DDS Group beer analysis

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```
#Load Libraries and Data
library(Hmisc)
library(dplyr)
library(ggplot2)
library(grid)
library(gridExtra)
library(jsonlite)
library(kableExtra)
library(knitr)
library(maps)
library(naniar)
library(stringr)
library(tidyr)
library(tidyverse)
library(usmap)
library(caret)
library(class)
```

##1. Number of Breweries Per State #merged Data first ## The number of breweries per state ranges from 1 to 47 with Colordo having the highest number.
## As seen from the map, the number increases with increase in the darckness of the color associated with each state.

```
#breweries <- read.csv("Breweries.csv")
#beer<- read.csv("Beers.csv")
breweries <- read.csv("~/Documents/SMU/DS6306 Doing DS/site/sophiawu1006.github.io/Breweries.csv")
beers <- read.csv("~/Documents/SMU/DS6306 Doing DS/site/sophiawu1006.github.io/Beers.csv")
```

#2. Merge Beer Data with Brewery Data ## The data was obtained in two parts, the beer data and the brewery data. Both files were merged to obtain a common
## data for which analysis was carried out to address the needs of Budweiser.

```
beerBrew=merge(beers,breweries,by.x="Brewery_id",by.y="Brew_ID")
beerBrew$Brewery_id = as.factor(beerBrew$Brewery_id)
beerBrew$Beer_ID = as.factor(beerBrew$Beer_ID)

head(beerBrew, 6)
```

```
##   Brewery_id        Name.x Beer_ID   ABV IBU                                Style Ounces
## 1          1  Get Together    2692 0.045  50                         American IPA     16
## 2          1 Maggie’s Leap    2691 0.049  26                  Milk / Sweet Stout     16
## 3          1    Wall’s End    2690 0.048  19                   English Brown Ale     16
## 4          1       Pumpion    2689 0.060  38                         Pumpkin Ale     16
## 5          1    Stronghold    2688 0.060  25                     American Porter     16
## 6          1   Parapet ESB    2687 0.056  47 Extra Special / Strong Bitter (ESB)     16
##               Name.y        City State
## 1 NorthGate Brewing  Minneapolis    MN
## 2 NorthGate Brewing  Minneapolis    MN
## 3 NorthGate Brewing  Minneapolis    MN
## 4 NorthGate Brewing  Minneapolis    MN
## 5 NorthGate Brewing  Minneapolis    MN
## 6 NorthGate Brewing  Minneapolis    MN
```

```
tail(beerBrew,6)
```

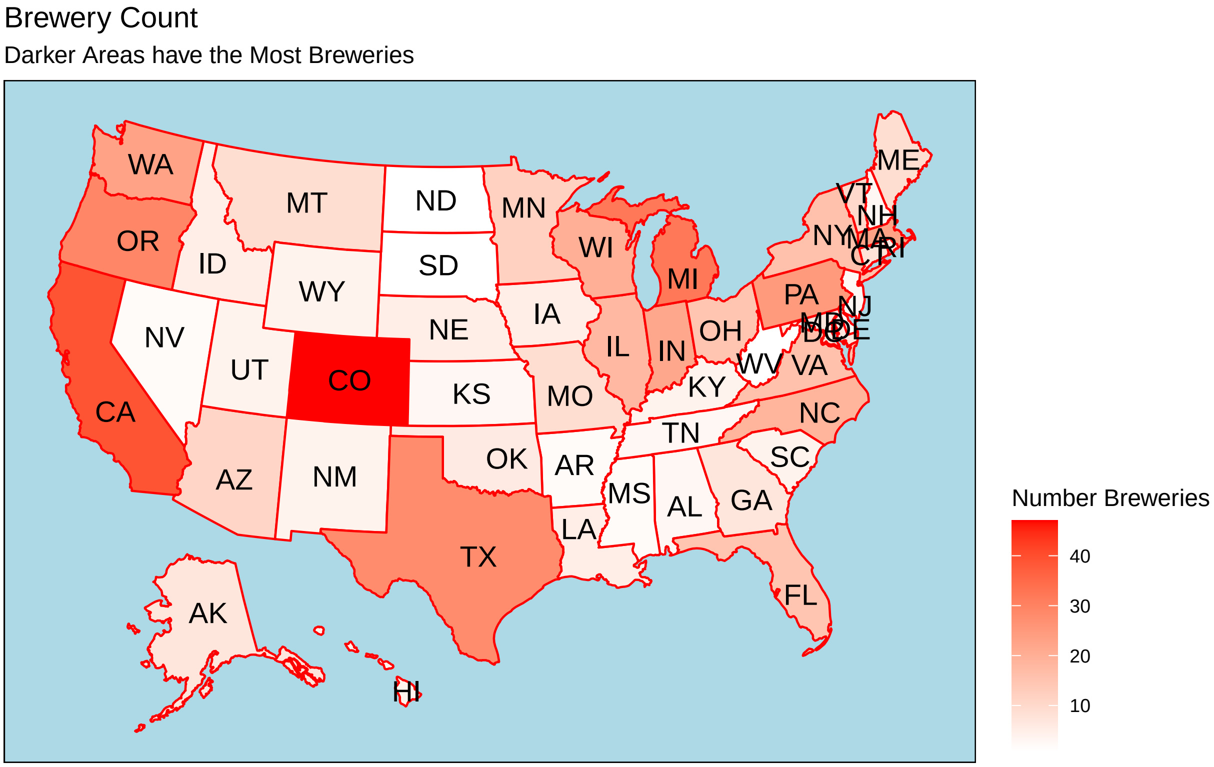
```
##      Brewery_id                    Name.x Beer_ID   ABV IBU                   Style Ounces
## 2405        556             Pilsner Ukiah      98 0.055  NA         German Pilsener     12
## 2406        557  Heinnieweisse Weissebier      52 0.049  NA              Hefeweizen     12
## 2407        557           Snapperhead IPA      51 0.068  NA            American IPA     12
## 2408        557         Moo Thunder Stout      50 0.049  NA      Milk / Sweet Stout     12
## 2409        557         Porkslap Pale Ale      49 0.043  NA American Pale Ale (APA)     12
## 2410        558 Urban Wilderness Pale Ale      30 0.049  NA        English Pale Ale     12
##                             Name.y          City State
## 2405         Ukiah Brewing Company         Ukiah    CA
## 2406       Butternuts Beer and Ale Garrattsville    NY
## 2407       Butternuts Beer and Ale Garrattsville    NY
## 2408       Butternuts Beer and Ale Garrattsville    NY
## 2409       Butternuts Beer and Ale Garrattsville    NY
## 2410 Sleeping Lady Brewing Company     Anchorage    AK
```

```
#add in map data
#add in map data
stateCoords=us_map()
# Remove Leading Spaces from State Column of merged Beer Brew Data frame (prepare for join)
beerBrew$State = gsub(" ","",beerBrew$State)
#str(beerBrew)

# Summarise Each State’s Number of Breweries and Beers
stateBrewBeer1 = beerBrew %>%
  select(State, Brewery_id) %>%
  group_by(State, Brewery_id)
stateBrewBeer2 = stateBrewBeer1 %>% distinct(State, Brewery_id)
stateBrewBeer3 = stateBrewBeer2 %>%  group_by(State) %>% tally()
stateBrewBeer3$state = stateBrewBeer3$State
str(stateBrewBeer3)
```

```
## tibble [51 x 3] (S3: tbl_df/tbl/data.frame)
##  $ State: chr [1:51] "AK" "AL" "AR" "AZ" ...
##  $ n    : int [1:51] 7 3 2 11 39 47 8 1 2 15 ...
##  $ state: chr [1:51] "AK" "AL" "AR" "AZ" ...
```

```r
stateBrewBeer4 = beerBrew %>%
  select(State, Beer_ID) %>%
  group_by(State, Beer_ID)
stateBrewBeer5 = stateBrewBeer4 %>% distinct(State, Beer_ID)
stateBrewBeer6 = stateBrewBeer5 %>%  group_by(State) %>% tally()

StatebeerBrew=merge(stateBrewBeer6,stateBrewBeer3,by.x="State",by.y="State")

#rename counts
colnames(StatebeerBrew)[2] <-"Beers"
colnames(StatebeerBrew)[3] <-"Breweries"

#put in DataFrame for table
#on ppt
map_view_df = StatebeerBrew[order(StatebeerBrew$Breweries),] %>% select(state, Count = Breweries)
view(head(map_view_df,26))
view(tail(map_view_df,25))


#put in nice little map
#on ppt
plot_usmap(data=map_view_df,values="Count",labels = TRUE, offset=0.5, color = "red")  +
  scale_fill_continuous(low = "white", high = "red", name="Number Breweries")+
  theme(legend.position = "right") +
  labs(title = "Brewery Count",
       subtitle = "Darker Areas have the Most Breweries") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

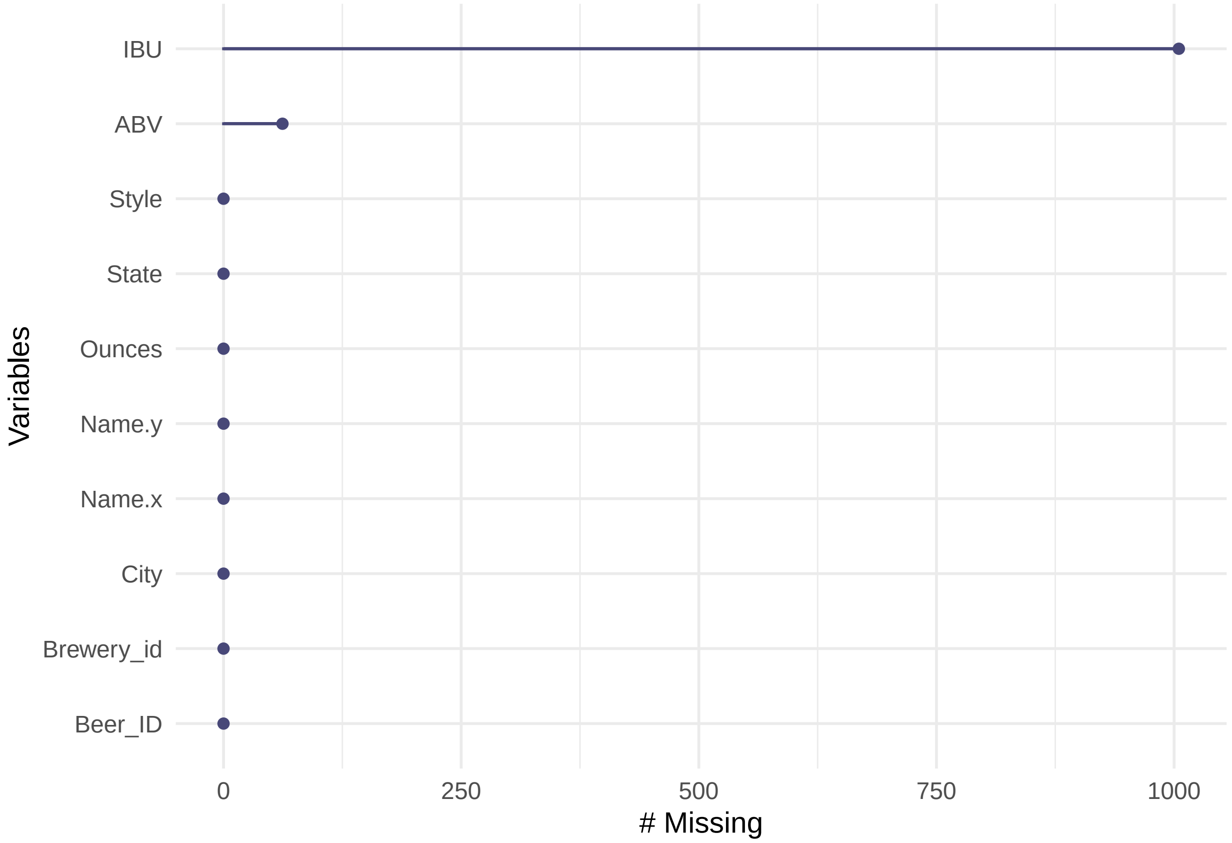
```
## Warning: Ignoring unknown parameters: offset

## Warning: Use of ‘map_df$x‘ is discouraged. Use ‘x‘ instead.

## Warning: Use of ‘map_df$y‘ is discouraged. Use ‘y‘ instead.

## Warning: Use of ‘map_df$group‘ is discouraged. Use ‘group‘ instead.

## Warning: Use of ‘centroid_labels$x‘ is discouraged. Use ‘x‘ instead.

## Warning: Use of ‘centroid_labels$y‘ is discouraged. Use ‘y‘ instead.

## Warning: Use of ‘centroid_labels$abbr‘ is discouraged. Use ‘abbr‘ instead.
```



