Creating informative maps

Based on Section 3.2.3 from Modern Data Science with R.

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```
# Initial packages required (we'll be adding more)
library(tidyverse)
library(mdsr)      # package associated with our MDSR book
```

Opening example

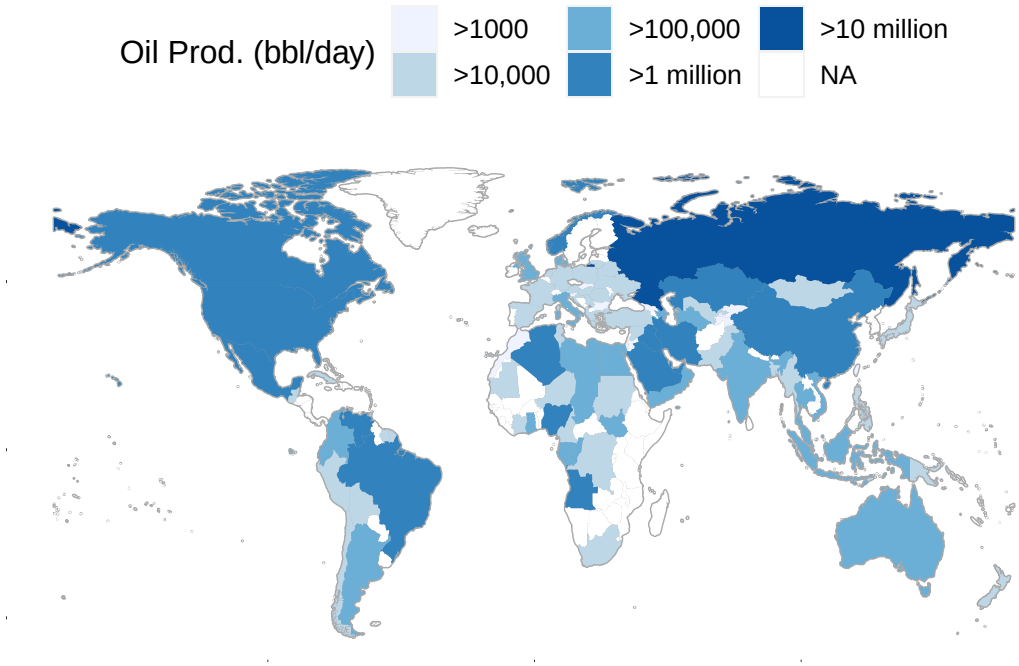
Here is a simple choropleth map example from MDSR

```
# CIACountries is a 236 x 8 data set with information on each country
#   taken from the CIA factbook - gdp, education, internet use, etc.
head(CIACountries)
```

```
         country      pop    area oil_prod   gdp educ   roadways net_users
1    Afghanistan 32564342  652230        0  1900   NA 0.06462444       >5%
2        Albania  3029278   28748    20510 11900  3.3 0.62613051      >35%
3        Algeria 39542166 2381741  1420000 14500  4.3 0.04771929      >15%
4 American Samoa    54343     199        0 13000   NA 1.21105528      <NA>
5        Andorra    85580     468       NA 37200   NA 0.68376068      >60%
6         Angola 19625353 1246700  1742000  7300  3.5 0.04125211      >15%
```

```
CIACountries |>
  select(country, oil_prod) |>
  mutate(oil_prod_disc = cut(oil_prod,
                             breaks = c(0, 1e3, 1e5, 1e6, 1e7, 1e8),
                             labels = c(">1000", ">10,000", ">100,000", ">1 million", ">10
  # we won't use mWorldMap often, but it's a good quick illustration
```

```
mosaic::mWorldMap(key = "country") +
geom_polygon(aes(fill = oil_prod_disc)) +
scale_fill_brewer("Oil Prod. (bbl/day)", na.value = "white") +
theme(legend.position = "top")
```



Choropleth Maps

When you have specific regions (e.g. countries, states, counties, census tracts,...) and a value associated with each region.

A choropleth map will color the entire region according to the value. For example, let's consider state vaccination data from March 2021.

```
vaccines <- read_csv("https://proback.github.io/264_fall_2024/Data/vacc_Mar21.csv")

vacc_mar13 <- vaccines |>
  filter(Date =="2021-03-13") |>
  select(State, Date, people_vaccinated_per100, share_doses_used, Governor)

