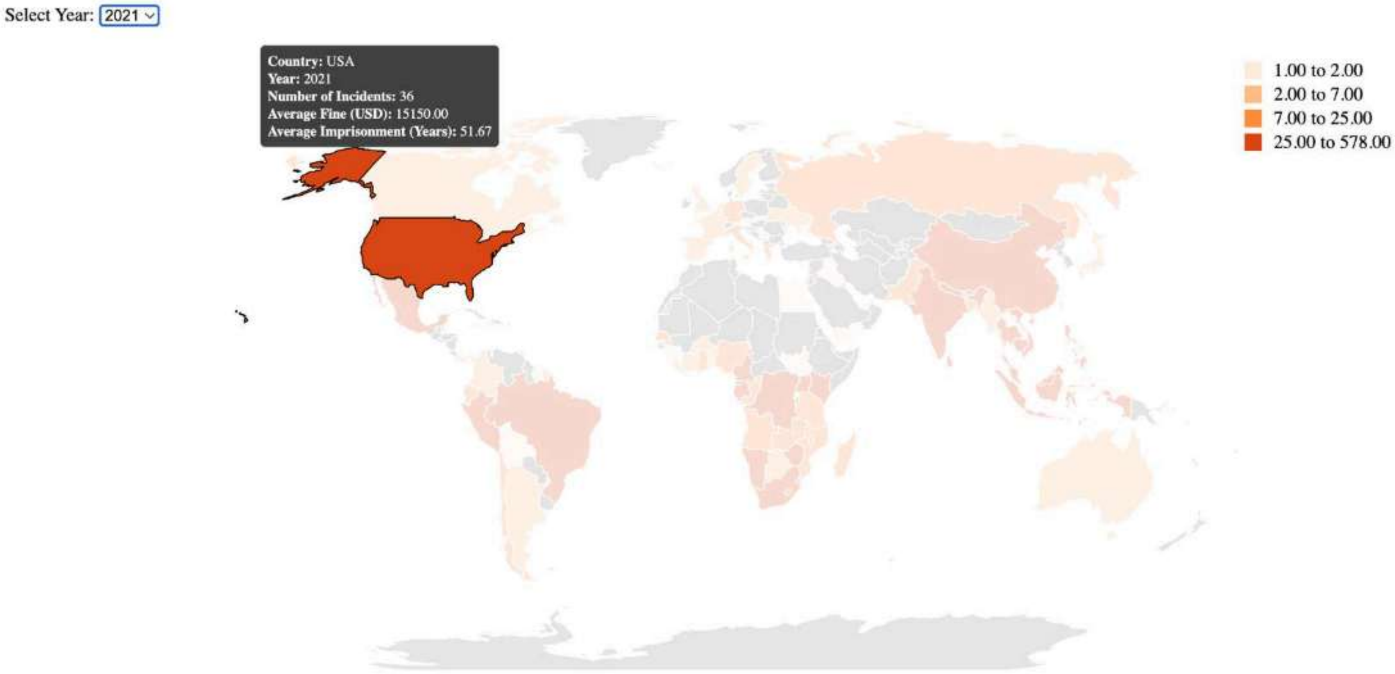


Figure 5.1: Reference example for Choropleth Map showing number of incidents in 2021. Your chart may appear different, but you will earn full credit as long as it meets all stated requirements.



Country: USA
Year: 2021
Number of Incidents: 36
Average Fine (USD): 15150.00
Average Imprisonment (Years): 51.67

Figure 5.2: Reference example for Choropleth Map showing tooltip for USA. Your chart may appear different, but you will earn full credit as long as it meets all stated requirements.

Hints

- Countries without data should be colored gray. These countries can be found using a condition that compares the country's average rating with 'undefined'.
- It is optional for your visualization to show (or not show) Antarctica.
- D3-tip warning may be ignored if it does not break the code.
- You may consider clearing the SVG and creating a new map when selecting a new game.

Note: You may change the given code in choropleth.html as necessary. Your D3 visualization **MUST** produce the following DOM structure.

```
<select id=”yearDropdown”> sorted list of year options
|
+-- <option> (one option for each year; value = year)
     |
     +-- text (= year)

<svg id=”choropleth”> contains choropleth map
|
+-- <g id="countries">
|    |
|    +-- <path>s for each country
|
+-- <g id=”legend”> legend

<div id=”tooltip”> contains tooltip to display (Q5.2)
|
+-- (text for tooltip)
```