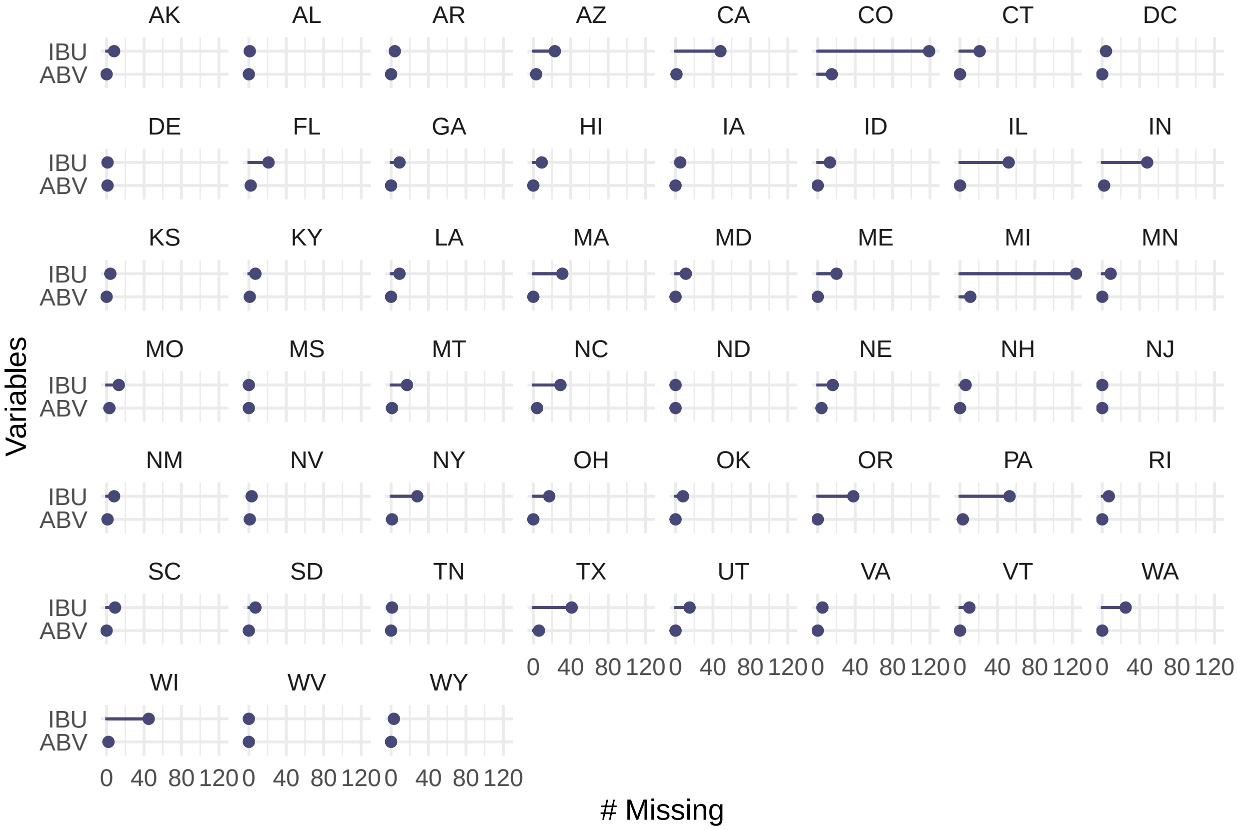
3. Address the missing values in each column.

The data set is missing information from three of the fields. IBU is missing 1,005 data points, ABV is missing 62 data points, and Style is missing 5 data points.

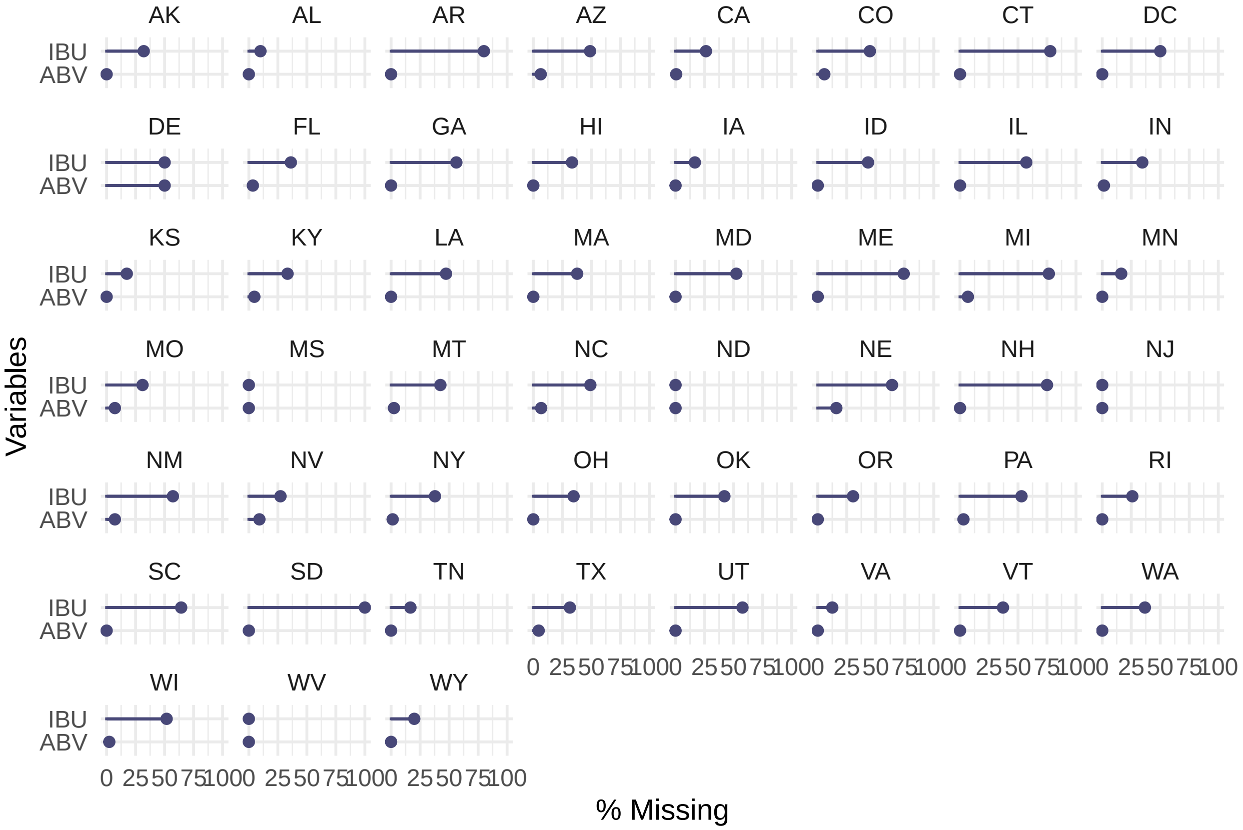
```
#on ppt
gg_miss_var(beerBrew)
```



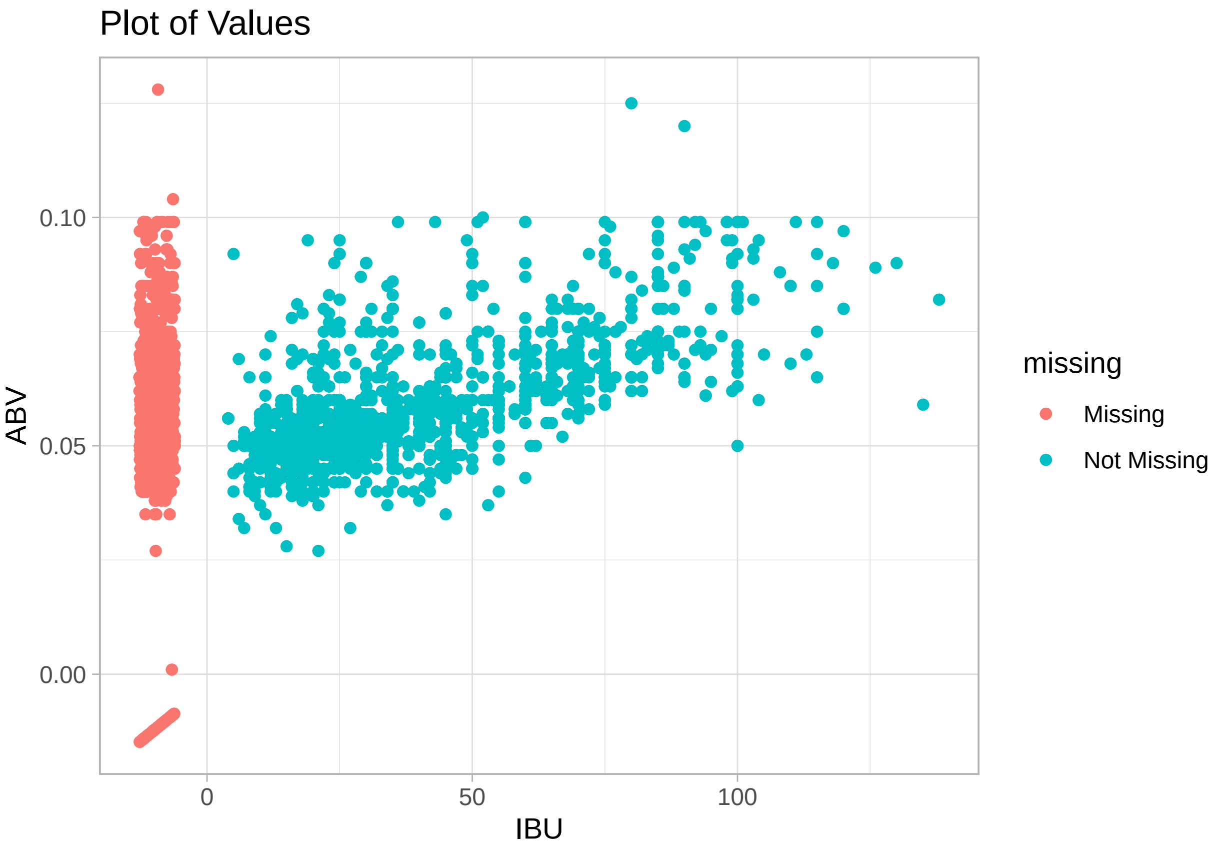
```
gg_miss_var(beerBrew %>% select(IBU,ABV, State), State)
```



```
gg_miss_var(beerBrew %>% select(IBU,ABV, State), State, show_pct = TRUE)
```



```r
ggplot(beerBrew,
       aes(x = IBU,
           y = ABV)) +
  geom_miss_point() + labs(title = "Plot of Values") + theme_light()
```

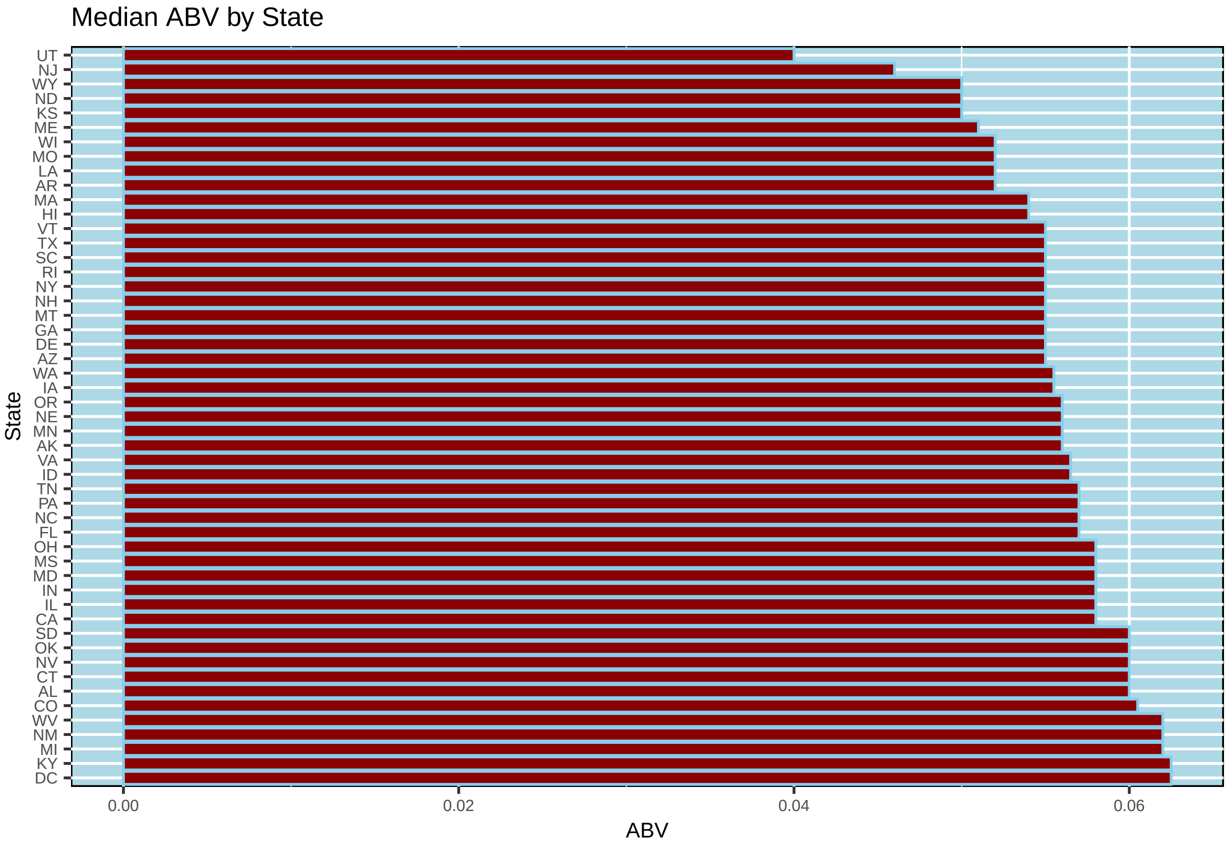


```
# convert empty string Styles to NAs to more easily see missings data in all columns
beerBrew$Style[which(beerBrew$Style=="")]=NA
view(sapply(beerBrew, function(x) sum(is.na(x))))
```

4.Compute the median alcohol content and international bitterness unit for each state. Plot a bar chart to compare. The median ABV for each state ranges between 4% and just over 6% while the IBU ranges between 20 and just over 60.