vacc_mar13
```

```
# A tibble: 50 x 5
   State       Date       people_vaccinated_per100 share_doses_used Governor
   <chr>       <date>                        <dbl>            <dbl> <chr>
 1 Alabama     2021-03-13                     17.2            0.671 R
 2 Alaska      2021-03-13                     27.0            0.686 R
 3 Arizona     2021-03-13                     21.5            0.821 R
 4 Arkansas    2021-03-13                     19.2            0.705 R
 5 California  2021-03-13                     20.3            0.726 D
 6 Colorado    2021-03-13                     20.8            0.801 D
 7 Connecticut 2021-03-13                     26.2            0.851 D
 8 Delaware    2021-03-13                     20.2            0.753 D
 9 Florida     2021-03-13                     20.1            0.766 R
10 Georgia     2021-03-13                     15.2            0.674 R
# i 40 more rows
```

The tricky part of choropleth maps is getting the shapes (polygons) that make up the regions. This is really a pretty complex set of lines for R to draw!

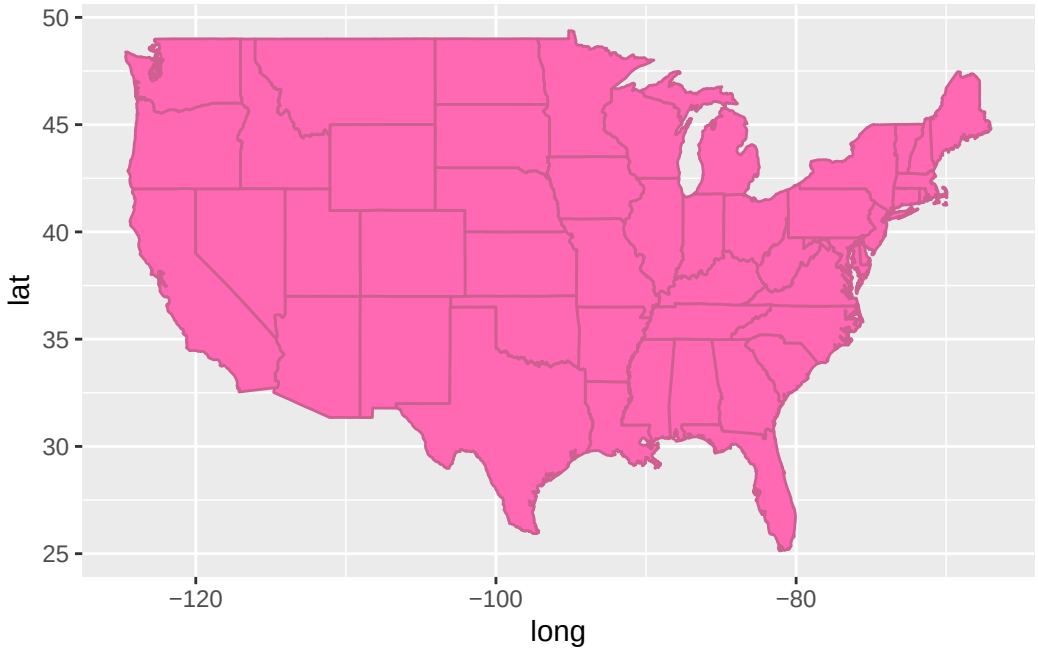
Luckily, some maps are already created in R in the maps package.

```r
library(maps)
us_states <- map_data("state")
head(us_states)
```

```
      long      lat group order  region subregion
1 -87.46201 30.38968     1     1 alabama      <NA>
2 -87.48493 30.37249     1     2 alabama      <NA>
3 -87.52503 30.37249     1     3 alabama      <NA>
4 -87.53076 30.33239     1     4 alabama      <NA>
5 -87.57087 30.32665     1     5 alabama      <NA>
6 -87.58806 30.32665     1     6 alabama      <NA>
```

```r
# Note that points in the same "group" are connected with a line

us_states |>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
  geom_polygon(fill = "hotpink", color = "hotpink3")
```



Other maps provided by the `maps` package include US counties, France, Italy, New Zealand, and two different views of the world. If you want maps of other countries or regions, you can often find them online.

Sometimes maps may be provided as shapefiles. To use these, you'll first need to read them into R and then turn them into tidy dataframes in order to use them with ggplot. See here:. More on shapefiles in Part 2.

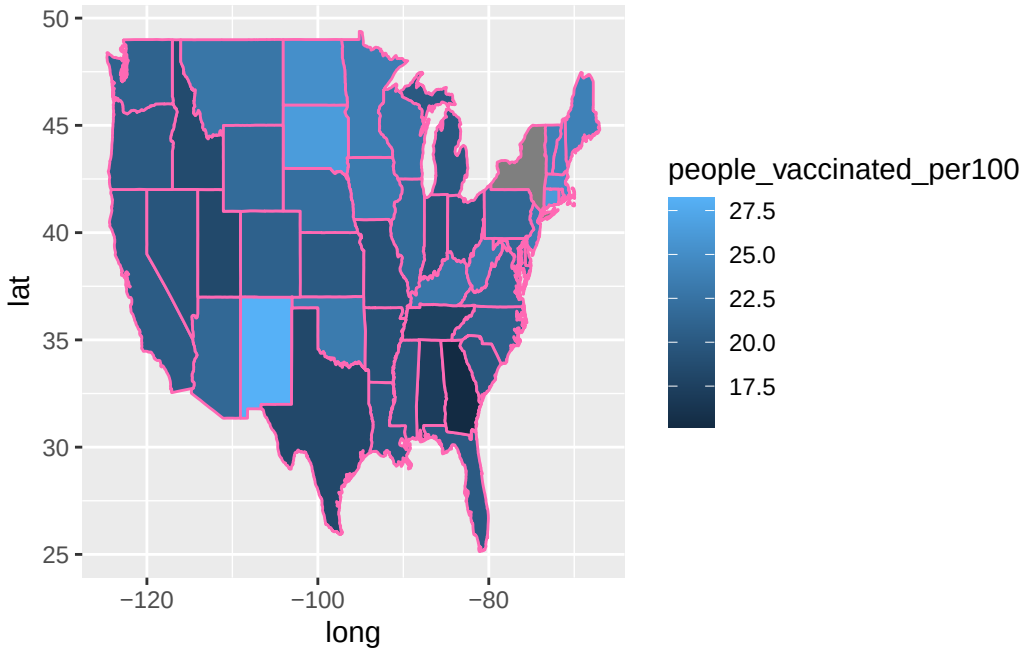
Where the really cool stuff happens is when we join our data to the `us_states` dataframe. Notice that the state name appears in the "region" column of `us_states`, and that the state name is in all small letters. In `vacc_mar13`, the state name appears in the State column and is in title case. Thus, we have to be very careful when we join the state vaccine info to the state geography data.

Run this line by line to see what it does:

```
vacc_mar13 <- vacc_mar13 |>
  mutate(State = str_to_lower(State))

vacc_mar13 |>
  right_join(us_states, by = c("State" = "region")) |>
  rename(region = State) |>
  ggplot(mapping = aes(x = long, y = lat,
```

```
                            group = group)) +
  geom_polygon(aes(fill = people_vaccinated_per100), color = "hotpink")
```



oops, New York appears to be a problem.

