# MATH 216: Assignment 4

Solutions

## Instructions

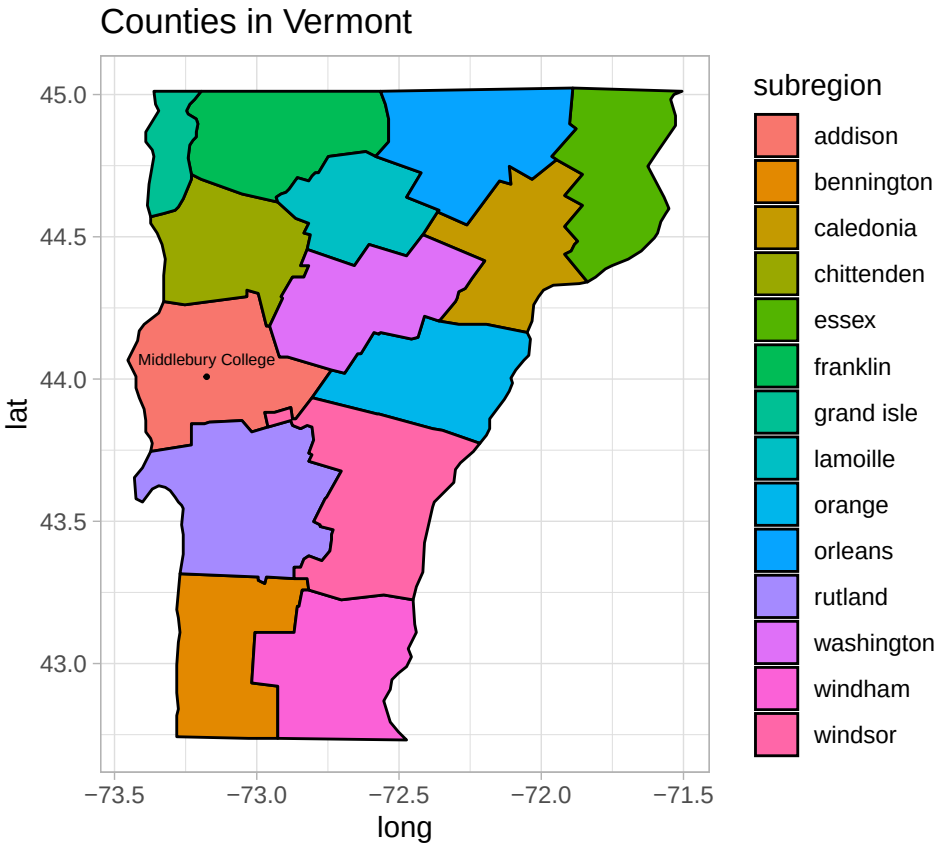
- submit the .html file to Canvas
- you are encouraged to work together and ask your peers questions. Each person should submit their own work.
- You may share parts of your code to ask or answer questions on Slack. You should avoid sharing (copying and pasting) the entirety of your answers.
- make sure you include at least one acknowledgement
- Note that is question is worth 4 points. The assignment is worth 12 points total.

**Loading the data**

```
## maps
library(maps)
world_map <- map_data("world")  #to map countries in the world
states_map <- map_data("state") #to map states in the US
counties_map <-map_data("county") #to map counties in the US

## rnaturalearth
library(rnaturalearth)
worldmap <- ne_countries(scale = 'medium', type = 'map_units',returnclass = 'sf')
```

### Question 1: Display a map of the State of Vermont. The map should display all the counties in Vermont. Make sure your plot is well labeled. (Optional: put a marker where Middlebury College is located.)

```
vermont_counties <- counties_map %>%
  filter(region == "vermont") %>%
  group_by(region)

long <- c(-73.1760)
lat <- c(44.0081)
mc <- as.data.frame(cbind(long,lat))

ggplot(vermont_counties, aes(long, lat)) +
  geom_polygon(aes(fill = subregion), col="black") +
  coord_fixed(ratio = 1) +
  geom_point(data = mc, aes(x = long, y = lat), pch = 19, size=0.5)+
  annotate("text", x = long, y = lat, label = "Middlebury College", size=2, vjust=-1)+
  theme_light() +
  ggtitle("Counties in Vermont")
```



