Mini Project 1 - Shen Rothermel

```r
library(ggthemes)
library(htmltools)
library(leaflet)
library(maps)
library(sf)
library(tidyr)
library(tidyverse)
library(viridis)

# Load mapping data
us_states <- tibble(map_data("state"))
sf_states <- read_sf("https://rstudio.github.io/leaflet/json/us-states.geojson")
```

```r
# Column names for the variables of the us_emissions data set
us_emissions_col_names <- c("state", "year", "total_ghg_no_lucf", "total_ghg_with_lucf", "tot

# Read the emission levels data, tidying up as necessary
us_emissions <- read_csv("C:/Users/scrot/Documents/St. Olaf - Junior/Data Science II/SDS264_S

us_emissions
```

```
# A tibble: 1,508 x 23
   state  year total_ghg_no_lucf total_ghg_with_lucf total_co2_no_lucf total_ch4
   <chr> <dbl>             <dbl>               <dbl>             <dbl>     <dbl>
 1 Alab~  1990              142.                81.6              112.      23.7
 2 Alas~  1990              47.4                45.0              35.9      11.2
 3 Ariz~  1990              71.7                68.0              63.3      4.09
 4 Arka~  1990              72.0                24.8              52.2      9.56
 5 Cali~  1990              431.                363.              369.      35.8
 6 Colo~  1990              87.4                91.7              65.9      13.7
 7 Conn~  1990              44.3                38.1              41.2      1.68
```

```
 8 Dela~  1990           19.4              18.9              17.9    0.450
 9 Dist~  1990            4.73              4.64              4.45    0.0798
10 Flor~  1990          213.              189.              190.     13.4
# i 1,498 more rows
# i 17 more variables: total_n2o <dbl>, total_f_gas <dbl>, energy <dbl>,
#   industrial_processes <dbl>, agriculture <dbl>, waste <dbl>, lucf <dbl>,
#   bunker_fuels <dbl>, electric_power <dbl>, commercial <dbl>,
#   residential <dbl>, industrial <dbl>, transportation <dbl>,
#   fugitive_emissions <dbl>, state_gdp <dbl>, population <dbl>,
#   total_energy_use <dbl>
```

```
# Joins us_emissions data with polygon data for each state
joined <- us_emissions |>
    mutate(state = str_to_lower(state)) |>
    right_join(us_states,
                     by = join_by(state == region),
                     relationship = "many-to-many")
```

```
joined |>
    filter(year == 2018) |> # We want just data from the year 2018
    ggplot(aes(long, lat, group = group)) +
    geom_polygon(aes(fill = energy), color = "black") +
    scale_fill_viridis(option = "rocket", direction = -1) +
    labs(title = "Greenhouse Gas Emissions Due to Energy (2018)",
            fill = "Emissions (MtCO2e)",
            caption = "Data from Climate Watch - https://www.wri.org/data/climate-watch-us-s
    theme_map()
```

Greenhouse Gas Emissions Due to Energy (2018)