```
vacc_mar13 |>
  anti_join(us_states, by = c("State" = "region"))
```

```
# A tibble: 3 x 5
  State          Date       people_vaccinated_per100 share_doses_used Governor
  <chr>          <date>                        <dbl>            <dbl> <chr>
1 alaska         2021-03-13                     27.0            0.686 R
2 hawaii         2021-03-13                     22.8            0.759 D
3 new york state 2021-03-13                     21.7            0.764 D
```

```
us_states |>
  anti_join(vacc_mar13, by = c("region" = "State")) |>
  count(region)
```

```
region  n
```

```
1 district of columbia  10
2             new york 495
```

[**Pause to ponder:**] What did we learn by running `anti_join()` above?

anti_join takes away any that match so we can fix that New York and New York State weren't matching.

Notice that the `us_states` map also includes only the contiguous 48 states. This gives an example of creating really beautiful map insets for Alaska and Hawaii.

```
vacc_mar13 <- vacc_mar13 |>
  mutate(State = str_replace(State, " state", ""))

vacc_mar13 |>
  anti_join(us_states, by = c("State" = "region"))
```

```
# A tibble: 2 x 5
  State  Date       people_vaccinated_per100 share_doses_used Governor
  <chr>  <date>                        <dbl>            <dbl> <chr>
1 alaska 2021-03-13                     27.0            0.686 R
2 hawaii 2021-03-13                     22.8            0.759 D
```

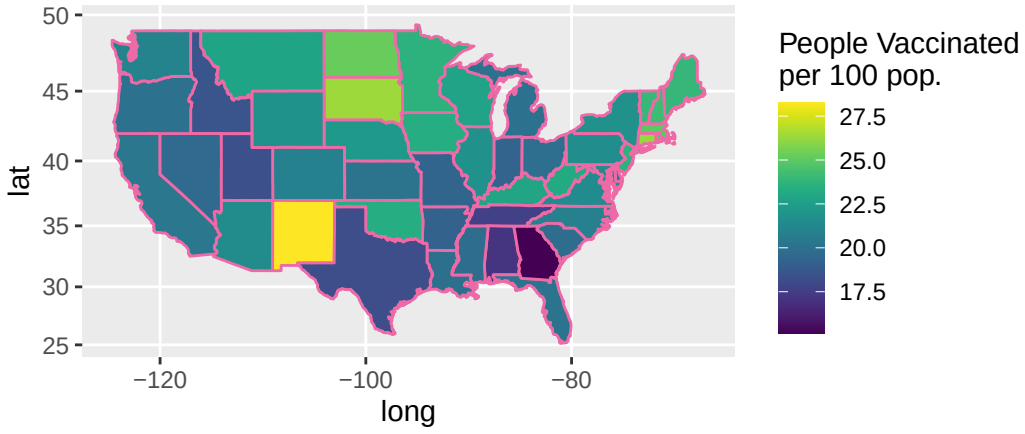
```
us_states |>
  anti_join(vacc_mar13, by = c("region" = "State")) %>%
  count(region)
```

```
               region  n
1 district of columbia 10
```

Better.

```
library(viridis) # for color schemes
vacc_mar13 |>
  right_join(us_states, by = c("State" = "region")) |>
  rename(region = State) |>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
  geom_polygon(aes(fill = people_vaccinated_per100), color = "hotpink2") +
  labs(fill = "People Vaccinated\nper 100 pop.") +
  # This scales the longitude and latitude so that the shapes look correct.
```

```
  coord_map() +
  # This theme can give you a really clean look!
  theme_get() +
  # you can change the fill scale for different color schemes.
  scale_fill_viridis()
```



[Pause to ponder:] Use autofill to play with different themes and scale_fills.

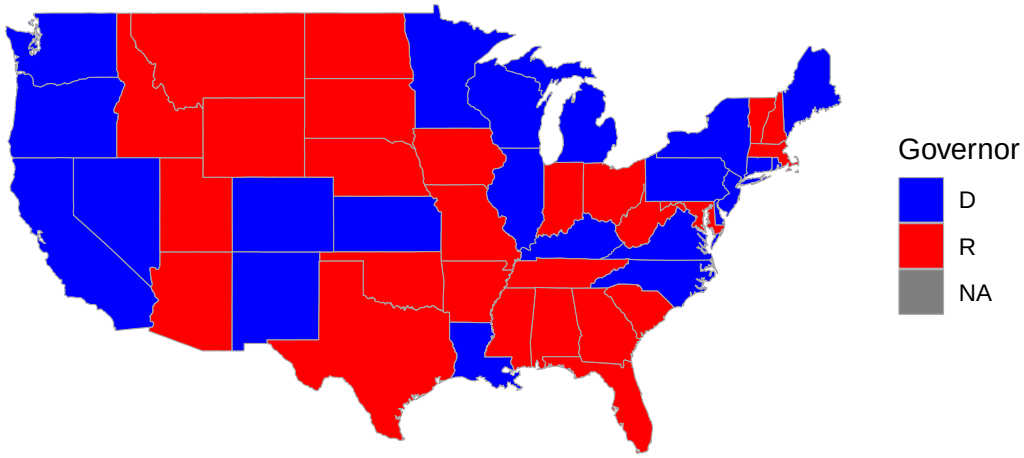
Note: Map projections are actually pretty complicated, especially if you're looking at large areas (e.g. world maps). It's impossible to preserve both shape and area when projecting a sphere onto a flat surface, so that's why you sometimes see such different maps of the world

There are a few different options in `coord_map()`. See the help menu, although this function is being phased out.

You can also use a categorical variable to color regions:

```
vacc_mar13 |>
  right_join(us_states, by = c("State" = "region")) |>
  rename(region = State) |>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
```

```
  geom_polygon(aes(fill = Governor), color = "darkgrey", linewidth = 0.2) +
  labs(fill = "Governor") +
  # This scales the longitude and latitude so that the shapes look correct.
  coord_map() +
  # This theme can give you a really clean look!
  theme_void() +
  # you can change the fill scale for different color schemes.
  scale_fill_manual(values = c("blue", "red"))
```



Multiple maps!

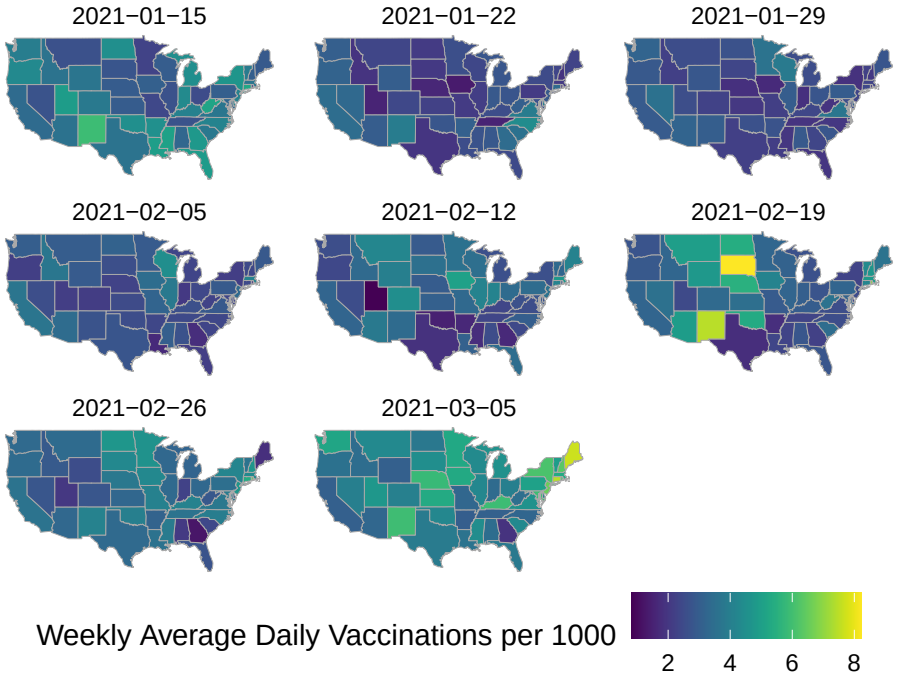
[Pause to ponder:] are we bothered by the warning about many-to-many when you run the code below?

Each state corresponds to many values in the vaccination dataset.

```
library(lubridate)
weekly_vacc <- vaccines |>
  mutate(State = str_to_lower(State)) |>
  mutate(State = str_replace(State, " state", ""),
         week = week(Date)) |>
```

```
  group_by(week, State) |>
  summarize(date = first(Date),
            mean_daily_vacc = mean(daily_vaccinated/est_population*1000)) |>
  right_join(us_states, by =c("State" = "region")) |>
  rename(region = State)

weekly_vacc |>
  filter(week > 2, week < 11) |>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
  geom_polygon(aes(fill = mean_daily_vacc), color = "darkgrey", size = 0.1) +
  labs(fill = "Weekly Average Daily Vaccinations per 1000") +
  coord_map() +
  theme_void() +
  scale_fill_viridis() +
  facet_wrap(~date) +
  theme(legend.position = "bottom")
```

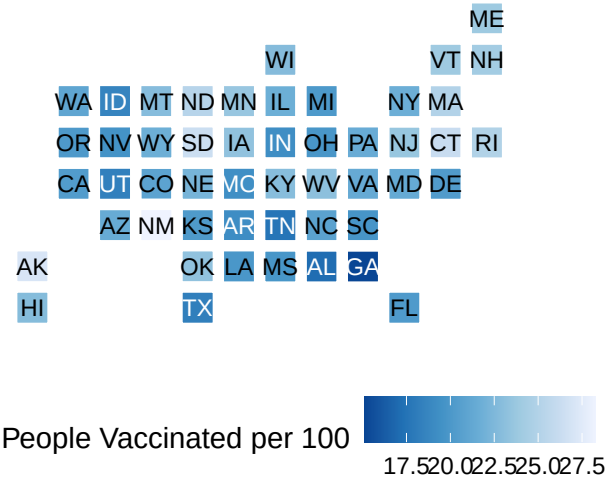


Other cool state maps

statebin (square representation of states)

