

Mini Project 1 - Shen Rothermel

```
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")
```

```
# 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", "total_co2_no_lucf", "total_co2_with_lucf", "total_ch4_no_lucf", "total_ch4_with_lucf")

# Read the emission levels data, tidying up as necessary
us_emissions <- read_csv("C:/Users/scrot/Documents/St. Olaf - Junior/Data Science II/SDS264_9/us_emissions.csv")

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
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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")

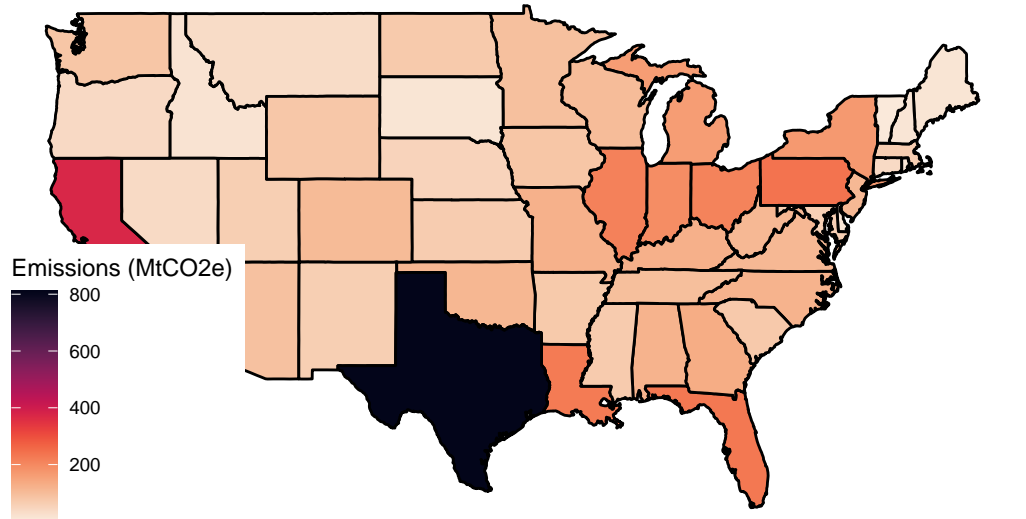
```

```

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-",
       theme_map()

```

Greenhouse Gas Emissions Due to Energy (2018)



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

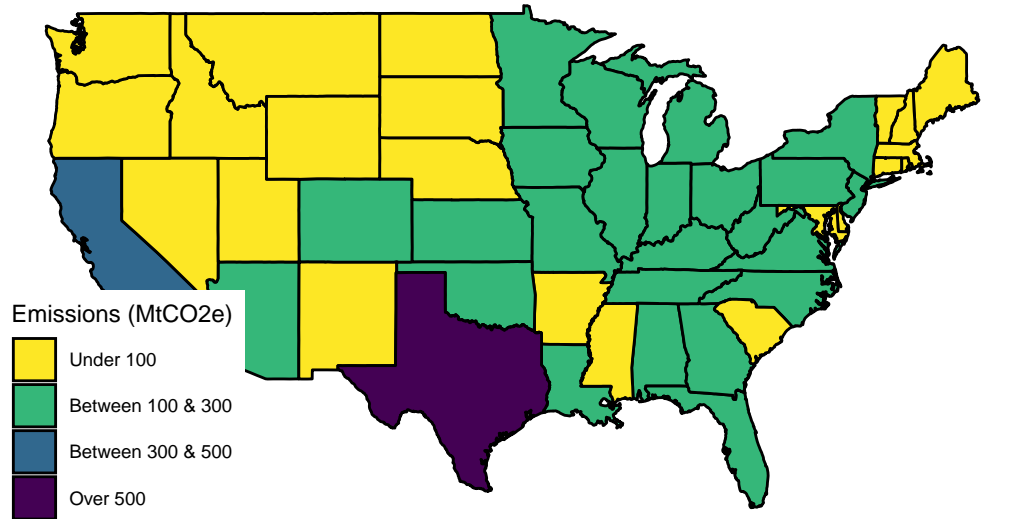
Alt text (since I'm not sure if PDFs can be inspected to see the alt text in the element):

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", "Over 500"))

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-states-greenhouse-gas-emissions")
  theme_map()
```

Total Greenhouse Gas Emissions in 2018 (without LUCF)



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.

