MINI PROJECT 2
By- Raghav Mathur, Deepak Shanmugam

Contribution to the Project: Each member contributed equally to the project. We worked together to analyse the dataset, study Map making in R, write the functions, and creating the map with gradient colours.

EXERCISE 1:

Section 1:
(b) What does the map show? Justify your conclusions.

(b) The map represents the margin of percentage of votes by which President elect Donald Trump won over Hillary Clinton in US Election-2016. The state in Red color shows that Trump won with a majority in that state whereas the different shades represent the margin of percentage of votes with which he won over Hillary Clinton. The state in Blue color shows that Clinton won with a majority in that state whereas the different shades represent the margin of percentage of votes with which she won over Donald Trump.

We can justify this by looking at the dataset. We are taking the difference of percentage of votes of Trump and Clinton and representing it in the map of USA using Red-Blue colours. If the value is positive, it means that Trump got a higher percentage of votes than Clinton and a negative value denotes that Clinton got a higher percentage of votes over Trump.

	State	Trump %
1	arizona	3.6
2	colorado	-4.9
3	florida	1.2
4	iowa	9.4
5	maine	-2.9
6	michigan	0.2
7	minnesota	-1.5

Table 1Winning Percentage of votes for Trump over Clinton (for 7 states)

Section 2: (R Code)

Main_Code.R –

```
library(raster) # to get map shape file
library(ggplot2) # for plotting and miscellaneous things
library(ggmap) # for plotting
library(plyr) # for merging datasets
library(scales) # to get nice looking legends
library(maps)
library(mapdata)
library(ggrepel)
```

```
library(gridExtra)
library(readr)

#get the shape file for the states excluding Alaska and Hawaii
usa.map = map_data("state")
#change column 5 name to "State"
colnames(usa.map)[5] = "State"
# set working directory to save image
setwd("C:/Users/mastr/Desktop/final mini project 2")
#get data from csv file
election_data <- read_csv("~/us_2016_election_data.csv",
                          col_types = cols(`Clinton %` = col_number(),
                                           `Others %` = col_number(), `Trump %` = col_number()))
election_data$State = tolower(election_data$State)
trump_data = election_data
#save the dfference of percentage of votes that Trump and Clinton received
trump_data$`Trump %`=(trump_data$`Trump %`-trump_data$`Clinton %`)
trump_data$`Clinton %`= NULL
trump_data$`Others %`= NULL
#join 2 tables by column="State" to store votes percentage
trump_states = join(usa.map, trump_data, by = "State", type = "inner")
#get longitoue, latitude and abbreviation of states
states = data.frame(state.center, state.abb)
#create array of small states whose names are to be dislayed explicitely with lines
lined_states = c('VT','NH','MA','RI','CT','NJ','DE','MD','DC')
not_lined_states=c('VT','NH','MA','RI','CT','NJ','DE','MD','DC','AK','HI')
#select states to be displayed with lines in map
projected_states = states[states$state.abb %in% lined_states, ]
#slect states to be displayed without lines in map
unprojected_states = states[!states$state.abb %in% not_lined_states, ]

#get the map data of alaska
alaska_map = map_data("world2Hires", "USA:Alaska")
colnames(alaska_map)[6] = "State"
alaska_map$State = tolower(alaska_map$State)
#store value that contain "alaska" as their state name
alaska_data = trump_data[trump_data$State == "alaska", c("State", "Trump %")]
#join 2 tables by column="State" to store votes percentage
alaska_map = join(alaska_map, alaska_data, by = "State", type = "inner")
stateswithalaska = states[states$state.abb %in% 'AK', ]

#get map data of hawaii
hawaii_map = map_data("world2Hires", "Hawaii")
colnames(hawaii_map)[5] = "State"
hawaii_map$State = tolower(hawaii_map$State)
#store value that contain "hawaii" as their state name
hawaii_data = trump_data[trump_data$State == "hawaii", c("State", "Trump %")]
#join 2 tables by column="State" to store votes percentage
hawaii_map = join(hawaii_map, hawaii_data, by = "State", type = "inner")
stateswithhawaii = states[states$state.abb %in% 'HI', ]

#defining breaks to be used in map for color variaton
brks.to.use = seq(0,100, by =25)
```

```
#display map title
figure.title = "Winning Margin of President Elect- Donald Trump over Clinton"
#call the function.R script which contains functions to display colors in map
source("functions.R")
#call 3 functions that fills color for map, alaska map, and hawaai map separetely
result1 = StatesFunction(trump_states,brks.to.use,figure.title)
result2 = AlaskaFunction(alaska_map,brks.to.use)
result3 = HawaiiFunction(hawaii_map,brks.to.use)
#used to position/layout 3 maps(states, alaska, hawaii) with respect to each other
lay = rbind(c(1,1,1,1,1),c(1,1,1,1,1),c(1,1,1,1,1),c(1,1,1,1,1),c(2,3,NA,NA,NA),c(NA,3,NA,NA,NA))
g = arrangeGrob(grobs = list(result1,result2,result3),layout_matrix = lay)
#save the map image
ggsave("election_result.jpg",g)
```

