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# Load packages -----

library(tidyverse)
library(ggplot2)
library(readxl)

# Load data -----

# Stations

stations <-
  read_csv('assignment5/alt_fuel_stations.csv') %>%

  # ON is a Canada state, exclude non-US states.

  filter(State != 'ON')

# EV registration

LDV_2021 <-
  read_excel('assignment5/2021_LDV_registration.xlsx')

LDV_2020 <-
  read_excel('assignment5/2020_LDV_registration.xlsx')

LDV_2019 <-
  read_excel('assignment5/2019_LDV_registration.xlsx')

LDV_2018 <-
  read_excel('assignment5/2018_LDV_registration.xlsx')

# State name and code

state <-
  read_csv('assignment5/state.csv') %>%
  select(-'abbrev') %>%
  rename('State' = 'state')

# Data wrangling -----

# 1. Repeat the process to generate the 'All_years' data frame as same as
# the first graph

# Electric vehicle supply equipment (EVSE, charging points) in 2021 by state

charger_2021 <-
  stations %>%
  filter(year(`Open Date`) < 2022) %>%
  filter(State != 'ON') %>%
  select(`Station Name`, `EV Level1 EVSE Num`, `EV Level2 EVSE Num`,
        `EV DC Fast Count`, State) %>%
  replace(is.na(.), 0) %>%

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mutate(EVSE = `EV Level1 EVSE Num` + `EV Level2 EVSE Num` +
        `EV DC Fast Count`) %>%
group_by(State) %>%
summarise(EVSE_state = sum(EVSE))

# the Plug-in Electric Vehicles in 2021 by state

PEV_2021 <-
  LDV_2021 %>%
  filter(State != 'United States') %>%
  mutate(PEV = `Electric (EV)` + `Plug-In Hybrid Electric (PHEV)`) %>%
  select(State, PEV)

# Merge the needed data for 2021

merge_2021 <-
  full_join(state, PEV_2021) %>%
  select(code, PEV) %>%
  rename(State = code) %>%
  full_join(charger_2021) %>%
  mutate(EV_per_charger = PEV / EVSE_state) %>%
  select(State, EV_per_charger) %>%
  mutate(year = 2021)

# Electric vehicle supply equipment (EVSE, charging points) in 2020 by state

charger_2020 <-
  stations %>%
  filter(year(`Open Date`) < 2021) %>%
  filter(State != 'ON') %>%
  select(`Station Name`, `EV Level1 EVSE Num`, `EV Level2 EVSE Num`,
        `EV DC Fast Count`, State) %>%
  replace(is.na(.), 0) %>%
  mutate(EVSE = `EV Level1 EVSE Num` + `EV Level2 EVSE Num` +
        `EV DC Fast Count`) %>%
  group_by(State) %>%
  summarise(EVSE_state = sum(EVSE))

# the Plug-in Electric Vehicles in 2020 by state

PEV_2020 <-
  LDV_2020 %>%
  filter(State != 'United States') %>%
  mutate(PEV = `Electric (EV)` + `Plug-In Hybrid Electric (PHEV)`) %>%
  select(State, PEV)

# Merge the needed data for 2020

merge_2020 <-
  full_join(state, PEV_2020) %>%
  select(code, PEV) %>%
  rename(State = code) %>%

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full_join(charger_2020) %>%
mutate(EV_per_charger = PEV / EVSE_state)%>%
select(State, EV_per_charger) %>%
mutate(year = 2020)

# Electric vehicle supply equipment (EVSE, charging points) in 2019 by state

charger_2019 <-
  stations %>%
  filter(year(`Open Date`) < 2020) %>%
  filter(State != 'ON') %>%
  select(`Station Name`, `EV Level1 EVSE Num`, `EV Level2 EVSE Num`,
        `EV DC Fast Count`, State) %>%
  replace(is.na(.), 0) %>%
  mutate(EVSE = `EV Level1 EVSE Num` + `EV Level2 EVSE Num` +
        `EV DC Fast Count`) %>%
  group_by(State) %>%
  summarise(EVSE_state = sum(EVSE))