Emissions (MtCO2e)
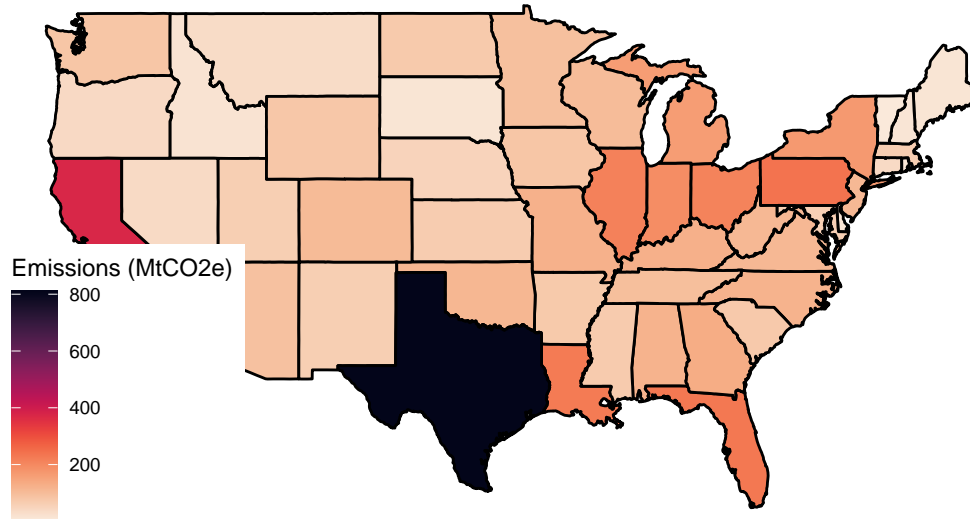
Data from Climate Watch – https://www.wri.org/data/climate–watch–us–states–greenhouse–gas–emissions
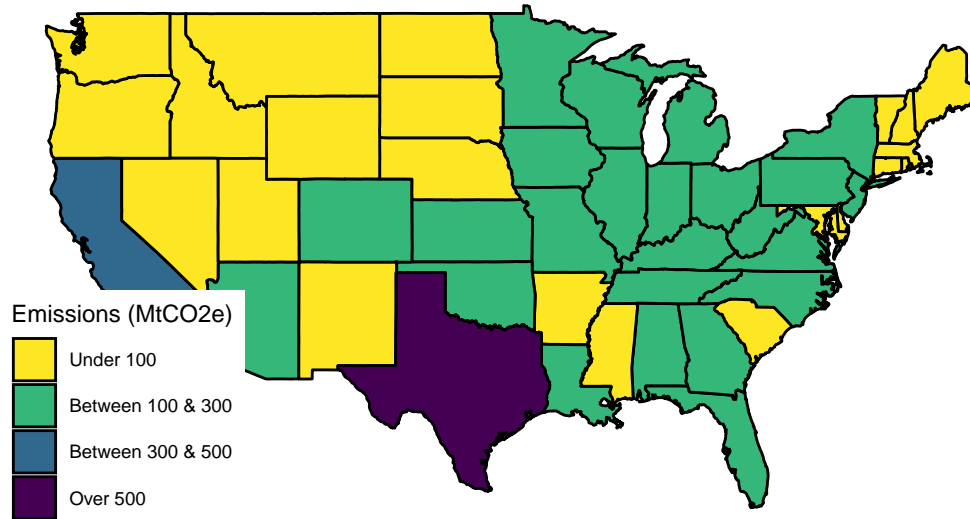MtCO2 = Metric tonnes of CO2 equivalent

Alt text (since I'm not sure if PDFs can be inspected to see the alt text in the element):

This is a map of the states of the United States of America. Each is colored to depict the state's emission levels from the energy sector, ranging from 0 to 800 metric tonnes of carbon dioxide equivalent. The colorings of the states suggest that most midwestern states have levels under 200, eastern states tend to be around 300 except for the far northeastern area. California stands out with its color, showing a level around 400, and Texas stands out the most with a level of around 800.

```
joined |>
    filter(year == 2018) |>
    mutate(ghg_bins = cut(total_ghg_no_lucf, # Converts continuous to discrete using bins
                                          breaks = c(-20, 100, 300, 500, 950),
                                          labels = c("Under 100",
                                                                "Between 100 & 300",
                                                                "Between 300 & 500", "Ov
    ggplot(aes(long, lat, group = group)) +
    geom_polygon(aes(fill = ghg_bins), color = "black") +
    scale_fill_viridis_d(direction = -1) +
    labs(title = "Total Greenhouse Gas Emissions in 2018 (without LUCF)",
              fill = "Emissions (MtCO2e)",
              caption = "Data from Climate Watch – https://www.wri.org/data/climate-watch-us-s
    theme_map()
```

Total Greenhouse Gas Emissions in 2018 (without LUCF)

Emissions (MtCO2e)

- Under 100
- Between 100 & 300
- Between 300 & 500
- Over 500

Data from Climate Watch – https://www.wri.org/data/climate–watch–us–states–greenhouse–gas–emissions
MtCO2 = Metric tonnes of CO2 equivalent

Alt text

This is a map of the states of the United States of America. Each has one of four colors to depict the state's total greenhouse gas emissions, not accounting for the land use sector. Yellow means under 100 metric tonnes of carbon dioxide equivalent, green means between 100 and 300, blue means between 300 and 500, and purple is over 500. Most midwestern states along with the northeastern states and a couple southeastern states are yellow. Most central states and a few southwestern states are green. California is the only blue state, and Texas is the only purple state.