functions.R

```
#to fill color in states exclusing alaska and hawaai
StatesFunction = function(data, brks, title) {
  ggp = ggplot() +
    #create a shape of map and fill color based on percentage votes using "fill" argument
    geom_polygon(data = data, aes(x = long, y = lat, group = group,
                                  fill = trump_states$`Trump %`), color = "black", size = 0.15) +
    #decide graduent colors in the map and to display it on the scale
    scale_fill_gradient2(midpoint=3.6,low="deepskyblue1",mid="aliceblue",high="red2",breaks=c(-86.8,-
53.525,-20.25,13.025,46.3),
                         labels=c("-80% Clinton","-50% ","-20% ","+10%","+40% Trump"),limits=c(-86.8,46.3))+
    theme_nothing(legend = TRUE) + labs(title = title, fill = "") +
    #label states with the abbreviations
    geom_text(data = unprojected_states, aes(x = x, y = y, label = state.abb), size = 3) +
    # label states using lines and abbreviations
    geom_text_repel(data = projected_states, aes(x = x, y = y,label = state.abb), size = 3,box.padding = unit(.6,
"lines"),
                    point.padding = unit(.175, "lines"),nudge_x = 5.5,nudge_y = .7)
  return(ggp)
}

#to fill color in the state of Alaska
AlaskaFunction = function(data, brks) {
  ggp = ggplot() +
    #create map boundaries and fill color based on votes data
    geom_polygon(data = data, aes(x = long, y = lat, group = group,
                                  fill = alaska_map$`Trump %`), color = "black", size = 0.15) +
    #decide graduent colors in the map and to display it on the scale
    scale_fill_gradient2(midpoint=3.6,low="deepskyblue1",mid="aliceblue",high="red2",breaks=c(-86.8,-
53.525,-20.25,13.025,46.3),
                         labels=c("-80% Clinton","-50%","-20%","10%","40% Trump"),limits=c(-86.8,46.3))+
    theme_nothing(legend = FALSE) + labs(fill = "") +
    #label alaska state with its abbreviation
    annotate("text", x = min(data$long)+ 30, y = min(data$lat) + 12, label = "AK")
  return(ggp)
}

#to fill colors in the state of Hawaii
```

```
HawaiiFunction = function(data, brks) {
  ggp = ggplot() +
    #create a shape of alaska map and fill colors based on votes data using "fill" argument
    geom_polygon(data = data, aes(x = long, y = lat, group = group,
                                  fill = hawaii_map$`Trump %`), color = "black", size = 0.15) +
     #decide graduent colors in the map and to display it on the scale
     scale_fill_gradient2(midpoint=3.6,low="deepskyblue1",mid="aliceblue",high="red2",breaks=c(-86.8,-
53.525,-20.25,13.025,46.3),
                          labels=c("-80% Clinton","-50%","-20%","10%","40% Trump"),limits=c(-86.8,46.3))+
    theme_nothing(legend = FALSE) + labs(fill = "") +
    #label hawaii state with its abbreviation
    annotate("text", x = min(data$long)+13, y = min(data$lat) + 2, label = "HI")
  return(ggp)
}
```