# the Plug-in Electric Vehicles in 2019 by state

PEV_2019 <-
  LDV_2019 %>%
  filter(State != 'United States') %>%
  mutate(PEV = `Electric (EV)` + `Plug-In Hybrid Electric (PHEV)`) %>%
  select(State, PEV)

# Merge the needed data for 2019

merge_2019 <-
  full_join(state, PEV_2019) %>%
  select(code, PEV) %>%
  rename(State = code) %>%
  full_join(charger_2019) %>%
  mutate(EV_per_charger = PEV / EVSE_state)%>%
  select(State, EV_per_charger) %>%
  mutate(year = 2019)

# Electric vehicle supply equipment (EVSE, charging points) in 2018 by state

charger_2018 <-
  stations %>%
  filter(year(`Open Date`) < 2019) %>%
  filter(State != 'ON') %>%
  select(`Station Name`, `EV Level1 EVSE Num`, `EV Level2 EVSE Num`,
        `EV DC Fast Count`, State) %>%
  replace(is.na(.), 0) %>%
  mutate(EVSE = `EV Level1 EVSE Num` + `EV Level2 EVSE Num` +
        `EV DC Fast Count`) %>%
  group_by(State) %>%
  summarise(EVSE_state = sum(EVSE))

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# the Plug-in Electric Vehicles in 2018 by state

PEV_2018 <-
  LDV_2018 %>%
  filter(State != 'United States') %>%
  mutate(PEV = `Electric (EV)` + `Plug-In Hybrid Electric (PHEV)` ) %>%
  select(State, PEV)

# Merge the needed data for 2018

merge_2018 <-
  full_join(state, PEV_2018) %>%
  select(code, PEV) %>%
  rename(State = code) %>%
  full_join(charger_2018) %>%
  mutate(EV_per_charger = PEV / EVSE_state)%>%
  select(State, EV_per_charger) %>%
  mutate(year = 2018)

# Merge the data of different years

All_years <-
  rbind(merge_2018,
        merge_2019) %>%
  rbind(merge_2020) %>%
  rbind(merge_2021)

# 2. Minor adjustments

All_years_heat <-
  All_years %>%
  filter(!is.na(EV_per_charger))

# factorize the state vector

level <-
  All_years_heat %>%
  filter(year == 2021) %>%
  arrange(desc(EV_per_charger)) %>%
  pull(State)

All_years_heat$State <-
  factor(All_years_heat$State, levels = level)

# Reset the discrete intervals that suit heat map better

All_years_heat <-
  All_years_heat %>%
  mutate(EV_per_Charger =
    case_when(EV_per_charger <= 7 ~ '0 - 7',
              EV_per_charger <= 14 ~ '7 - 14',
              EV_per_charger <= 21 ~ '14 - 21',

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EV_per_charger <= 28 ~ '21 - 28',
EV_per_charger <= 35 ~ '28 - 35',
EV_per_charger <= 42 ~ '35 - 42',
.default = '42 - 49'))

All_years_heat$EV_per_Charger <-
  factor(All_years_heat$EV_per_Charger,
    levels = c('0 - 7', '7 - 14', '14 - 21', '21 - 28', '28 - 35',
      '35 - 42', '42 - 49'))

# Heat map -----

heat_map <-
  All_years_heat %>%
  ggplot(mapping =
    aes(x = State,
      y = year)) +
  geom_tile(
    aes(fill = EV_per_Charger)) +

  # the mid point is EV-to-charger ratio equals to 10, which is the recommended
  # level of EV charger deployment by the Alternative Fuel Infrastructure
  # Directive (AFID).

  scale_fill_manual(values =
    c('#91cf60', '#f0f9e8', '#ffffb2',
      '#fecc5c', '#fd8d3c', '#f03b20', '#bd0026')) +
  labs(title = paste('Electric Vehicle Charging Point Deployment by State in',
    'the U.S., 2018 - 2021'),
    subtitle = paste('From left to right: the state with the least (NJ) to',
      'most (WY) adequate deployment of EV charging points'),
    caption = 'Data Source: Alternative Fuels Data Center') +
  theme(axis.title = element_blank(),
    axis.ticks = element_blank(),
    panel.background = element_blank())

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