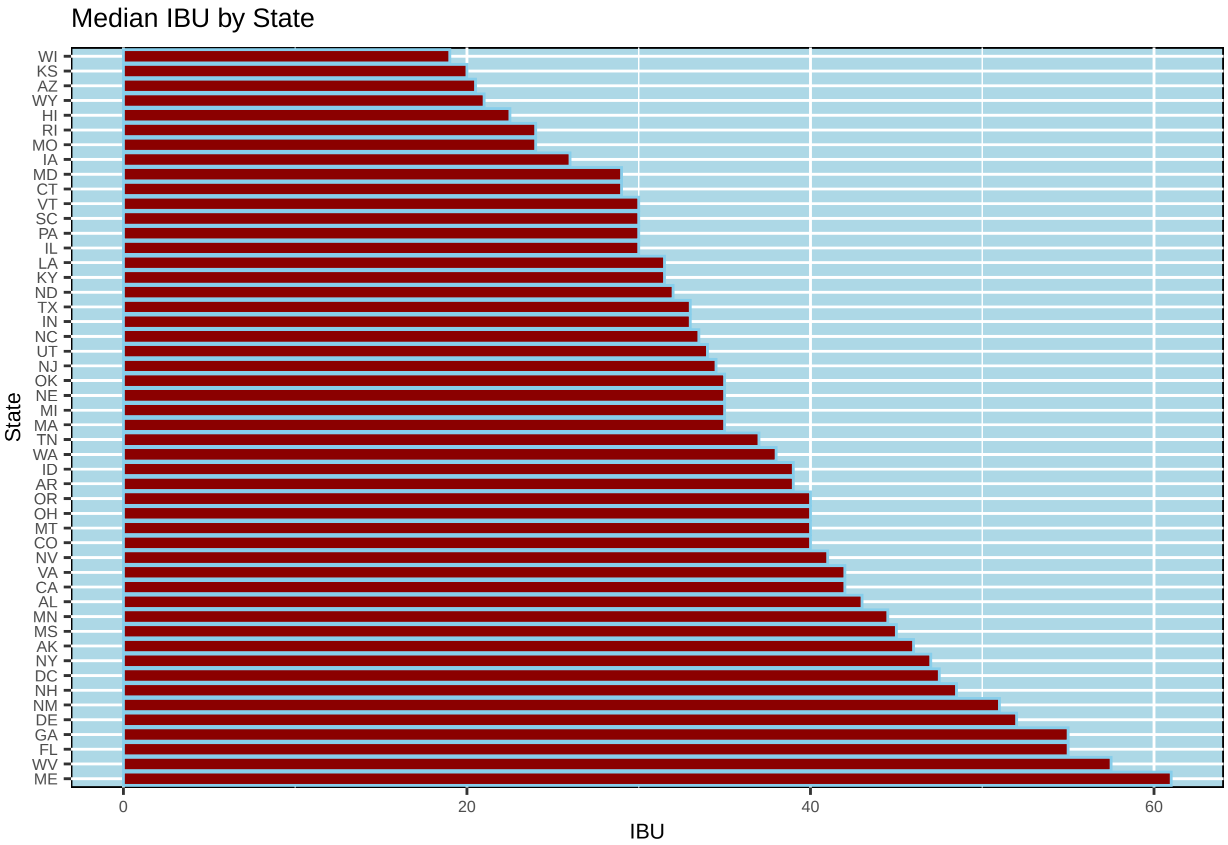
```
beerBrew %>% filter(!is.na(ABV)) %>%
 group_by(State) %>%
  summarise(ABV=median(ABV)) %>%
  ggplot(aes(x=reorder(State,-ABV),ABV)) +
  geom_bar(stat="identity", position="dodge", color='skyblue',fill='darkred') +
  # scale_y_continuous(limits = c(0.5,0.07))+
  coord_flip()+
  xlab("State") +  ylab("ABV") + ggtitle("Median ABV by State") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  theme(text = element_text(size=8,color= 'black'))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```



```
beerBrew %>% filter(!is.na(IBU)) %>%
  group_by(State) %>%
  summarise(IBU=median(IBU)) %>%
  ggplot(aes(x=reorder(State,-IBU),IBU)) +
  geom_bar(stat="identity", position="dodge", color='skyblue',fill='darkred') +
  coord_flip()+
  xlab("State") +  ylab("IBU") + ggtitle("Median IBU by State") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  theme(text = element_text(size=8,color= 'black'))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```



#5. (part 1) Which state has the maximum alcoholic (ABV) beer? #Which state has the most bitter (IBU) beer? ## The state with the maximum ABV was found to be Colorado with 12.8% ##The state with the minimum ABV was found to be CA with 1% ## The state with the maximum IBU was found to be Oregon with 138

## The state with the minimum IBU was found to be CA with 4

```
#find the single most ABV beer
beerBrew %>% filter(!is.na(ABV)) %>% mutate(maxABV=max(ABV)) %>%
  filter(ABV==maxABV) %>% select(State, Name.x, Name.y, ABV)
```

```
##   State                                               Name.x                  Name.y   ABV
## 1    CO Lee Hill Series Vol. 5 - Belgian Style Quadrupel Ale Upslope Brewing Company 0.128
```

```
beerBrew %>% filter(!is.na(ABV)) %>% mutate(minABV=min(ABV)) %>%
  filter(ABV==minABV) %>% select(State, Name.x, Name.y, ABV)
```

```
##   State      Name.x           Name.y   ABV
## 1    CA Scotty K NA Uncommon Brewers 0.001
```

```
beerBrew %>% filter(!is.na(IBU)) %>% mutate(maxABV=max(IBU)) %>%
  filter(IBU==maxABV) %>% select(State, Name.x, Name.y, IBU)
```

```
##   State                    Name.x                  Name.y IBU
## 1    OR Bitter Bitch Imperial IPA Astoria Brewing Company 138
```

```
beerBrew %>% filter(!is.na(IBU)) %>% mutate(minIBU = min(IBU)) %>%
  filter(IBU==minIBU) %>% select(State, Name.x, Name.y, IBU)
```

```
##   State                               Name.x                          Name.y IBU
## 1    CA                      Summer Solstice Anderson Valley Brewing Company   4
## 2    CA Summer Solstice Cerveza Crema (2009) Anderson Valley Brewing Company   4
## 3    CA               Summer Solstice (2011) Anderson Valley Brewing Company   4
```

```
#find the single most bitter beer
beerBrew %>% filter(!is.na(IBU)) %>% mutate(maxIBU=max(IBU)) %>%
  filter(IBU==maxIBU)%>%select(State,Name.x,Name.y,IBU)
```

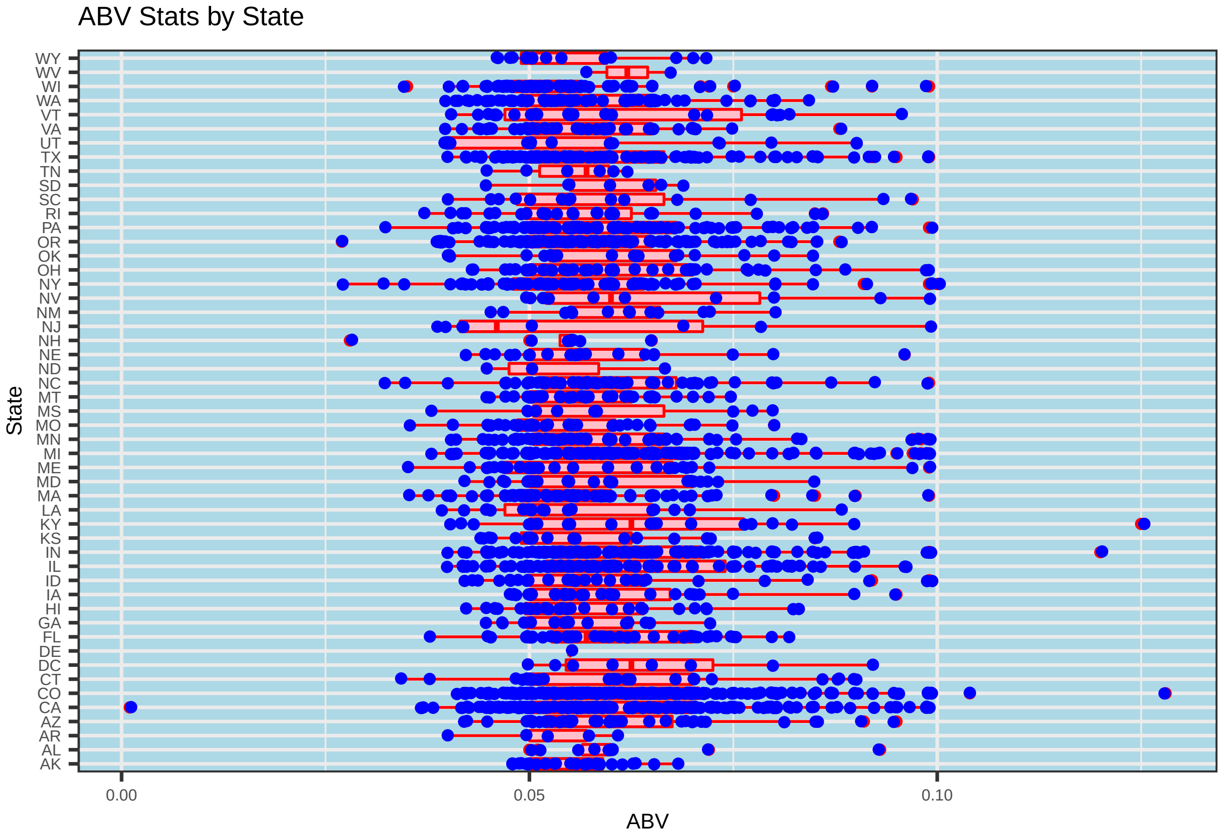
```
##   State                    Name.x                  Name.y IBU
## 1    OR Bitter Bitch Imperial IPA Astoria Brewing Company 138
```

#6.Comment on the summary statistics and distribution of the ABV variable #The ABV is mostly normally distributed although slightly skewed to the right as the mean is Larger than the median.

```
ggplot(data=beerBrew, aes(x = State, y = ABV)) +
  geom_boxplot(col = "red", fill="pink") + coord_flip() +
  geom_jitter(position=position_jitter(0.05),col="blue") +
  theme_bw(base_size = 14) +
  xlab("State") +  ylab("ABV") + ggtitle("ABV Stats by State") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  theme(text = element_text(size=8,color= 'black'))
```

```
## Warning: Removed 62 rows containing non-finite values (stat_boxplot).
```

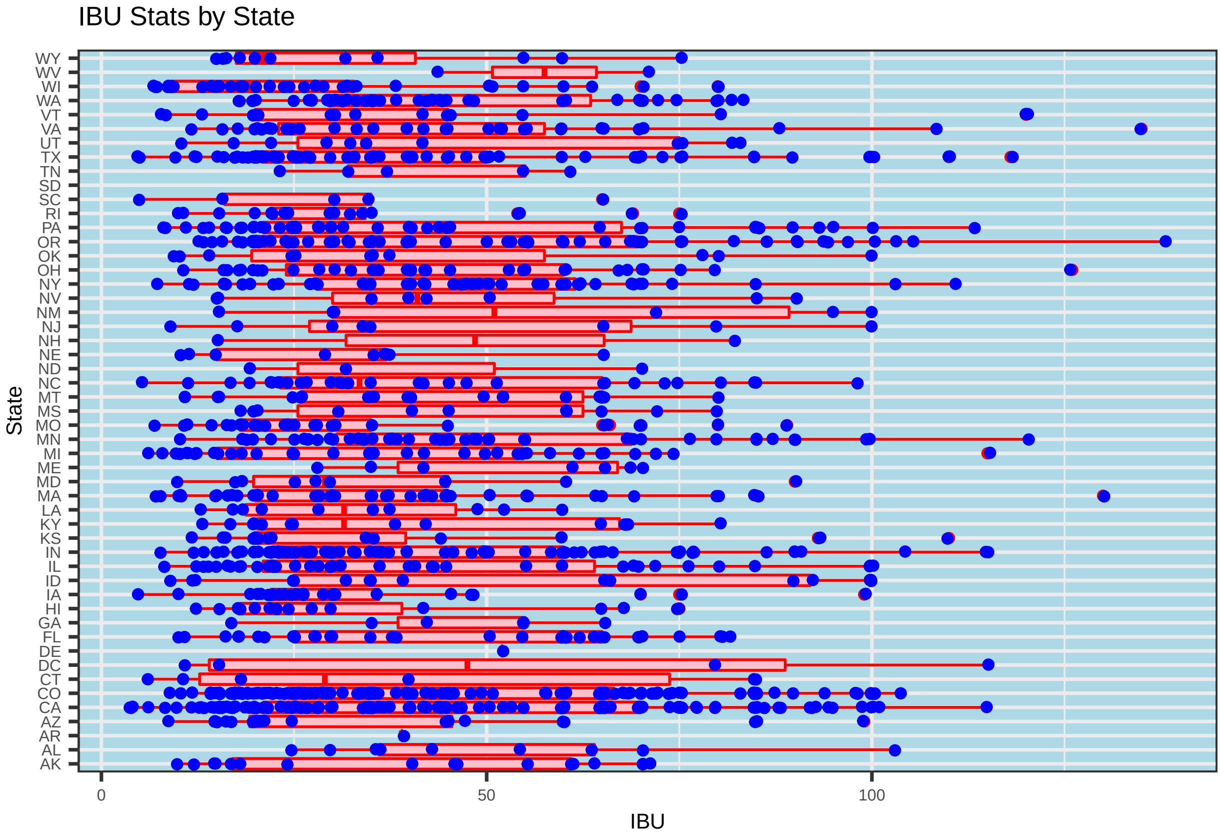
```
## Warning: Removed 62 rows containing missing values (geom_point).
```



```r
ggplot(data=beerBrew, aes(x = State, y = IBU)) +
  geom_boxplot(col = "red", fill="pink") + coord_flip() +
  geom_jitter(position=position_jitter(0.05),col="blue") +
  theme_bw(base_size = 14) +
  xlab("State") +  ylab("IBU") + ggtitle("IBU Stats by State") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  theme(text = element_text(size=8,color= 'black'))
```

```
## Warning: Removed 1005 rows containing non-finite values (stat_boxplot).
```

```
## Warning: Removed 1005 rows containing missing values (geom_point).
```