Link to Github for code, including that for the interactive plots

https://github.com/Sloth186/SDS264_S25/tree/main/Mini%20Project%201

```
# Joins emissions data to mapping data for use in interactive map
joined_interactive <- us_emissions |>
    filter(year == 2018) |>
    right_join(sf_states, by = join_by(state == name)) |>
    filter(!(state %in% c("District of Columbia", "Puerto Rico"))) |>
    select(state, geometry, total_ghg_no_lucf, energy)


# Adds labels to each state to provide additional information when hovering over one
joined_energy_interactive <- joined_interactive |>
    mutate(energy_labels = str_c(state, ": ", energy, " MtCO2e"))
```
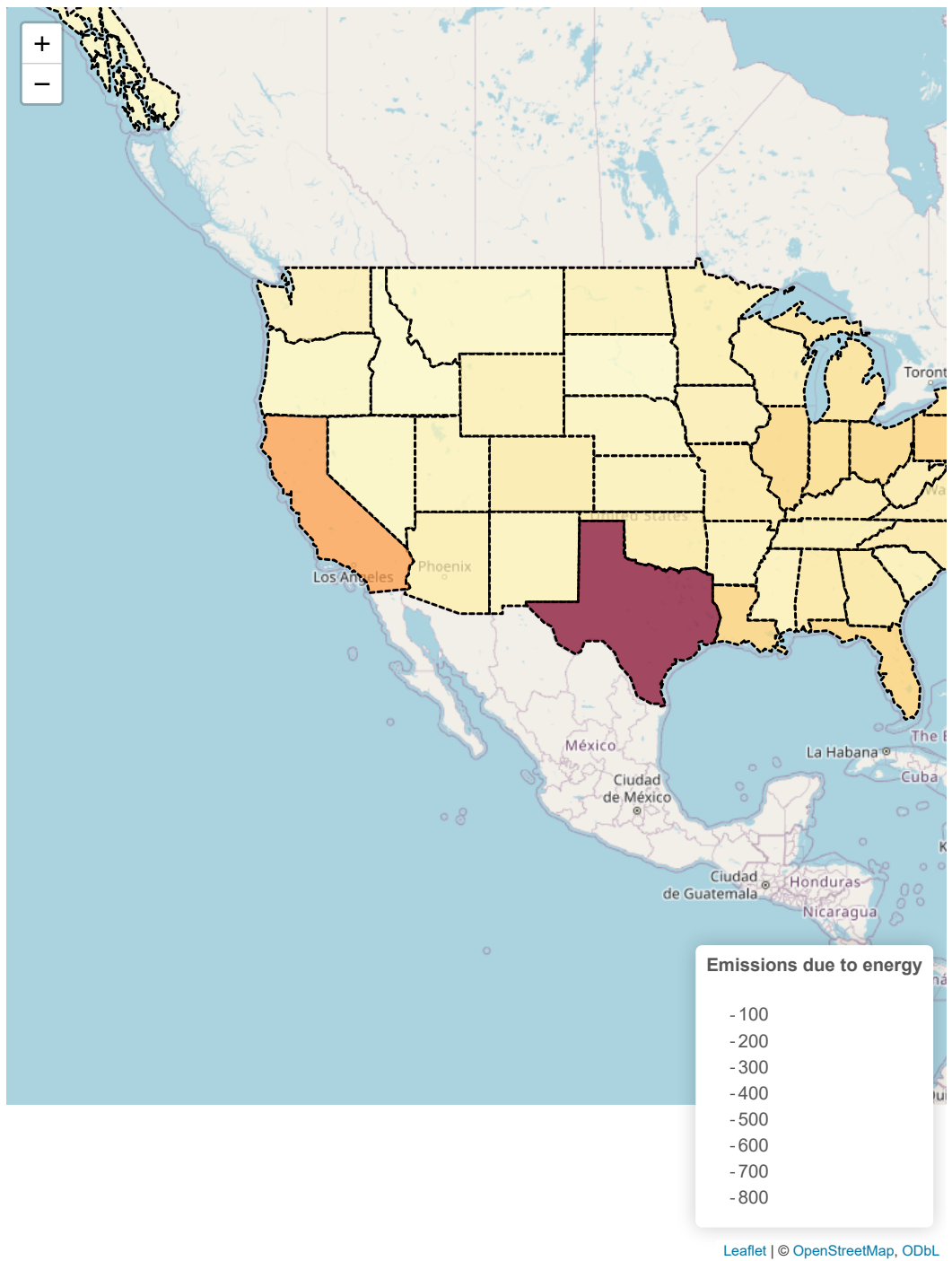
```r
# Turns labels into an HTML object
energy_labels <- lapply(joined_energy_interactive$energy_labels, HTML)

# Need to convert tibble back to an sf object so that geometry is recognized
leaflet(sf::st_as_sf(joined_energy_interactive)) |>
    setView(-96, 37.8, 4) |>
    addTiles() |>
    addPolygons(
        fillColor = ~colorNumeric("YlOrRd", energy)(energy), # Color scale
        weight = 2,
        opacity = 1,
        color = "black",
        dashArray = "3",
        fillOpacity = 0.7,
        highlightOptions = highlightOptions(
            weight = 5,
            color = "#666",
            dashArray = "",
            fillOpacity = 0.7,
            bringToFront = TRUE),
        label = energy_labels,
        labelOptions = labelOptions(
            style = list("font-weight" = "normal", padding = "3px 8pm"),
            textsize = "15px",
            direction = "auto")) |>
    addLegend(pal = colorNumeric("YlOrRd", joined_energy_interactive$energy), values = ~energ
```