```
library(statebins) # may need to install

vacc_mar13 |>
  mutate(State = str_to_title(State)) |>
  statebins(state_col = "State",
            value_col = "people_vaccinated_per100") +
  # one nice layout. You can customize with usual ggplot themes.
  theme_statebins() +
  labels(fill = "People Vaccinated per 100")
```



[**Pause to ponder:**] Why might one use a map like above instead of our previous choropleth maps?

It makes all the states equal size, so smaller states are better represented and also doesn't have large states with small populations taking up a lot of room.

I used this example to create the code above. The original graph is located here.

Interactive map with leaflet

Leaflet is a powerful open-source JavaScript library for building interactive maps in HTML. Although the commands are different, the architecture is very similar to ggplot2. However,

instead of putting data-based layers on top of a static map, leaflet allows you to put data-based layers on top of an interactive map. Because leaflet renders as HTML to allow interactivity, they are less effective as static pdfs.

With leaflet, you can have "pop-up" messages when you hover over points, and have a zoom-in and zoom-out option.

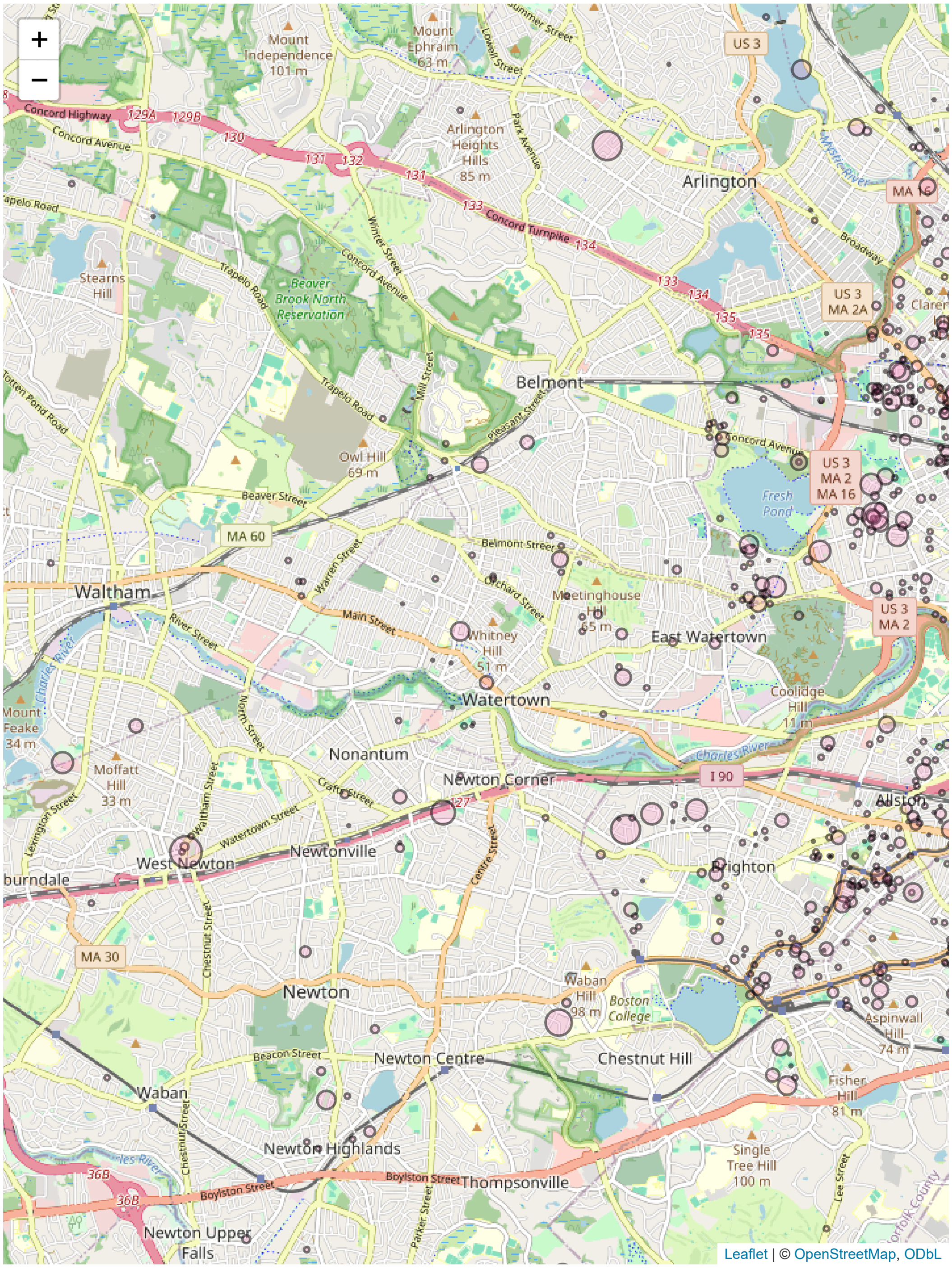
Two main features: `addTiles()` = Add background map `setView()` = Set where the map should originally zoom to

```
# This part is for the pop-up messages.... some are weird or just "\n" for example, so thi
Encoding( x = airbnb.df$AboutListing ) <- "UTF-8"
airbnb.df$AboutListing <-
  iconv( x = airbnb.df$AboutListing
         , from = "UTF-8"
         , to = "UTF-8"
         , sub = "" )
head(airbnb.df)
```

```
# A tibble: 6 x 65
  ListingID Title    UserID baseurl Price AboutListing HostName MemberDate   Lat
      <dbl> <chr>     <dbl> <chr>   <dbl> <chr>        <chr>    <chr>      <dbl>
1    281552 Harvard~ 1.47e6 https:~   175 "\n"         Mary Ca~ December ~  42.4
2    182613 Luxury ~ 8.76e5 https:~   249 "Entire lar~ Max      July 2011   42.4
3   1587540 Cozy Ho~ 2.00e6 https:~   225 "\n"         Finola   March 2012  42.4
4    469506 Luxury ~ 1.77e6 https:~   140 "\n"         Rupal    February ~  42.3
5   3937268 Boston ~ 2.53e6 https:~    99 "I offer a ~ Natasha  June 2012   42.3
6   3036349 Top flo~ 1.37e6 https:~    89 "Two bedroo~ Carol    November ~  42.3
# i 56 more variables: Long <dbl>, BookInstantly <chr>, Cancellation <chr>,
#   PageCounter <dbl>, PageNumber <dbl>, A_AC <dbl>, A_Breakfast <dbl>,
#   A_CableTV <dbl>, A_CarbonMonoxDetector <dbl>, A_Doorman <dbl>,
#   A_Dryer <dbl>, A_TV <dbl>, A_Elevator <dbl>, A_Essentials <dbl>,
#   A_Events <dbl>, A_FamilyFriendly <dbl>, A_FireExt <dbl>, A_Fireplace <dbl>,
#   A_FirstAidKit <dbl>, A_Gym <dbl>, A_Heat <dbl>, A_HotTub <dbl>,
#   A_Intercom <dbl>, A_Internet <dbl>, A_Kitchen <dbl>, A_Parking <dbl>, ...
```