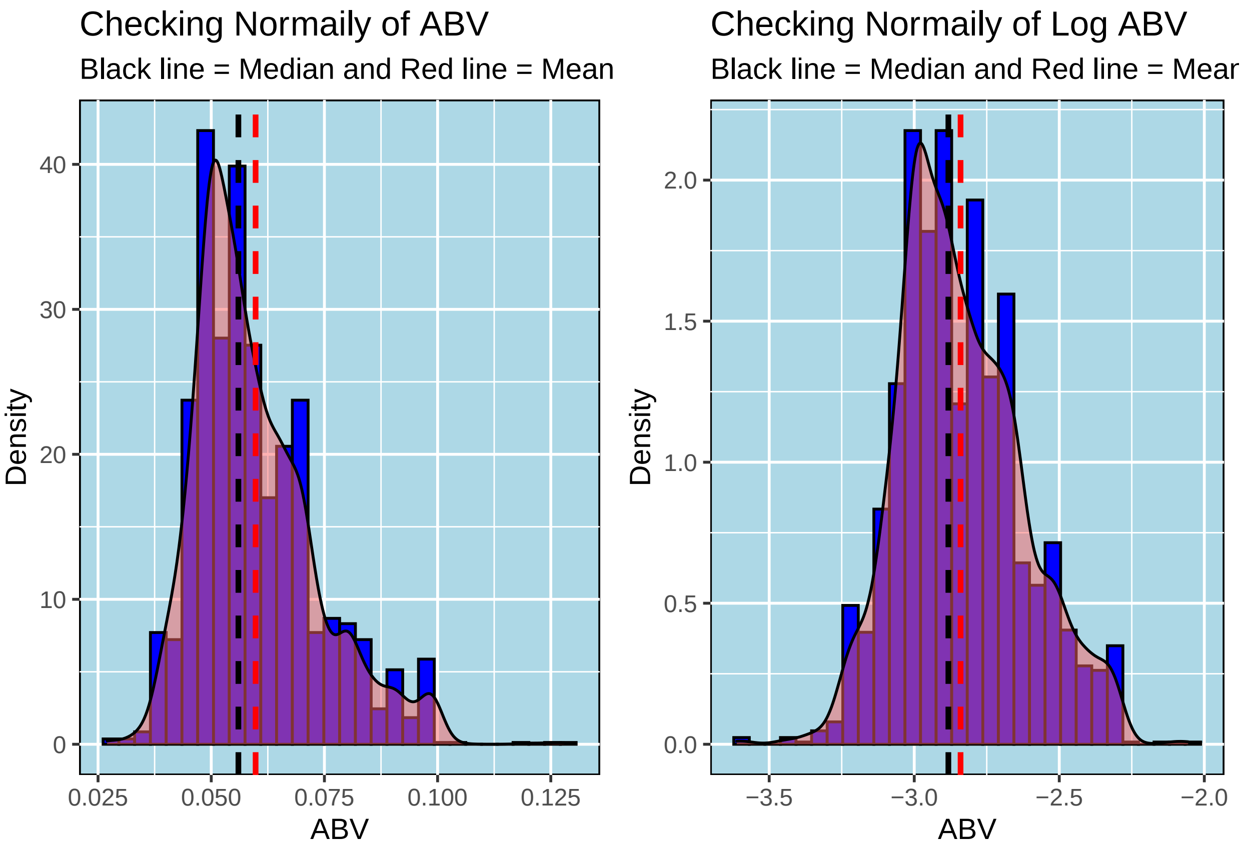


```
#Check for normality of ABV using qq plot and histogram
#on ppt
beerBrew %>% filter(!is.na(ABV)) %>% select(ABV)%>%summary()
```

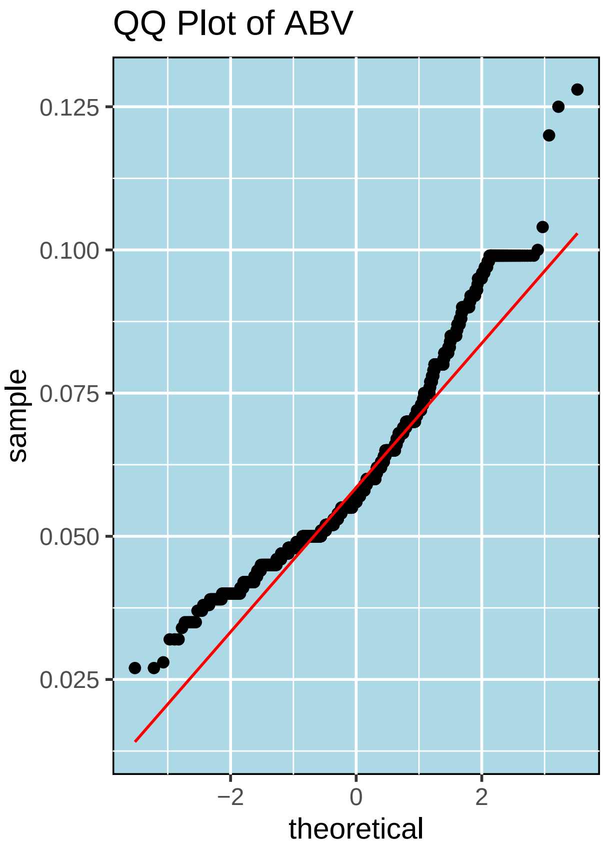
```
##       ABV
##  Min.   :0.00100
##  1st Qu.:0.05000
##  Median :0.05600
##  Mean   :0.05977
##  3rd Qu.:0.06700
##  Max.   :0.12800
```

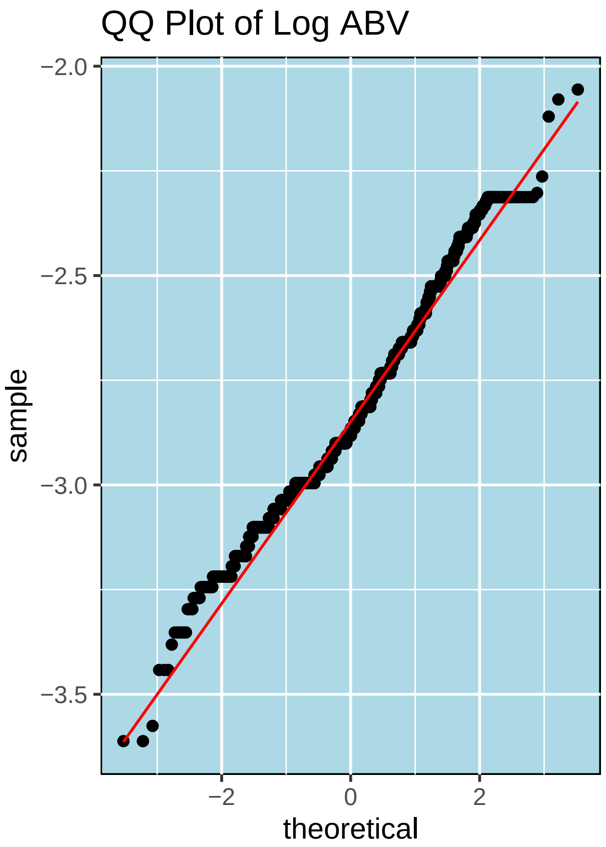
```
gridExtra::grid.arrange(
beerBrew %>% filter(!is.na(ABV)& ABV > .001) %>% ggplot(aes(x=ABV))+
  geom_histogram(aes(y=..density..), colour="black", fill="blue")+
  geom_density(alpha=.5, fill="#FF6666") +
  geom_vline(aes(xintercept=mean(ABV)),
             color="red", linetype="dashed", size=1) +
  geom_vline(aes(xintercept=median(ABV)),
             color="black", linetype="dashed", size=1) +
  labs(y = "Density") + labs(x = "ABV") +
  ggtitle("Checking Normaily of ABV", subtitle = "Black line = Median and Red line = Mean") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue")),


beerBrew %>% filter(!is.na(ABV) & ABV > .001) %>% ggplot(aes(x=log(ABV))+
  geom_histogram(aes(y=..density..), colour="black", fill="blue")+
  geom_density(alpha=.5, fill="#FF6666") +
  geom_vline(aes(xintercept=mean(log(ABV))),
             color="red", linetype="dashed", size=1) +
  geom_vline(aes(xintercept=median(log(ABV))),
             color="black", linetype="dashed", size=1) +
    labs(y = "Density") + labs(x = "ABV") +
  ggtitle("Checking Normaily of Log ABV", subtitle = "Black line = Median and Red line = Mean") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue")),
nrow  = 1
)
```

```
## ‘stat_bin()‘ using ‘bins = 30‘. Pick better value with ‘binwidth‘.
## ‘stat_bin()‘ using ‘bins = 30‘. Pick better value with ‘binwidth‘.
```



```
gridExtra::grid.arrange(
beerBrew %>% filter(!is.na(ABV) & ABV > .001) %>% ggplot(aes(sample=ABV)) +stat_qq() + stat_qq_line(col
  theme(panel.background = element_rect(color = "black", fill = "lightblue")),
beerBrew %>% filter(!is.na(ABV) & ABV > .001) %>% ggplot(aes(sample=log(ABV))) + stat_qq() + stat_qq_li
  theme(panel.background = element_rect(color = "black", fill = "lightblue")),
nrow  = 1
)
```