```
# 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)
```

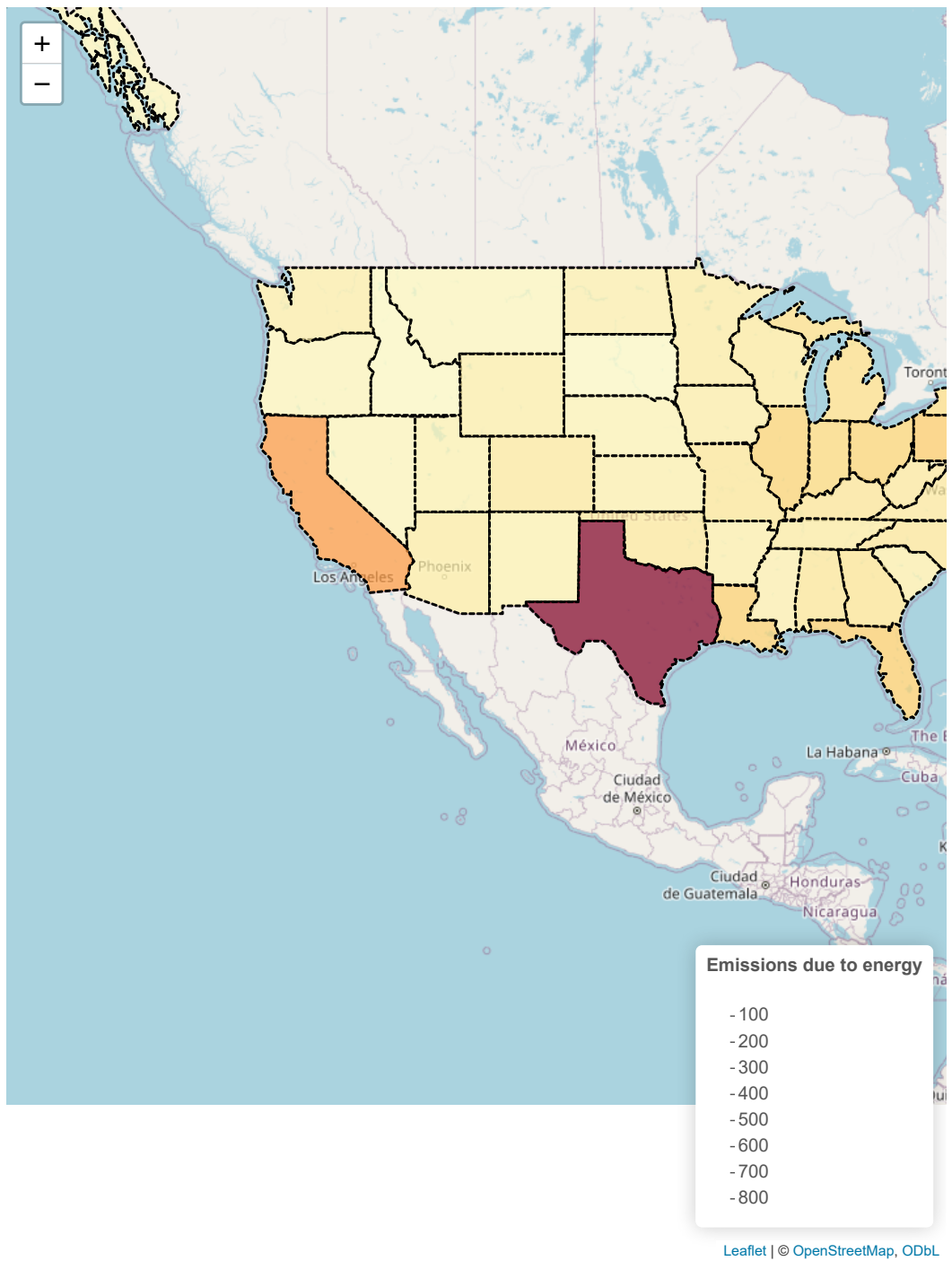
```
# Adds labels to each state to provide additional information when hovering over one
joined_energy_interactive <- joined_interactive |>
  mutate(energy_labels = str_c(state, ": ", energy, " MtCO2e"))

# 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 8px"),
      textsize = "15px",
      direction = "auto")) |>
  addLegend(pal = colorNumeric("YlOrRd", joined_energy_interactive$energy), values = ~energy)

```



```

# 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_bins)

# 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 8px"),
      textsize = "15px",
      direction = "auto")) |>
  addLegend(pal = pal, values = ~total_ghg_no_lucf, opacity = 0.7, title = "Total Greenhouse")

```