```
# This part makes the map!
leaflet() |>
    addTiles() |>
    setView(lng = mean(airbnb.df$Long), lat = mean(airbnb.df$Lat),
            zoom = 13) |>
    addCircleMarkers(data = airbnb.df,
```

```
        lat = ~ Lat,
        lng = ~ Long,
        popup = ~ AboutListing,
        radius = ~ S_Accomodates,
        # These last options describe how the circles look
        weight = 2,
        color = "black",
        fillColor = "hotpink")
```


+
−
Mount Independence 101 m
Mount Ephraim 63 m
Arlington Heights Hills 85 m
Arlington
US 3
MA 16
Concord Highway
Concord Avenue
Concord Turnpike
Trapelo Road
Stearns Hill
Beaver Brook North Reservation
Broadway
US 3 MA 2A
Belmont
Concord Avenue
Owl Hill 69 m
Beaver Street
Pleasant Street
Mill Street
US 3 MA 2 MA 16
Fresh Pond
MA 60
Belmont Street
Waltham
Warren Street
Orchard Street
Meetinghouse Hill 65 m
River Street
Main Street
Whitney Hill 51 m
East Watertown
US 3 MA 2
Charles River
Coolidge Hill 11 m
Mount Feake 34 m
North Street
Watertown
Nonantum
Moffatt Hill 33 m
Newton Corner
I 90
Allston
Crafts Street
Waltham Street
Watertown Street
West Newton
Newtonville
Centre Street
Brighton
burndale
Lexington Street
MA 30
Chestnut Street
Newton
Waban Hill 98 m
Boston College
Aspinwall Hill 74 m
Beacon Street
Newton Centre
Chestnut Hill
Waban
Fisher Hill 81 m
Newton Highlands
Single Tree Hill 100 m
Boylston Street
Thompsonville
Parker Street
Lee Street
Newton Upper Falls
Leaflet | © OpenStreetMap, ODbL

On Your Own

The `states` dataset in the `poliscidata` package contains 135 variables on each of the 50 US states. See here for more detail.

Your task is to create a two meaningful choropleth plots, one using a numeric variable and one using a categorical variable from `states`. Write a sentence or two describing what you can learn from each plot.

Here's some R code to get you going:

```
library(poliscidata)   # may have to install first

# Be sure you know what the mutate statement below is doing!
state_data <- as_tibble(poliscidata::states) |>
  mutate(state_name = str_squish(str_to_lower(as.character(state)))) |>
  select(-state)
print(state_data, n = 5, width = Inf)
```

```
# A tibble: 50 x 135
  abort_rank3 abortion_rank12 adv_or_more ba_or_more cig_tax12 cig_tax12_3
  <fct>                 <dbl>       <dbl>      <dbl>     <dbl> <fct>
1 Less restr               35         9         26.6     2     HiTax
2 Mid                      20         7.7       22       0.425 LoTax
3 More restr                4         6.1       18.9     1.15  MidTax
4 More restr                5         9.3       25.6     2     HiTax
5 Less restr               49        10.7       29.9     0.87  MidTax
  conserv_advantage conserv_public dem_advantage govt_worker gun_rank3
              <dbl>          <dbl>         <dbl>       <dbl> <fct>
1              21.3           43.1         -12.2        28   Less restr
2              36             44.7         -14.6        17.5 Mid
3              26.7           45.2          -1.4        17.6 Less restr
4              19.5           36            -3.5        15.5 Less restr
5               6.3           30.8          14.9        14.9 More restr
  gun_rank11 gun_scale11 hr_cons_rank11 hr_conserv11 hr_lib_rank11 hr_liberal11
       <dbl>       <dbl>          <dbl>        <dbl>         <dbl>        <dbl>
1         50           0           200          55.7          228          44.3
2         17          14           152.         65.6          278.         34.4
3         39           4           132.         69.3          295.         30.7
4         50           0           156.         62.6          270.         37.4
5          1          81           274.         54.8          152.         81.0
  hs_or_more obama2012 obama_win12  pop2000  pop2010 pop2010_hun_thou
       <dbl>     <dbl> <fct>          <dbl>    <dbl>            <dbl>
```