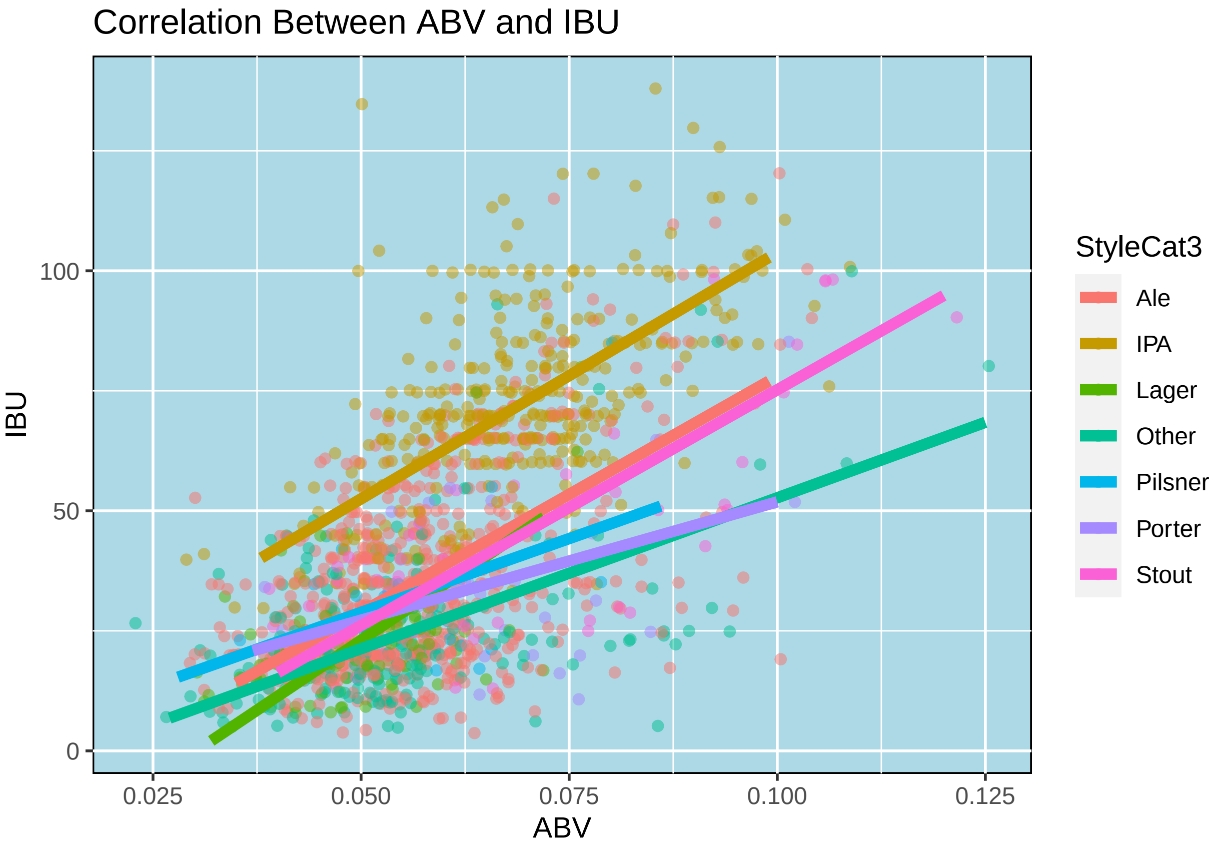


#7. Is there an apparent relationship between the bitterness of the beer and its alcoholic content? Draw a scatter plot. Make your best judgment of a relationship and EXPLAIN your answer. #There is a moderate positive correlation between ABV and IBU.
#The upward slope is evidence of a positive relationship, meaning as the ABV increases, so does the IBU.

```
#Categorize the many styles into 7 groups
beerBrew$StyleCat= case_when(
  grepl( "Ale",beerBrew$Name.x) ~ "Ale",
  grepl("(India Pale Ale|IPA)",beerBrew$Name.x) ~ "IPA",
  grepl("Lager",beerBrew$Name.x)~"Lager",
  grepl("Stout",beerBrew$Name.x)~"Stout",
  grepl("Porter",beerBrew$Name.x)~"Porter",
  grepl("Cider",beerBrew$Name.x)~"Cider",
  grepl("Pilsner",beerBrew$Name.x)~"Pilsner",
  TRUE~"Other"
)


beerBrew$StyleCat2 =   case_when(
  grepl( "Ale",beerBrew$Style) ~ "Ale",
  grepl("(India Pale Ale|IPA)",beerBrew$Style) ~ "IPA",
  grepl("Lager",beerBrew$Style)~"Lager",
  grepl("Stout",beerBrew$Style)~"Stout",
  grepl("Porter",beerBrew$Style)~"Porter",
  grepl("Cider",beerBrew$Style)~"Cider",
  grepl("Pilsner",beerBrew$Style)~"Pilsner",
  TRUE~"Other"
)
```

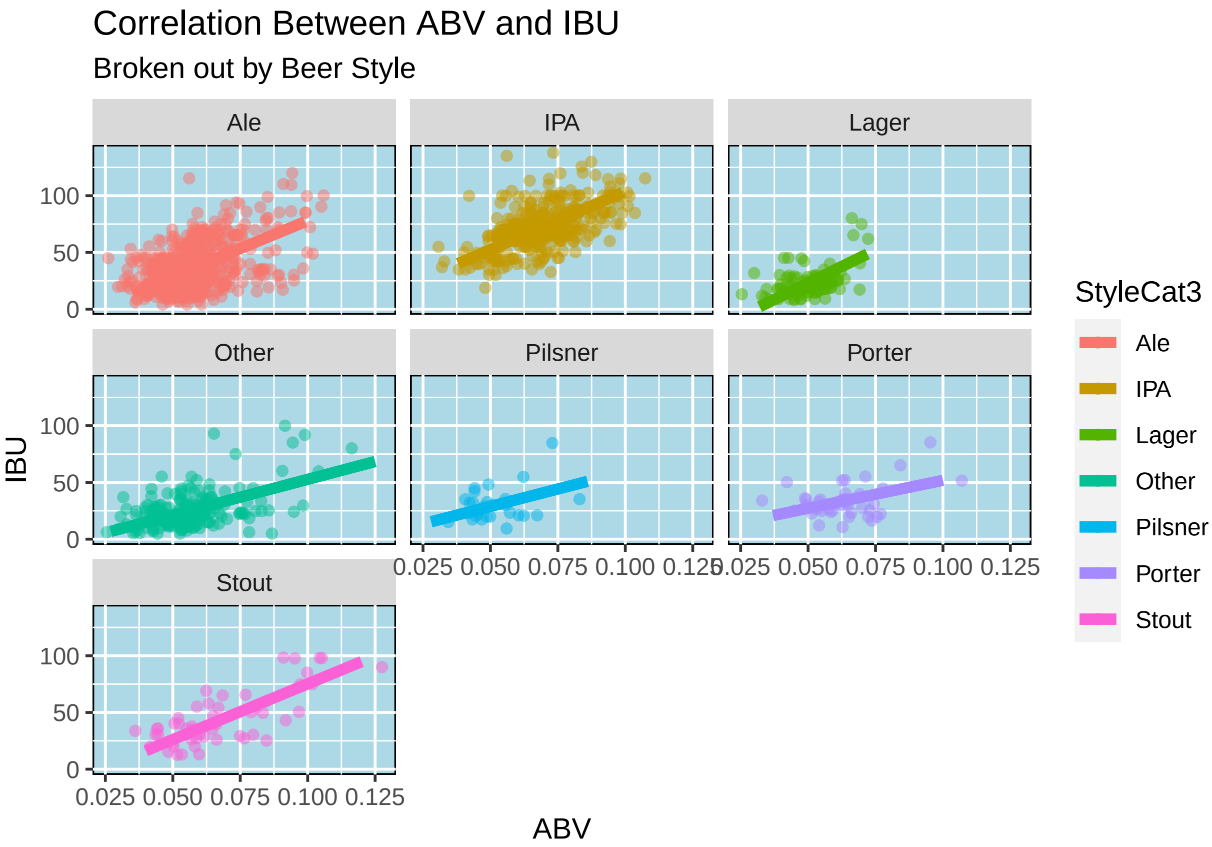
```
beerBrew$StyleCat3 =   case_when(beerBrew$StyleCat == "Other" ~ beerBrew$StyleCat2, TRUE ~ beerBrew$Styl

beerBrew %>% filter(!is.na(ABV)&!is.na(IBU))%>%
  ggplot(aes(ABV,IBU,color=StyleCat3))+
  geom_point(position=position_jitter(width=0.01),alpha=0.5)+
  geom_smooth(method="lm",se=FALSE,size=2) +
  labs(title="Correlation Between ABV and IBU") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

```
## `geom_smooth()` using formula 'y ~ x'
```



```
beerBrew %>% filter(!is.na(ABV)&!is.na(IBU))%>%
  ggplot(aes(ABV,IBU,color=StyleCat3))+
  geom_point(position=position_jitter(width=0.01),alpha=0.5)+
  geom_smooth(method="lm",se=FALSE,size=2) +
  facet_wrap(~StyleCat3) +
  labs(title="Correlation Between ABV and IBU", subtitle = "Broken out by Beer Style") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

```
## `geom_smooth()` using formula 'y ~ x'
```



#8.1 Group beer styles into larger style buckets #Categorize the many styles into 5 groups

```r
beers2 <- beers
colnames(beers2)
```

```
## [1] "Name"        "Beer_ID"     "ABV"         "IBU"         "Brewery_id" "Style"
## [7] "Ounces"
```

```r
names(beers2) <- c("beername", "beerID", "beerABV", "beerIBU", "beer.brewery.id", "beerstyle", "beerOun
head(beers2)
```

```
##               beername beerID beerABV beerIBU beer.brewery.id                      beerstyle
## 1             Pub Beer   1436   0.050      NA             409            American Pale Lager
## 2          Devil’s Cup   2265   0.066      NA             178        American Pale Ale (APA)
## 3  Rise of the Phoenix   2264   0.071      NA             178                   American IPA
## 4             Sinister   2263   0.090      NA             178 American Double / Imperial IPA
## 5        Sex and Candy   2262   0.075      NA             178                   American IPA
## 6         Black Exodus   2261   0.077      NA             178                  Oatmeal Stout
##   beerOunce
## 1        12
## 2        12
## 3        12
## 4        12
## 5        12
## 6        12
```

```
brew2 <- breweries
colnames(brew2)
```

```
## [1] "Brew_ID" "Name"    "City"    "State"
```

```
names(brew2) <- c("brewery.id", "brewery.name", "brewery.city", "brewery.state.abb")

brew2 <- brew2 %>%
  mutate(brewery.state.abb = trimws(brewery.state.abb))

head(brew2)
```

```
##   brewery.id              brewery.name  brewery.city brewery.state.abb
## 1          1         NorthGate Brewing   Minneapolis                MN
## 2          2 Against the Grain Brewery    Louisville                KY
## 3          3  Jack’s Abby Craft Lagers    Framingham                MA
## 4          4 Mike Hess Brewing Company     San Diego                CA
## 5          5   Fort Point Beer Company San Francisco                CA
## 6          6     COAST Brewing Company    Charleston                SC
```

#Insert State name and region

```
#makes a data frame with State abbreviation, name  and region
stateinf= data.frame(state.abb, state.name, state.region, state.x77, stringsAsFactors=FALSE)
head(stateinf[1:5])
```

```
##            state.abb state.name state.region Population Income
## Alabama           AL    Alabama        South       3615   3624
## Alaska            AK     Alaska         West        365   6315
## Arizona           AZ    Arizona         West       2212   4530
## Arkansas          AR   Arkansas        South       2110   3378
## California        CA California         West      21198   5114
## Colorado          CO   Colorado         West       2541   4884
```