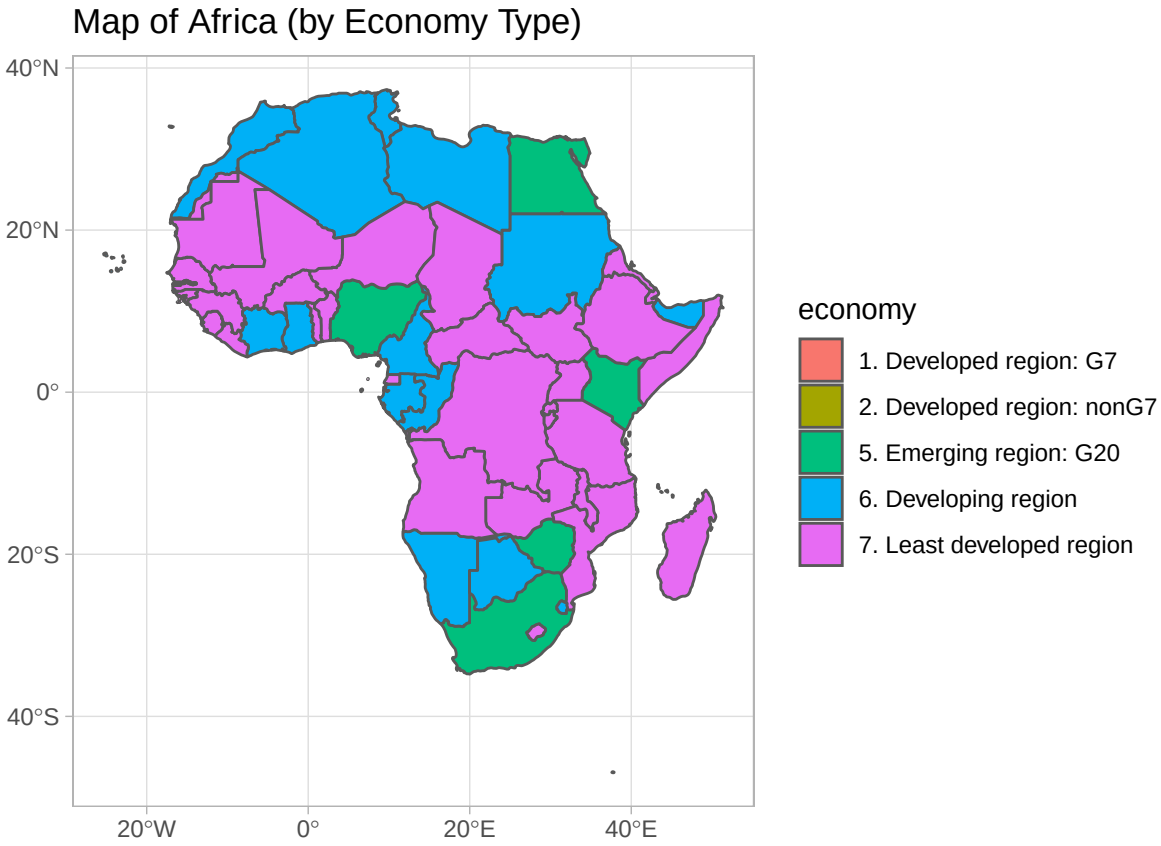

It should have: - a title - x and y axis labels - counties labelled in some way

Things I'm not picky about:

- color choice
- whether or not Middlebury College is labelled
- how the counties are labelled - some students may do it in a legend and other may have gone the extra mile and labelled on the map

**Question 2: Use `rnaturalearth` and the dataset `worldmap` to create a map of Africa. Shade the countries by the variable `economy` (contained within the `worldmap` dataset). Make sure your plot is well labeled.**

```
africa <- ne_countries(scale = 'medium', type = 'map_units',returnclass = 'sf', continent = 'africa')
ggplot() +
  geom_sf(data = africa) +
  aes(fill=economy)+
  theme_light()+
  ggtitle("Map of Africa (by Economy Type)")
```