```
1       91.4      40.8 No            626932   710231             7.10
2       82.1      38.4 No           4447100  4779736            47.8
3       82.4      36.9 No           2673400  2915918            29.2
4       84.2      44.4 No           5130632  6392017            63.9
5       80.6      60.2 Yes         33871648 37253956           373.
  popchng0010 popchngpct pot_policy          prochoice prolife relig_cath
        <dbl>      <dbl> <fct>                   <dbl>   <dbl>      <dbl>
1       83299       13.3 Medicinal                  58      37       14.6
2      332636        7.5 Decrim                     36      54        6.6
3      242518        9.1 Not legal                  40      55        5.9
4     1261385       24.6 Medicinal                  56      39       27.3
5     3382308       10   Medicinal / Decrim.        65      28       31.9
  relig_prot relig_high relig_low religiosity3 romney2012 smokers12 stateid
       <dbl>      <dbl>     <dbl> <fct>             <dbl>     <dbl> <fct>
1       50         31.3      39.5 Low                54.8        24 "AK    "
2       79.3       55.7      14.3 High               60.6        25 "AL    "
3       78.6       52.3      18.7 High               60.6        26 "AR    "
4       43.3       36.6      33.9 Mid                53.5        21 "AZ    "
5       37.8       34.5      36.6 Low                37.1        15 "CA    "
  to_0812 uninsured_pct abort_rate05 abort_rate08 abortlaw3  abortlaw10 alcohol
    <dbl>         <dbl>        <dbl>        <dbl> <fct>           <dbl>   <dbl>
1   -9.40          21.8         13.6         12   0-5 restr           5    3.02
2   -2.90          18.8         11.9         12   6-8 restr           8    2.01
3   -2.90          21.9          8.3          8.7 9-10 restr          9    1.83
4   -3.10          20.5         16           15.2 6-8 restr           6    2.31
5   -6.5           23.2         27.1         27.6 0-5 restr           4    2.33
  attend_pct battle04 blkleg blkpct04 blkpct08 blkpct10 bush00 bush04 carfatal
       <dbl> <fct>     <dbl>    <dbl>    <dbl>    <dbl>  <dbl>  <dbl>    <dbl>
1         22 No            2      3.6      4.3      4.7   58.6   61.1     17.4
2         52 No           25     26.4     26.4     26.8   56.5   62.5     24.9
3         50 No           11     15.8     15.8     16.1   51.3   54.3     25.6
4         29 No            1      3.5      4.2      5     51.0   54.8     20.3
5         33 No            5      6.8      6.7      7.2   41.7   44.4     12.1
  carfatal07 cig_tax cig_tax_3   cigarettes college conpct_m cons_hr06 cons_hr09
       <dbl>   <dbl> <fct>           <dbl>   <dbl>    <dbl>     <dbl>     <dbl>
1       15.2   2     $1.41-$2.58       6.22    26.7     36.3      72        75
2       25.9   0.425 $.07-$.64         9.41    21.1     40.7      77.7      72
3       23.7   0.59  $.07-$.64         8.51    19.1     38.9      56.2      28.5
4       17.6   2     $1.41-$2.58       2.4     24.3     33.3      69        49.5
5       11.7   0.87  $.695-$1.36       3.69    29.1     28.5      37.3      35.1
  cook_index cook_index3 defexpen demhr11 dem_hr09 demnat06 dempct_m demstate06
       <dbl> <fct>          <dbl>   <dbl>    <dbl>    <dbl>    <dbl>      <dbl>
1      -13.4 More Rep        3556     0        0        0       26.1       43.3
```

```
2      -13.2 More Rep        1757    14.3     42.9     22.2     38.9       60.7
3       -8.8 More Rep         530    25       75       83.3     43.1       75.6
4       -6.1 Even            1771    28.6     62.5     20       31.9       44.4
5        7.4 More Dem        1106    64.2     64.2     63.6     41.3       60.8
  demstate09 demstate13 density division      earmarks_pcap   evm   evo evo2012
       <dbl>      <dbl>   <dbl> <fct>                 <dbl> <dbl> <dbl>   <dbl>
1       46.7       36.7     1.2 Pacific               426.      3     0       0
2       57.9       35.7    94.4 E. South Cent          38.9     9     0       0
3       72.6       46.7    56   W. South Cent          26.7     6     0       0
4       41.1       41.1    56.3 Mountain               20.9    10     0       0
5       64.2       66.7   239.  Pacific                12.5     0    55      55
  evr2012 gay_policy        gay_policy2  gay_policy_con gay_support gay_support3
    <dbl> <fct>             <fct>        <fct>                <dbl> <fct>
1       3 Conservative      Conservative No                      56 Med
2       9 Most conservative Conservative Yes                     44 Low
3       6 Most conservative Conservative Yes                     44 Low
4      11 Conservative      Conservative No                      58 Med
5       0 Liberal           Liberal      No                      64 High
  gb_win00 gb_win04  gore00 gun_check gun_dealer gun_murder10 gun_rank_rev
  <fct>    <fct>      <dbl>     <dbl>      <dbl>        <dbl>        <dbl>
1 Bush win Bush win    27.7    12016.      139.           2.7            6
2 Bush win Bush win    41.6     9025.       47.4          2.8           30
3 Bush win Bush win    45.9     8443.       67.4          3.2           13
4 Bush win Bush win    44.7     5314.       45.4          3.6           13
5 Gore win Kerry win   53.4     3040.       21.6          3.4           48
  gunlaw_rank gunlaw_rank3_rev gunlaw_scale hispanic04 hispanic08 hispanic10
        <dbl> <fct>                   <dbl>      <dbl>      <dbl>      <dbl>
1          43 Fewer restr                 4        4.9        6.1        5.5
2          19 Mid                        15        2.2        2.9        3.9
3          36 Fewer restr                 6        4.4        5.6        6.4
4          36 Fewer restr                 6       28         30.1       29.6
5           1 More restr                 79       34.7       36.6       37.6
  indpct_m kerry04 libpct_m mccain08 modpct_m nader00 obama08 obama_win08 over64
     <dbl>   <dbl>    <dbl>    <dbl>    <dbl>   <dbl>   <dbl> <fct>        <dbl>
1     43.6    35.5     17.9     59.4     45.7   10.1     37.9 McCain win     6.4
2     30.0    36.8     16.8     60.3     42.5    1.10    38.7 McCain win    13.2
3     35.9    44.6     16.8     58.7     44.3    1.46    38.9 McCain win    13.8
4     29.7    44.4     19.2     53.4     47.4    2.98    44.9 McCain win    12.7
5     25.8    54.3     24.2     36.9     47.3    3.82    60.9 Obama win     10.7
  permit pop_18_24 pop_18_24_10 prcapinc region relig_import religiosity
   <dbl>     <dbl>        <dbl>    <dbl> <fct>         <dbl>       <dbl>
1   NA       11.1         10.6     34454 West           NA          -177
2   27.6     10.0         10.0     27795 South          58.5         -13
```

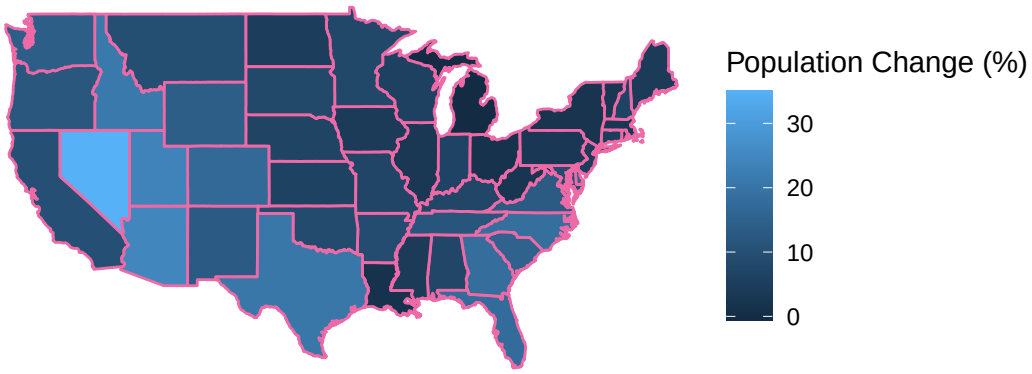
```
3   21.1     10.1          9.74    25725 South          53.1         -23
4   46.2      9.61         9.90    28442 West           33.2        -140
5   52.8      9.95        10.5     35019 West           28.8        -147
  reppct_m rtw   secularism secularism3 seniority_sen2 south    to_0004 to_0408
     <dbl> <fct>      <dbl> <fct>       <fct>          <fct>      <dbl>   <dbl>
1     30.3 No           177 Secular     Yes            Nonsouth  -12.4   -0.800
2     31.2 Yes           13 Religious   No             South       4.2    4.60
3     21.0 Yes           23 Religious   No             South       3.31  -0.200
4     38.3 Yes          140 Secular     No             Nonsouth   -2.32   1.90
5     32.9 No           147 Secular     No             Nonsouth    6.63   2.90
  trnout00 trnout04 unemploy union04 union07 union10 urban vep00_turnout
     <dbl>    <dbl>    <dbl>   <dbl>   <dbl>   <dbl> <dbl>         <dbl>
1     67.2     54.8      7.5    20.1    23.8    22.3  65.6          68.1
2     50.6     54.8      5.8     9.7     9.5    10.9  55.4          51.6
3     46.9     50.2      5.9     4.8     5.4     4.2  52.5          47.9
4     44.6     42.3      5.1     6.3     8.8     6.5  88.2          45.6
5     54.6     61.2      6.2    16.5    16.7    17.2  94.4          55.7
  vep04_turnout vep08_turnout vep12_turnout womleg_2007 womleg_2010 womleg_2011
         <dbl>         <dbl>         <dbl>       <dbl>       <dbl>       <dbl>
1          69.1          68.3          58.9        21.7        21.7        23.3
2          57.2          61.8          58.9        12.9        12.9        13.6
3          53.6          53.4          50.5        20.7        23          22.2
4          54.1          56            52.9        34.4        31.1        34.4
5          58.8          61.7          55.2        28.3        27.5        28.3
  womleg_2015 state_name
       <dbl> <chr>
1        28.3 alaska
2        14.3 alabama
3        20   arkansas
4        35.6 arizona
5        25.8 california
# i 45 more rows
```