#Merge data brew2 with data stateinf and calculate breweries numbers are present in each state

```
brewstate<- merge(brew2, stateinf[1:5], by.x = "brewery.state.abb", by.y = "state.abb", all.x = TRUE)

head(brewstate)
```

```
##   brewery.state.abb brewery.id                  brewery.name brewery.city state.name
## 1                AK        494  Broken Tooth Brewing Company    Anchorage     Alaska
## 2                AK        224  Midnight Sun Brewing Company    Anchorage     Alaska
## 3                AK        459   Kenai River Brewing Company     Soldotna     Alaska
## 4                AK        454        Denali Brewing Company    Talkeetna     Alaska
## 5                AK        558 Sleeping Lady Brewing Company    Anchorage     Alaska
## 6                AK        271       Alaskan Brewing Company       Juneau     Alaska
##   state.region Population Income
## 1         West        365   6315
## 2         West        365   6315
## 3         West        365   6315
## 4         West        365   6315
## 5         West        365   6315
## 6         West        365   6315
```

```
beermerged <- merge(beers2, brewstate, by.x = "beer.brewery.id", by.y = "brewery.id")
```

```
beermerged$beeripaale<- ''

head(beermerged)
```

```
##   beer.brewery.id      beername beerID beerABV beerIBU                           beerstyle
## 1               1  Get Together   2692   0.045      50                        American IPA
## 2               1 Maggie's Leap   2691   0.049      26                 Milk / Sweet Stout
## 3               1    Wall's End   2690   0.048      19                   English Brown Ale
## 4               1       Pumpion   2689   0.060      38                         Pumpkin Ale
## 5               1    Stronghold   2688   0.060      25                     American Porter
## 6               1   Parapet ESB   2687   0.056      47 Extra Special / Strong Bitter (ESB)
##   beerOunce brewery.state.abb       brewery.name brewery.city state.name  state.region
## 1        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
## 2        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
## 3        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
## 4        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
## 5        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
## 6        16                MN NorthGate Brewing   Minneapolis  Minnesota North Central
##   Population Income beeripaale
## 1       3921   4675
## 2       3921   4675
## 3       3921   4675
## 4       3921   4675
## 5       3921   4675
## 6       3921   4675
```

```
#Get all different beers styles' numbers
beermerged %>%count(beerstyle)
```

```
##                               beerstyle   n
## 1                                         5
## 2                     Abbey Single Ale    2
## 3                              Altbier   13
## 4                American Adjunct Lager  18
## 5              American Amber / Red Ale 133
## 6            American Amber / Red Lager  29
## 7                   American Barleywine   3
## 8                    American Black Ale  36
## 9                   American Blonde Ale 108
## 10                   American Brown Ale  70
## 11              American Dark Wheat Ale   7
## 12       American Double / Imperial IPA 105
## 13   American Double / Imperial Pilsner   2
## 14     American Double / Imperial Stout   9
## 15            American India Pale Lager   3
## 16                         American IPA 424
## 17                  American Malt Liquor   1
## 18              American Pale Ale (APA) 245
## 19                  American Pale Lager  39
## 20                American Pale Wheat Ale  97
## 21                     American Pilsner  25
## 22                      American Porter  68
## 23                       American Stout  39
## 24                  American Strong Ale  14
## 25                   American White IPA  11
## 26                    American Wild Ale   6
## 27                        Baltic Porter   6
## 28                     Belgian Dark Ale  11
## 29                          Belgian IPA  18
## 30                     Belgian Pale Ale  24
## 31              Belgian Strong Dark Ale   6
## 32              Belgian Strong Pale Ale   7
## 33                   Berliner Weissbier  11
## 34                       Bière de Garde   7
## 35                                 Bock   7
## 36                              Braggot   1
## 37       California Common / Steam Beer   6
## 38                           Chile Beer   3
## 39                                Cider  37
## 40                            Cream Ale  29
## 41                       Czech Pilsener  28
## 42                           Doppelbock   7
## 43            Dortmunder / Export Lager   6
## 44                               Dubbel   5
## 45                         Dunkelweizen   4
## 46                   English Barleywine   3
## 47                       English Bitter   3
## 48                    English Brown Ale  18
## 49                English Dark Mild Ale   6
## 50         English India Pale Ale (IPA)  13
## 51                     English Pale Ale  12
## 52                English Pale Mild Ale   3
## 53                        English Stout   2
## 54                   English Strong Ale   4
## 55                      Euro Dark Lager   5
## 56                      Euro Pale Lager   2
## 57  Extra Special / Strong Bitter (ESB)  20
## 58                   Flanders Oud Bruin   1
## 59                     Flanders Red Ale   1
## 60               Foreign / Export Stout   6
## 61               Fruit / Vegetable Beer  49
## 62                      German Pilsener  36
## 63                                 Gose  10
## 64                             Grisette   1
## 65                           Hefeweizen  40
## 66                 Herbed / Spiced Beer   9
## 67                      Irish Dry Stout   5
## 68                        Irish Red Ale  12
## 69           Keller Bier / Zwickel Bier   3
## 70                               Kölsch  42
## 71                        Kristalweizen   1
## 72                          Light Lager  12
## 73                     Low Alcohol Beer   1
## 74                Maibock / Helles Bock   5
## 75                 Märzen / Oktoberfest  30
## 76                                 Mead   5
## 77                   Milk / Sweet Stout  10
## 78                  Munich Dunkel Lager   4
## 79                  Munich Helles Lager  20
## 80                        Oatmeal Stout  18
## 81                              Old Ale   2
## 82                                Other   1
## 83                          Pumpkin Ale  23
## 84                     Quadrupel (Quad)   4
## 85                               Radler   3
## 86                            Rauchbier   2
## 87                           Roggenbier   2
## 88               Russian Imperial Stout  11
## 89                             Rye Beer  18
## 90               Saison / Farmhouse Ale  52
## 91                          Schwarzbier   9
## 92                Scotch Ale / Wee Heavy  15
## 93                         Scottish Ale  19
## 94                               Shandy   3
## 95                          Smoked Beer   1
## 96                               Tripel  11
## 97                         Vienna Lager  20
## 98                            Wheat Ale   1
## 99                        Winter Warmer  15
## 100                             Witbier  51
```

```
#filter missing value
beermerged %>%
  filter(beerstyle == ’’)
```

```
##   beer.brewery.id                       beername beerID beerABV beerIBU beerstyle beerOunce
## 1              30                Special Release   2210      NA      NA                  16
## 2              67                  OktoberFiesta   2527   0.053      27                  12
## 3             161 Kilt Lifter Scottish-Style Ale   1635   0.060      21                  12
## 4             167                   The CROWLER   1796      NA      NA                  32
## 5             167           CAN’D AID Foundation   1790      NA      NA                  12
##   brewery.state.abb               brewery.name brewery.city state.name state.region
## 1                TX        Cedar Creek Brewery Seven Points      Texas        South
## 2                TX   Freetail Brewing Company  San Antonio      Texas        South
## 3                AZ Four Peaks Brewing Company        Tempe    Arizona         West
## 4                CO        Oskar Blues Brewery     Longmont   Colorado         West
## 5                CO        Oskar Blues Brewery     Longmont   Colorado         West
##   Population Income beeripaale
## 1      12237   4188
## 2      12237   4188
## 3       2212   4530
## 4       2541   4884
## 5       2541   4884
```

```
beermerged %>%
  filter(beerstyle %in% c("American Double / Imperial IPA", "American IPA", "Belgian IPA", "English Indi
  count(beerstyle)
```

```
##                         beerstyle   n
## 1 American Double / Imperial IPA 105
## 2                   American IPA 424
## 3                    Belgian IPA  18
## 4   English India Pale Ale (IPA)  13
```

```
beeripa <- beermerged %>%
  filter(beerstyle %in% c("American Double / Imperial IPA", "American IPA", "Belgian IPA", "English Indi
  mutate(beeripaale= ’IPA’)


head(beeripa)
```

```
##   beer.brewery.id       beername beerID beerABV beerIBU                      beerstyle
## 1               1   Get Together   2692   0.045      50                   American IPA
## 2               2 Citra Ass Down   2686   0.080      68 American Double / Imperial IPA
## 3               2    Rico Sauvin   2678   0.076      68 American Double / Imperial IPA
## 4               2   Pile of Face   2675   0.060      65                   American IPA
## 5               4 Habitus (2014)   2668   0.080     100 American Double / Imperial IPA
## 6               4          Solis   2667   0.075      85                   American IPA
##   beerOunce brewery.state.abb              brewery.name brewery.city state.name
## 1        16                MN        NorthGate Brewing   Minneapolis  Minnesota
## 2        16                KY Against the Grain Brewery   Louisville   Kentucky
## 3        16                KY Against the Grain Brewery   Louisville   Kentucky
## 4        16                KY Against the Grain Brewery   Louisville   Kentucky
## 5        16                CA Mike Hess Brewing Company    San Diego California
## 6        16                CA Mike Hess Brewing Company    San Diego California
##    state.region Population Income beeripaale
## 1 North Central       3921   4675        IPA
## 2         South       3387   3712        IPA
## 3         South       3387   3712        IPA
## 4         South       3387   3712        IPA
## 5          West      21198   5114        IPA
## 6          West      21198   5114        IPA
```

```
# Kilt Lifter Scottish-Style Ale (1635)
beermerged[946,]
```

```
##     beer.brewery.id                       beername beerID beerABV beerIBU beerstyle
## 946             161 Kilt Lifter Scottish-Style Ale   1635    0.06      21          
##     beerOunce brewery.state.abb               brewery.name brewery.city state.name
## 946        12                AZ Four Peaks Brewing Company        Tempe    Arizona
##     state.region Population Income beeripaale
## 946         West       2212   4530
```

```
beermerged %>%
  filter(!beerstyle %in% c("American Double / Imperial IPA", "American IPA", "Belgian IPA", "English Ind
  filter(str_detect(beerstyle, "Ale") |  beerID==1635) %>%
  count(beerstyle)
```

```
##                    beerstyle   n
## 1                              1
## 2          Abbey Single Ale   2
## 3  American Amber / Red Ale 133
## 4        American Black Ale  36
## 5       American Blonde Ale 108
## 6        American Brown Ale  70
## 7   American Dark Wheat Ale   7
## 8   American Pale Ale (APA) 245
## 9   American Pale Wheat Ale  97
## 10      American Strong Ale  14
## 11        American Wild Ale   6
## 12         Belgian Dark Ale  11
## 13         Belgian Pale Ale  24
## 14  Belgian Strong Dark Ale   6
## 15  Belgian Strong Pale Ale   7
## 16                Cream Ale  29
## 17        English Brown Ale  18
## 18    English Dark Mild Ale   6
## 19         English Pale Ale  12
## 20    English Pale Mild Ale   3
## 21       English Strong Ale   4
## 22         Flanders Red Ale   1
## 23            Irish Red Ale  12
## 24                  Old Ale   2
## 25              Pumpkin Ale  23
## 26   Saison / Farmhouse Ale  52
## 27   Scotch Ale / Wee Heavy  15
## 28             Scottish Ale  19
## 29                Wheat Ale   1
```

```
beerale <- beermerged %>%
  filter(!beerstyle %in% c("American Double / Imperial IPA", "American IPA", "Belgian IPA", "English Ind
  filter(str_detect(beerstyle, "Ale") |beerID==1635) %>%
  mutate(beeripaale= ’Ale’)

head(beerale)
```

```
##   beer.brewery.id         beername beerID beerABV beerIBU               beerstyle beerOunce
## 1               1       Wall’s End   2690   0.048      19       English Brown Ale        16
## 2               1          Pumpion   2689   0.060      38             Pumpkin Ale        16
## 3               2           A Beer   2683   0.042      42 American Pale Ale (APA)        16
## 4               2    Flesh Gourd’n   2681   0.066      21             Pumpkin Ale        16
## 5               2         Sho’nuff   2680   0.040      13        Belgian Pale Ale        16
## 6               2 Coq de la Marche   2677   0.051      38  Saison / Farmhouse Ale        16
##   brewery.state.abb              brewery.name brewery.city state.name  state.region
## 1                MN        NorthGate Brewing   Minneapolis  Minnesota North Central
## 2                MN        NorthGate Brewing   Minneapolis  Minnesota North Central
## 3                KY Against the Grain Brewery   Louisville   Kentucky         South
## 4                KY Against the Grain Brewery   Louisville   Kentucky         South
## 5                KY Against the Grain Brewery   Louisville   Kentucky         South
## 6                KY Against the Grain Brewery   Louisville   Kentucky         South
##   Population Income beeripaale
## 1       3921   4675        Ale
## 2       3921   4675        Ale
## 3       3387   3712        Ale
## 4       3387   3712        Ale
## 5       3387   3712        Ale
## 6       3387   3712        Ale
```

```
head(beermerged) %>%
  mutate(beer.style.words = as.character(str_split(beerstyle, boundary("word")))) %>%
  select(beer.style.words)
```

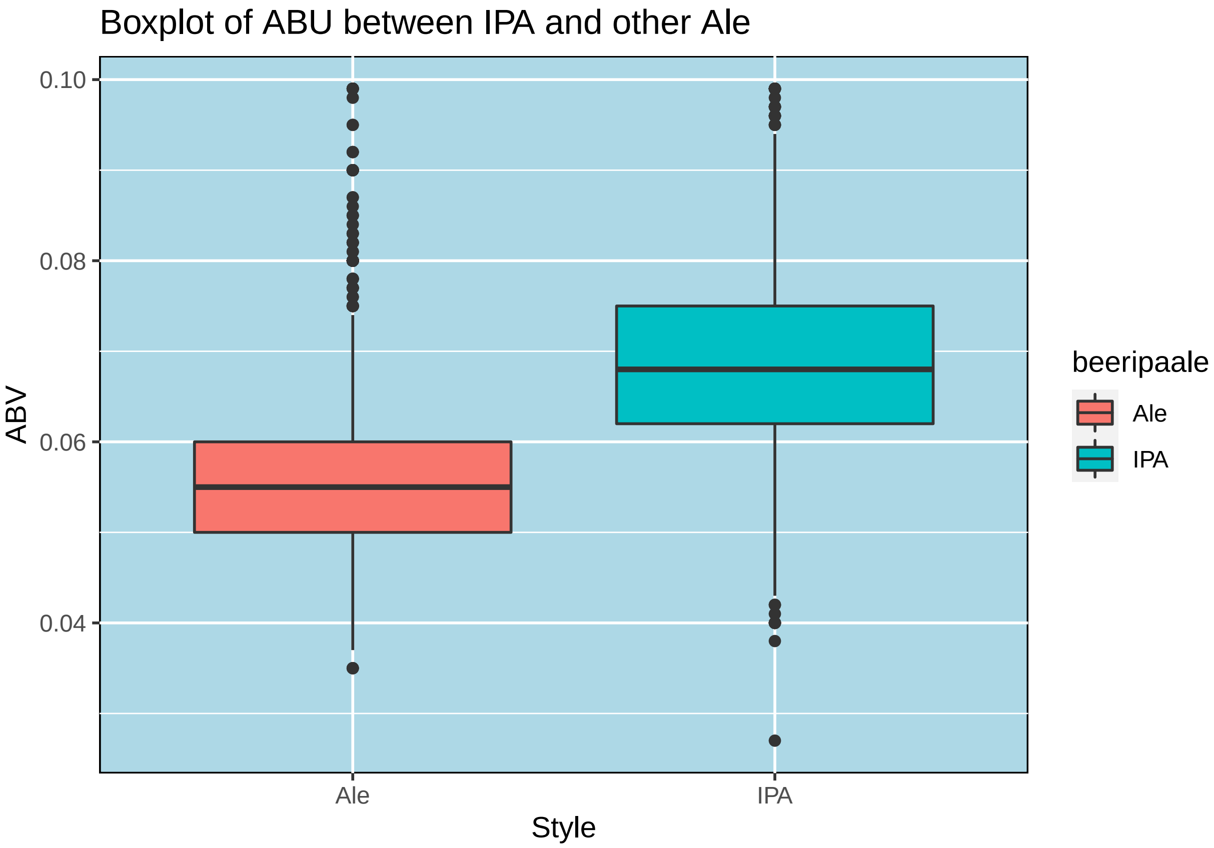
```
##                                    beer.style.words
## 1                             c("American", "IPA")
## 2                     c("Milk", "Sweet", "Stout")
## 3                    c("English", "Brown", "Ale")
## 4                              c("Pumpkin", "Ale")
## 5                          c("American", "Porter")
## 6 c("Extra", "Special", "Strong", "Bitter", "ESB")
```

```
# India Pale Ale
IPA <- c("American Double / Imperial IPA", "American IPA", "Belgian IPA", "English India Pale Ale (IPA)
```