Output:

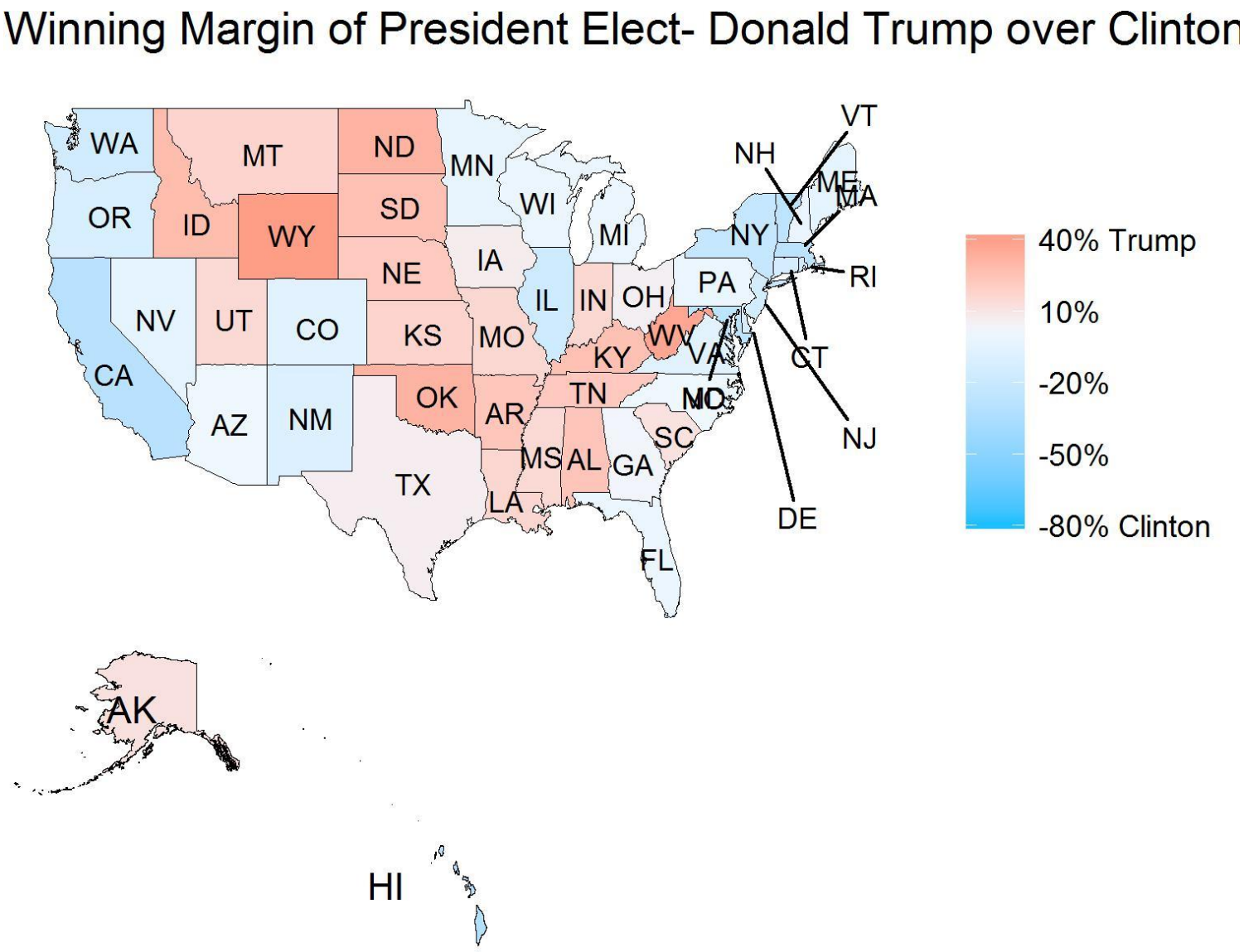

Figure 1: Output map from the R Code