```
usstates<-us_states|>
  mutate(region=str_replace_all(region, " ", ""))
```

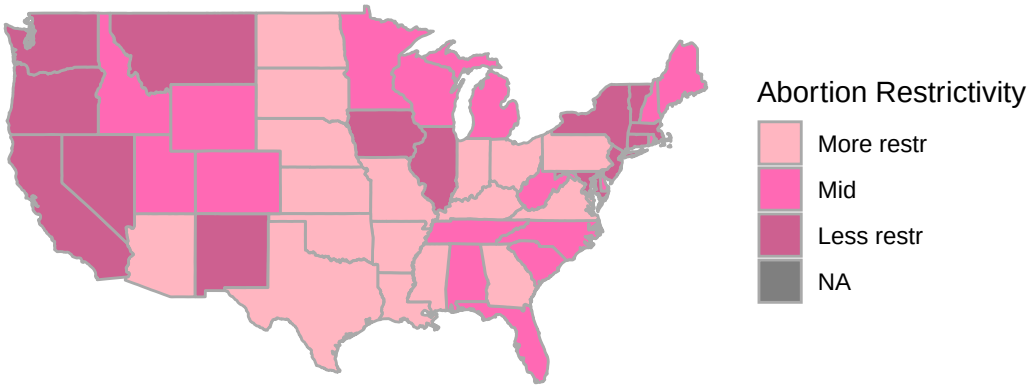
library(maps) us_states <- map_data("state")

```
state_data|>right_join(usstates, by=c("state_name"="region")) |>
  select(popchngpct, state_name, long, lat, group)|>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
```

```
  geom_polygon(aes(fill = popchngpct), color="hotpink2", linewidth = 0.5) +
  labs(fill = "Population Change (%)") +
  coord_map() +
  theme_void()
```




```
state_data|>right_join(usstates, by=c("state_name"="region")) |>
  select(abort_rank3, state_name, long, lat, group)|>
  ggplot(mapping = aes(x = long, y = lat,
                       group = group)) +
  geom_polygon(aes(fill = abort_rank3), color="darkgray", linewidth = 0.5) +
  labs(fill = "Abortion Restrictivity") +
  coord_map() +
  theme_void() +
  scale_fill_manual(values = c("lightpink", "hotpink", "hotpink3"))
```


Abortion Restrictivity
More restr
Mid
Less restr
NA