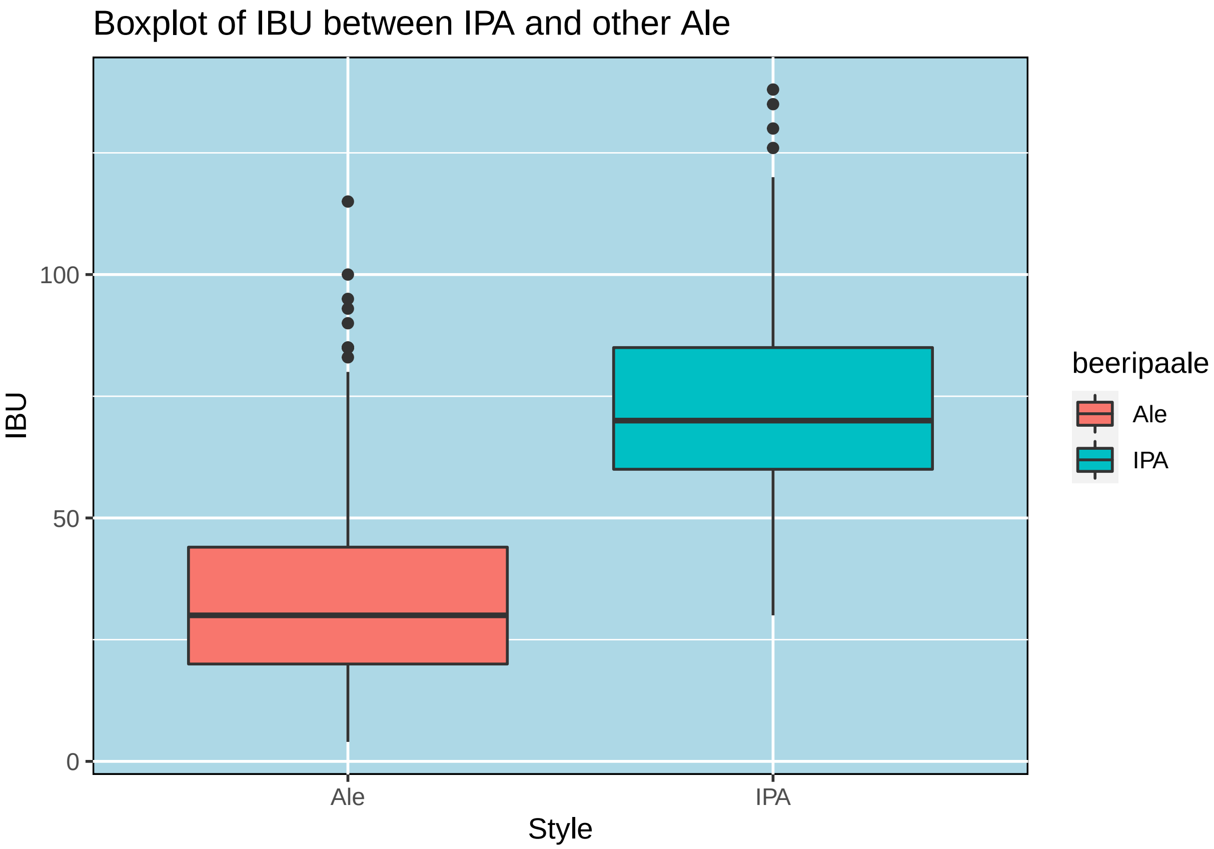
```
total_beers_count <- dim(beermerged)[1]
ipa_count <- dim(beeripa)[1]
ale_count <- dim(beerale)[1]

beercombined_ale <- rbind(beeripa, beerale)

ipa_ale_count <- dim(beercombined_ale)[1]


head(beercombined_ale)
```

```
##   beer.brewery.id       beername beerID beerABV beerIBU                      beerstyle
## 1               1   Get Together   2692   0.045      50                   American IPA
## 2               2 Citra Ass Down   2686   0.080      68 American Double / Imperial IPA
## 3               2    Rico Sauvin   2678   0.076      68 American Double / Imperial IPA
## 4               2   Pile of Face   2675   0.060      65                   American IPA
## 5               4 Habitus (2014)   2668   0.080     100 American Double / Imperial IPA
## 6               4          Solis   2667   0.075      85                   American IPA
##   beerOunce brewery.state.abb              brewery.name brewery.city state.name
## 1        16                MN       NorthGate Brewing    Minneapolis  Minnesota
## 2        16                KY Against the Grain Brewery   Louisville   Kentucky
## 3        16                KY Against the Grain Brewery   Louisville   Kentucky
## 4        16                KY Against the Grain Brewery   Louisville   Kentucky
## 5        16                CA Mike Hess Brewing Company    San Diego California
## 6        16                CA Mike Hess Brewing Company    San Diego California
##    state.region Population Income beeripaale
## 1 North Central       3921   4675        IPA
## 2         South       3387   3712        IPA
## 3         South       3387   3712        IPA
## 4         South       3387   3712        IPA
## 5          West      21198   5114        IPA
## 6          West      21198   5114        IPA
```

```
beercombined_ale %>%
  filter(!is.na(beerABV)) %>%
  ggplot(aes(x =beeripaale, y =beerABV, fill = beeripaale)) +
  geom_boxplot() +
  ggtitle("Boxplot of ABU between IPA and other Ale") +
  xlab("Style") +
  ylab("ABV")+
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```



```
beercombined_ale %>%
  filter(!is.na(beerIBU)) %>%
  ggplot(aes(x = beeripaale, y =beerIBU, fill = beeripaale)) +
  geom_boxplot() +
  ggtitle("Boxplot of IBU between IPA and other Ale") +
  xlab("Style") +
  ylab("IBU")+
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

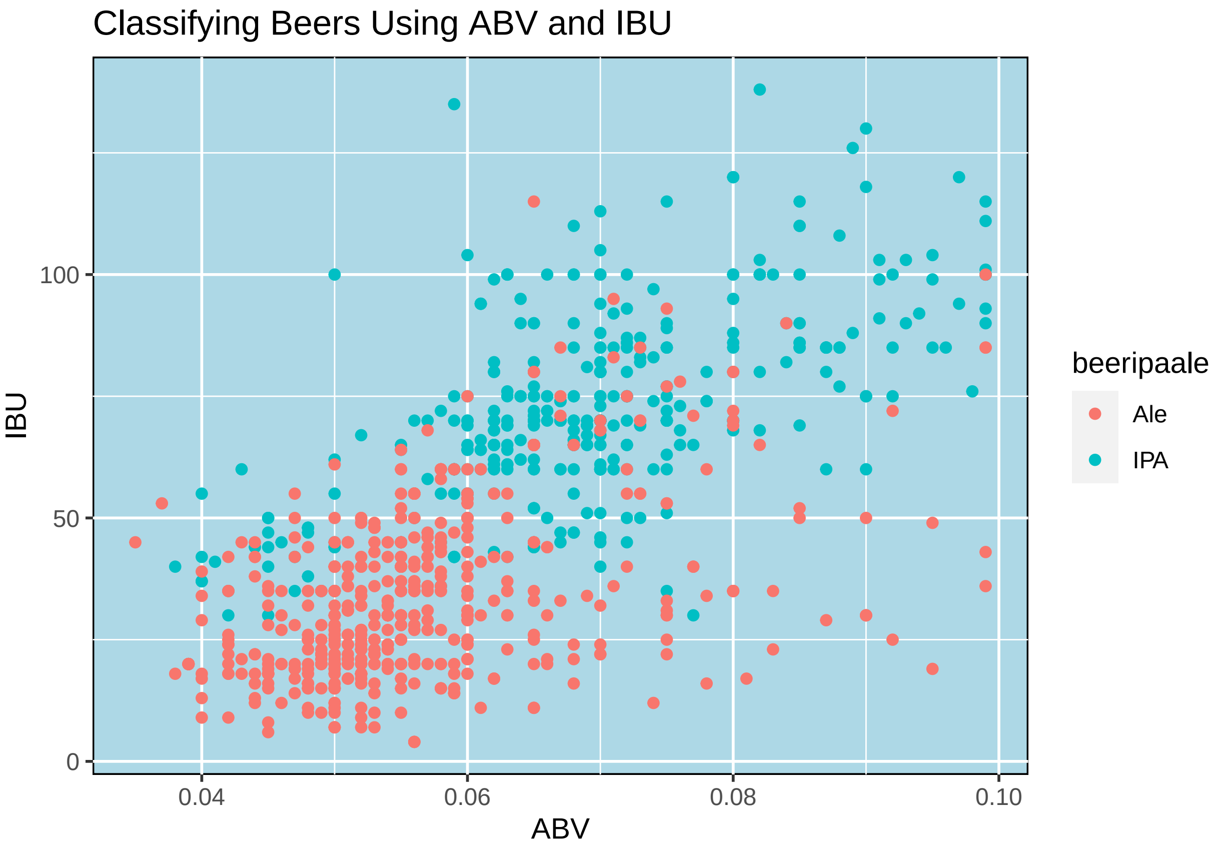


```
library(Hmisc)
beerclassify <- beercombined_ale %>%
  filter(!is.na(beerABV) & !is.na(beerIBU) & !is.na(Population) & !is.na(Income))

beerclassify %>%
  group_by(beeripaale) %>%
  summarise(beers.abv.median = median(beerABV), beers.ibu.median = median(beerIBU), count = n())
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 2 x 4
##   beeripaale beers.abv.median beers.ibu.median count
##   <chr>                 <dbl>            <dbl> <int>
## 1 Ale                  0.0545               30   552
## 2 IPA                  0.0685               70   384
```

```
beerclassify %>%
  ggplot(aes(x = beerABV, y = beerIBU, color =  beeripaale)) +
  xlab("ABV") + ylab("IBU") +
  geom_point()+
  ggtitle("Classifying Beers Using ABV and IBU") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```



```r
library(class)
library(caret)
library(e1071)
library(purrr)

#use KNN classification to investigate the beer type with respect to IBV and ABU between IPA and ALE
set.seed(300)
split.perc = .70

train.indices = sample(1:dim(beerclassify)[1],round(split.perc * dim(beerclassify)[1]))

train = beerclassify[train.indices,]
test = beerclassify[-train.indices,]

dim(beerclassify)
```

```
## [1] 936  15
```

```r
dim(train)
```

```
## [1] 655  15
```

```r
dim(test)
```

```
## [1] 281  15
```

```r
#use IBV and ABU variables to get beerIPAale type accuracy
classifications = knn(train[,c(4,5)],test[,c(4,5)], train$beeripaale, prob = TRUE, k = 10)
confusionMatrix(table(test$beeripaale,classifications))
```

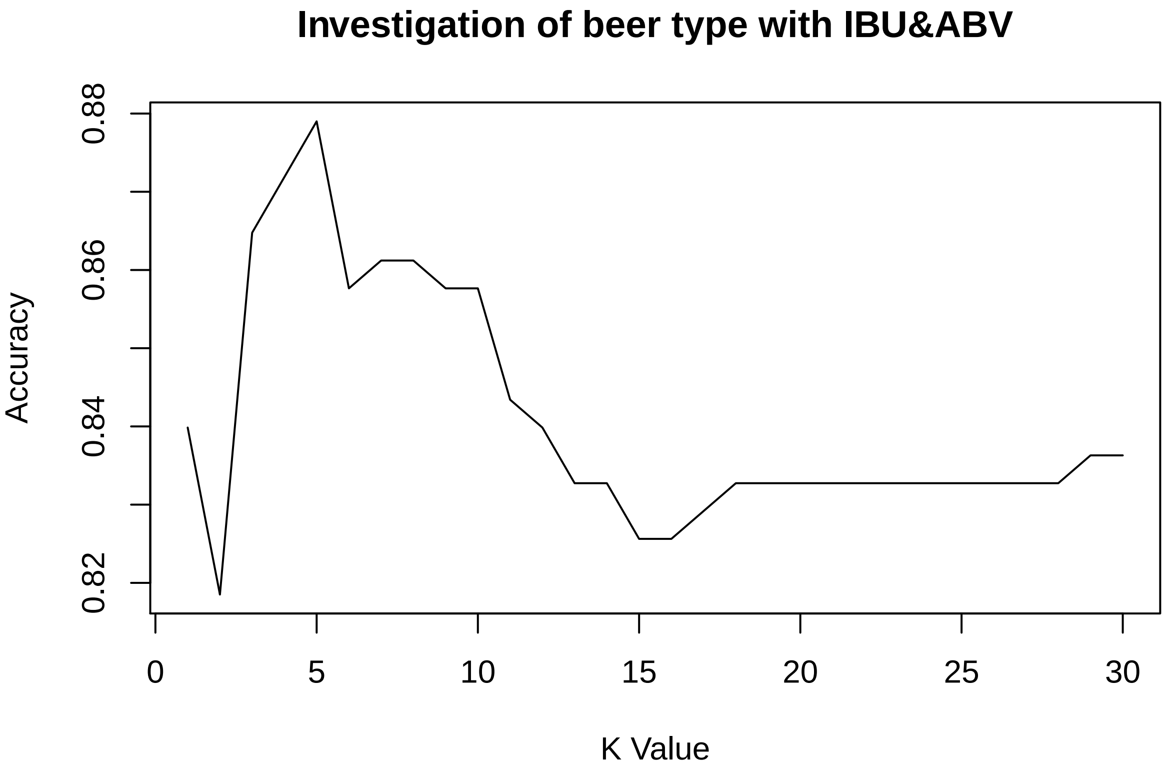
```
## Confusion Matrix and Statistics
##
##      classifications
##       Ale IPA
##   Ale 166  10
##   IPA  31  74
##
##                Accuracy : 0.8541
##                  95% CI : (0.8073, 0.8932)
##     No Information Rate : 0.7011
##     P-Value [Acc > NIR] : 1.723e-09
##
##                   Kappa : 0.6752
##
##  Mcnemar’s Test P-Value : 0.001787
##
##             Sensitivity : 0.8426
##             Specificity : 0.8810
##          Pos Pred Value : 0.9432
##          Neg Pred Value : 0.7048
##              Prevalence : 0.7011
##          Detection Rate : 0.5907
##    Detection Prevalence : 0.6263
##       Balanced Accuracy : 0.8618
##
##        ’Positive’ Class : Ale
##
```