**Question 3: The following should help you create a dataset `world_data` which contains information about many countries in the world. Create a map in an area of the world of your choice (ie. Africa, Caribbean, etc.) shading each of the countries using the variable `phones` which represents the number of phones per 1000 people. Make sure your plot is well labeled.**

```
#read in and format dataset
data <- read.csv("https://ebmwhite.github.io/MATH0216/data/worlddata.csv")
data$Country <- as.character(trimws(data$Country))
data$phones <- as.numeric(data$phones)

#format map data for joining
world_map$Country <- as.character(world_map$region)

#join map data with dataset
world_data <- left_join(world_map, data , by = "Country")
```

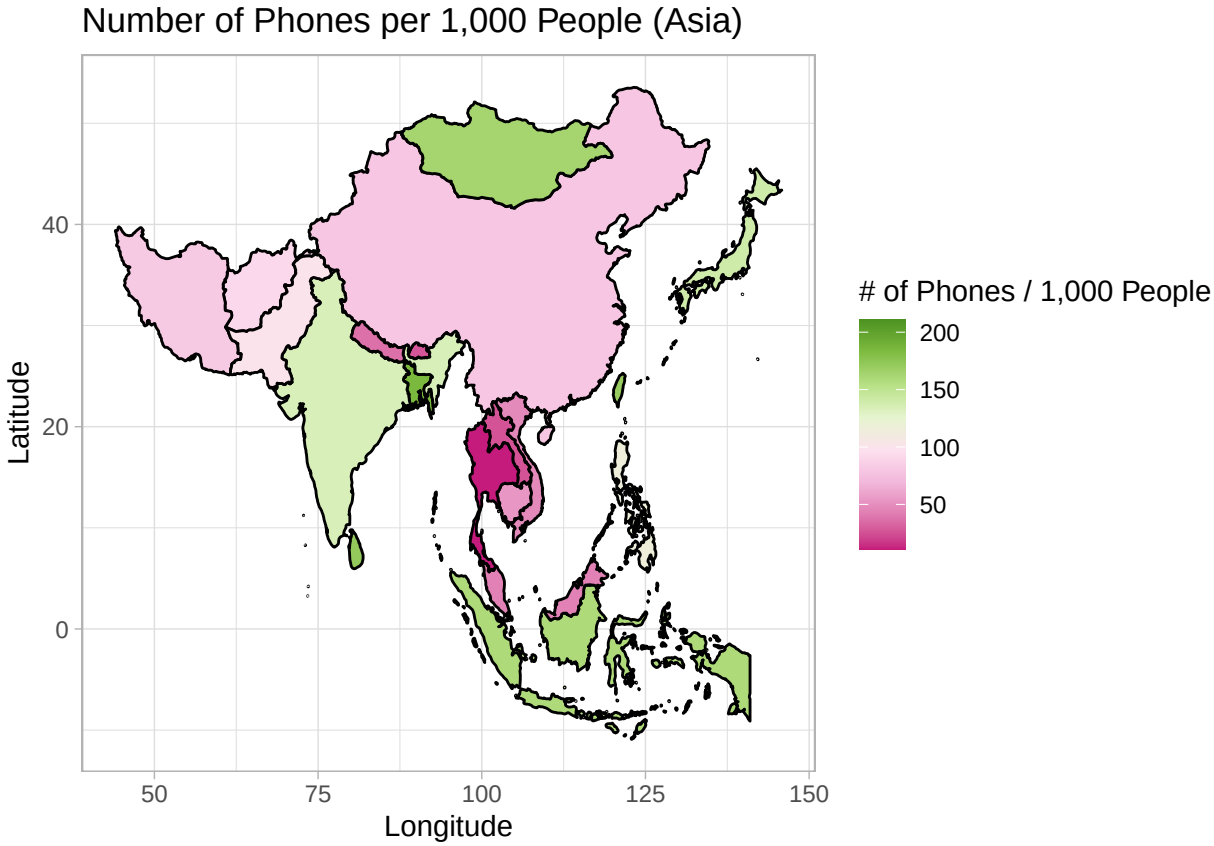
There are MANY different possibilities here. Students maps should:

- have a title
- x and y axis labelled clearly
- have regions shaded by density of cell phones

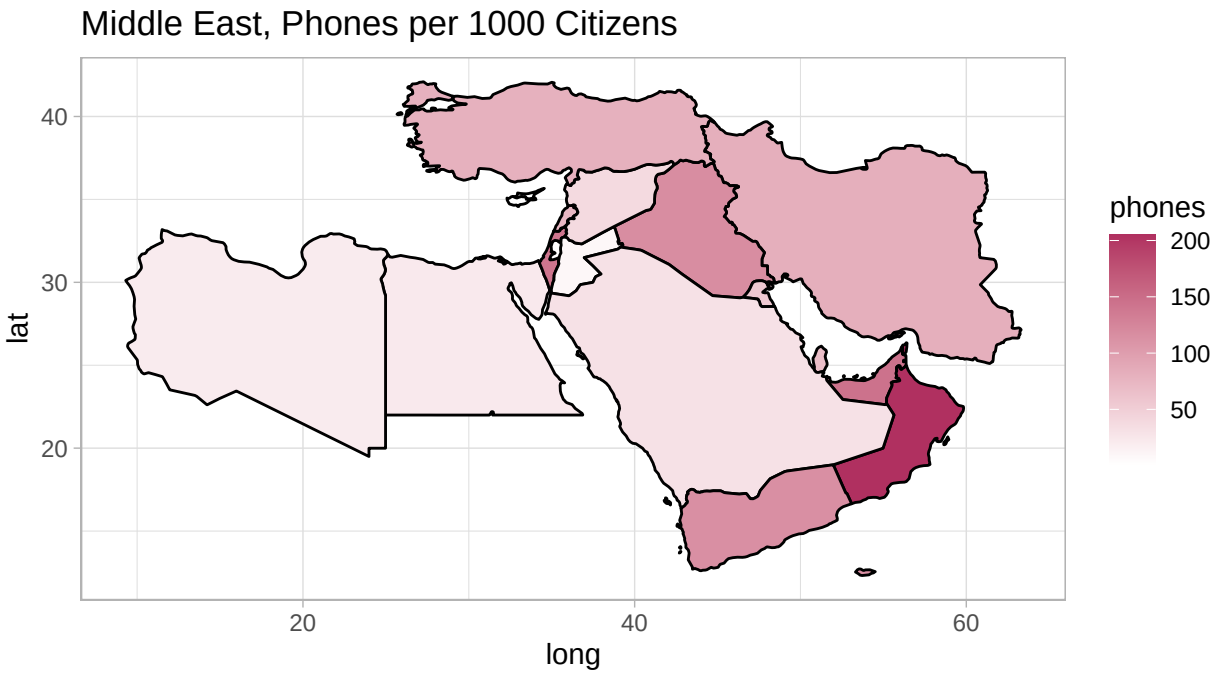
Here are a couple of great examples:

```
#create a map!
#create a map!
```

```
library(RColorBrewer)

asia_phones <- world_data %>%
  filter(Region=="ASIA (EX. NEAR EAST)         ")

ggplot(asia_phones, aes(long, lat)) +
  geom_polygon(aes(group=group, fill=phones), col="black") +
  ggtitle("Number of Phones per 1,000 People (Asia)") +
  theme_light() +
  labs(x="Longitude", y="Latitude") +
  scale_fill_gradientn(name="# of Phones / 1,000 People", colors = brewer.pal(8, "PiYG"))
```




```
world_data <- subset(world_data, region == "Cyprus" | region == "Turkey" | region ==  "Syria" | region =

ggplot(world_data, aes(long, lat, group = group)) +
  geom_polygon(aes(fill = phones), color = "black") +
  scale_fill_gradientn(colors = c('white','maroon')) +
  coord_fixed(ratio = 1)+
  theme_light() +
  ggtitle("Middle East, Phones per 1000 Citizens")
```




## Acknowledgements

Use this space to acknowledge anyone who has helped you with this lab. This could be a peer who helped you when you got stuck. This could be the peer tutor. This could be your family or a friend for their support. **You must include at least one acknowledgement**.