Emissions due to energy

- 100
- 200
- 300
- 400
- 500
- 600
- 700
- 800

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```r
# Adds labels to each state to provide additional information when hovering over one
joined_total_interactive <- joined_interactive |>
    mutate(ghg_labels = str_c(state, ": ", total_ghg_no_lucf, " MtCO2e"))

# Turns labels into an HTML object
ghg_labels <- lapply(joined_total_interactive$ghg_labels, HTML)

# Creates bins to convert the continuous scale to a discrete scale
ghg_bins <- c(-1, 25, 50, 75, 125, 200, 275, 500, 925)
pal <- colorBin("YlOrRd", domain = joined_total_interactive$total_ghg_no_lucf, bins = ghg_bir

# Need to convert tibble back to an sf object so that geometry is recognized
leaflet(sf::st_as_sf(joined_total_interactive)) |>
    setView(-96, 37.8, 4) |>
    addTiles() |>
    addPolygons(
        fillColor = ~pal(total_ghg_no_lucf), # Color scale
        weight = 2,
        opacity = 1,
        color = "black",
        dashArray = "3",
        fillOpacity = 0.7,
        highlightOptions = highlightOptions(
            weight = 5,
            color = "#666",
            dashArray = "",
            fillOpacity = 0.7,
            bringToFront = TRUE),
        label = ghg_labels,
        labelOptions = labelOptions(
            style = list("font-weight" = "normal", padding = "3px 8pm"),
            textsize = "15px",
            direction = "auto")) |>
    addLegend(pal = pal, values = ~total_ghg_no_lucf, opacity = 0.7, title = "Total Greenhous
```

Total Greenhouse Gas Emissions (without LUCF)

-1 – 25
25 – 50
50 – 75
75 – 125
125 – 200
200 – 275
275 – 500
500 – 925

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