```r
# use ABV and Income two variables to check beerIPAale type accuracy,then compare it with the above ori
classifications = knn(train[,c(5,14)],test[,c(5,14)], train$beeripaale, prob = TRUE, k = 17)
confusionMatrix(table(test$beeripaale,classifications))
```

```
## Confusion Matrix and Statistics
##
##      classifications
##       Ale IPA
##   Ale 159  17
##   IPA  37  68
##
##                Accuracy : 0.8078
##                  95% CI : (0.7568, 0.8522)
##     No Information Rate : 0.6975
##     P-Value [Acc > NIR] : 1.881e-05
##
##                   Kappa : 0.573
##
##  Mcnemar’s Test P-Value : 0.009722
##
##             Sensitivity : 0.8112
##             Specificity : 0.8000
##          Pos Pred Value : 0.9034
##          Neg Pred Value : 0.6476
##              Prevalence : 0.6975
##          Detection Rate : 0.5658
##    Detection Prevalence : 0.6263
##       Balanced Accuracy : 0.8056
##
##        'Positive' Class : Ale
##
```

Loop for many k and one training / test partition

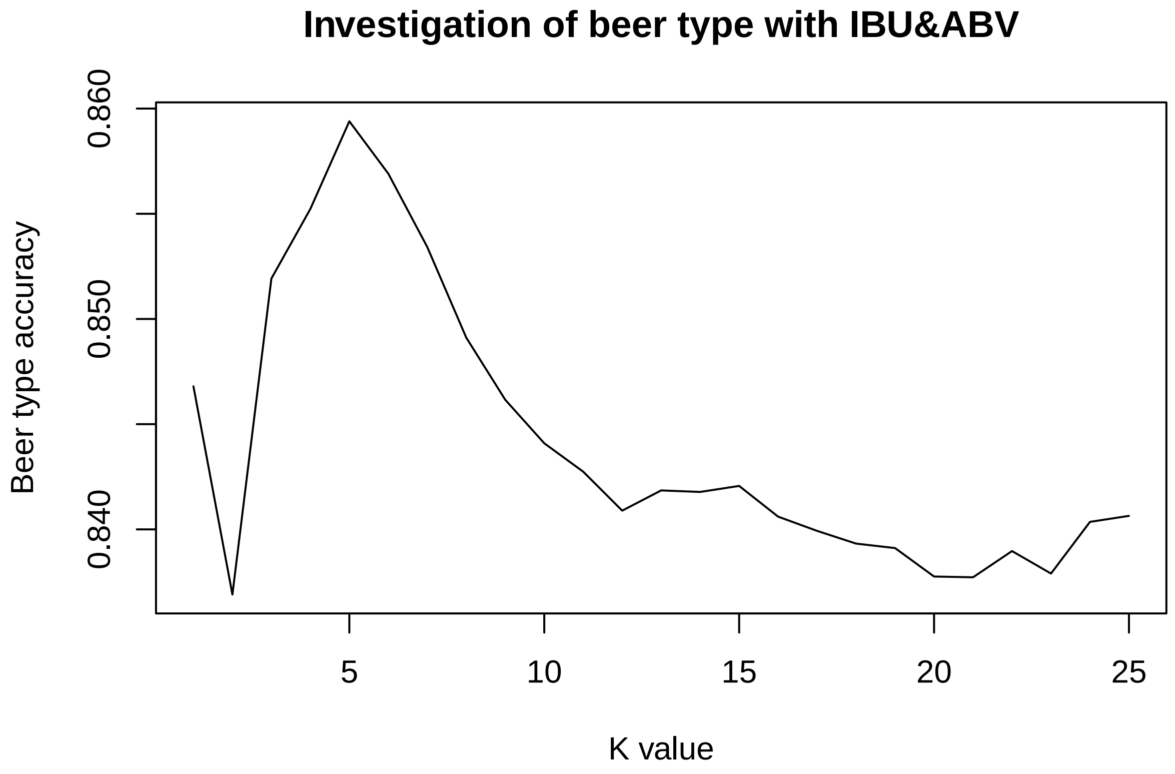
```
acc = data.frame(accuracy = numeric(30), k = numeric(30))

for(i in 1:30)
{
  classifications = knn(train[,c(4,5)],test[,c(4,5)], train$beeripaale, prob = TRUE, k = i)
  table(test$beeripaale, classifications)
  CM = confusionMatrix(table(test$beeripaale,classifications))
  acc$accuracy[i] = CM$overall[1]
  acc$k[i] = i
}

plot(acc$k,acc$accuracy, type = "l", main = "Investigation of beer type with IBU&ABV",xlab = "K Value",
```



##

Loop for many k and many training / test partitions

```
set.seed(100)
iterations = 100
numks = 25


masterAcc = matrix(nrow = iterations, ncol = numks)

for(j in 1:iterations)
{
  train.indices = sample(1:dim(beerclassify)[1],round(split.perc * dim(beerclassify)[1]))
  train = beerclassify[train.indices,]
  test = beerclassify[-train.indices,]
  for(i in 1:numks)
  {
    classifications = knn(train[,c(4,5)],test[,c(4,5)], train$beeripaale, prob = TRUE, k = i)
    table(test$beeripaale, classifications)
    CM = confusionMatrix(table(test$beeripaale,classifications))
    masterAcc[j,i] = CM$overall[1]
  }

}

MeanAcc = colMeans(masterAcc)

plot(seq(1,numks,1),MeanAcc, type = "l",main = "Investigation of beer type with IBU&ABV",xlab = "K valu
```



```
which.max(MeanAcc)
```

```
## [1] 5
```

```r
max(MeanAcc)
```

```
## [1] 0.859395
```

```r
#check multicorrelation within IBU,ABV,Income, population, ounce
library(tidyverse)
library(corrplot)
library(RColorBrewer)
library(ggplot2)
library(GGally)

#Replace missing value with mean
beermerged1<- beermerged
beermerged1$beerABV[which(is.na(beermerged1$beerABV))] <- mean(beermerged1$beerABV,na.rm=TRUE)
beermerged1$beerIBU[which(is.na(beermerged1$beerIBU))] <- mean(beermerged1$beerIBU,na.rm=TRUE)


filterbeermerged <-beermerged1 %>% select(beerIBU,beerABV, beerOunce,Income, Population)

ggpairs(filterbeermerged, title="correlogram with ggpairs()")
```

```
## plot: [1,1] [=>------------------------------------------------------------] 4% est: 0s
## plot: [1,2] [====>---------------------------------------------------------] 8% est: 0s
## plot: [1,3] [======>-------------------------------------------------------] 12% est: 1s
## plot: [1,4] [=========>----------------------------------------------------] 16% est: 1s
```

```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values
```

```
## plot: [1,5] [===========>--------------------------------------------------] 20% est: 1s
```

```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values
```

```
## plot: [2,1] [==============>-----------------------------------------------] 24% est: 1s
## plot: [2,2] [================>---------------------------------------------] 28% est: 1s
## plot: [2,3] [===================>------------------------------------------] 32% est: 1s
## plot: [2,4] [=====================>----------------------------------------] 36% est: 1s
```

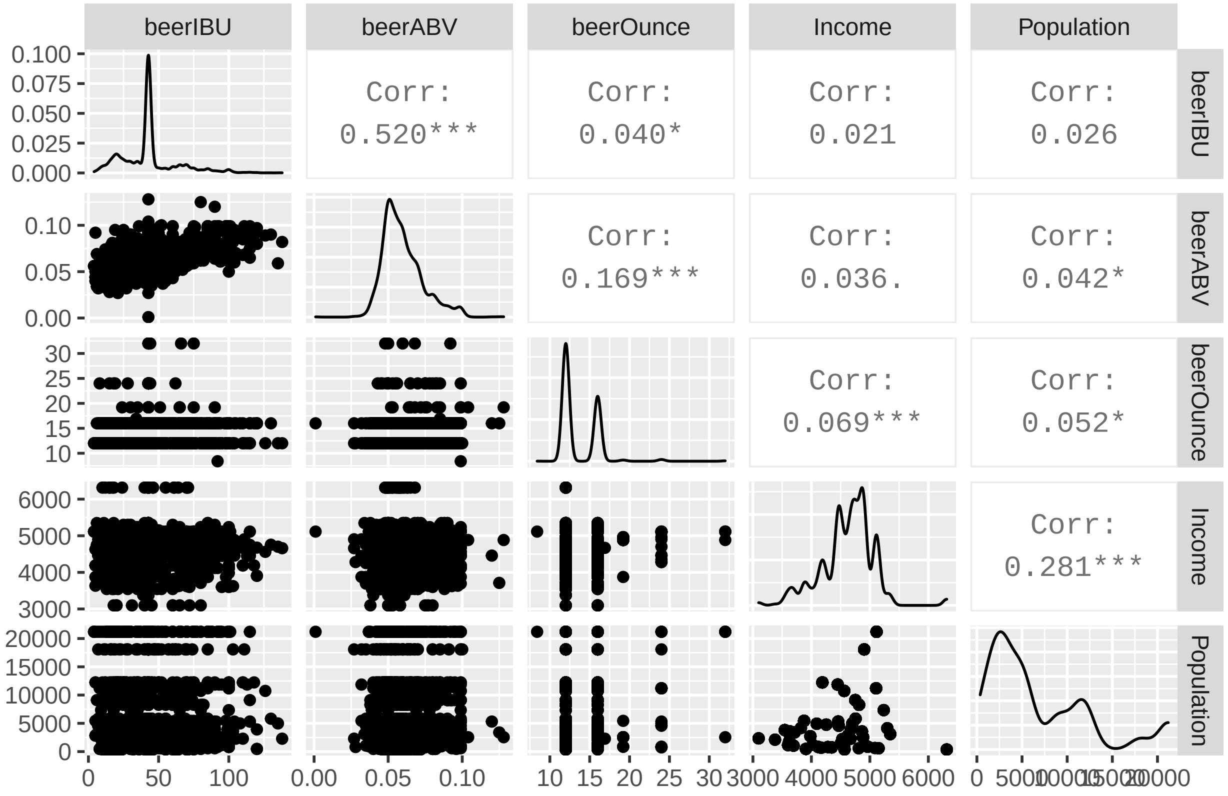
```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values
```

```
## plot: [2,5] [========================>-------------------------------------] 40% est: 1s
```

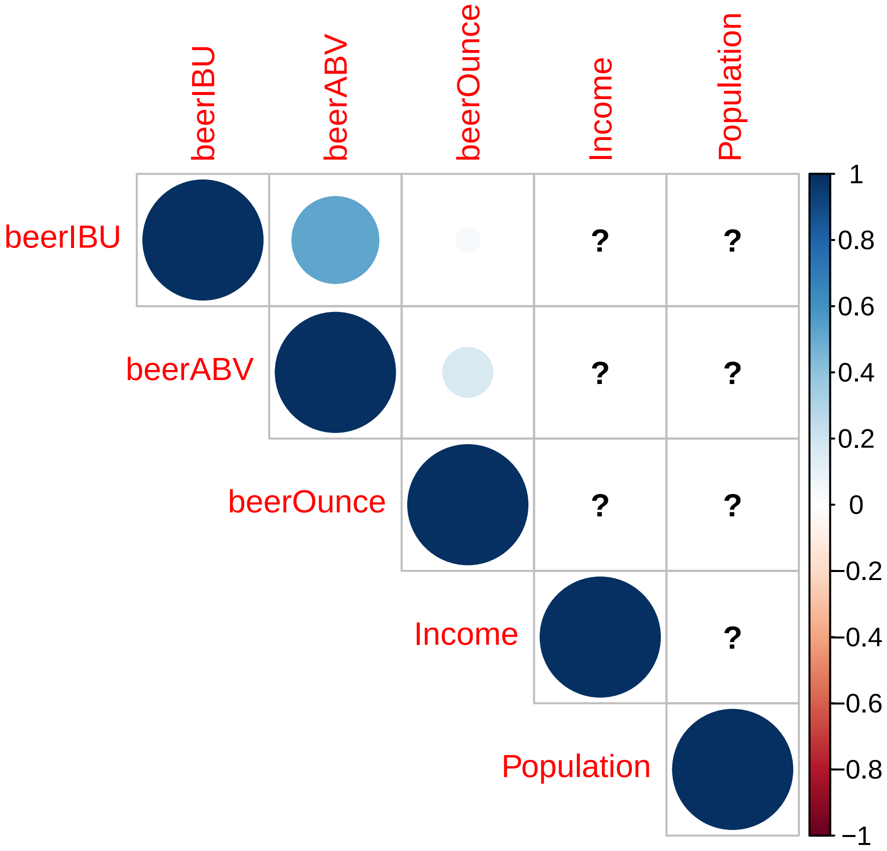
```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values
```

```
## plot: [3,1] [==========================>-----------------------------------] 44% est: 1s
## plot: [3,2] [=============================>--------------------------------] 48% est: 1s
## plot: [3,3] [===============================>------------------------------] 52% est: 0s
## plot: [3,4] [==================================>---------------------------] 56% est: 0s
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values

## plot: [3,5] [====================================>-------------------------] 60% est: 0s

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values

## plot: [4,1] [=======================================>----------------------] 64% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [4,2] [=========================================>--------------------] 68% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [4,3] [============================================>-----------------] 72% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [4,4] [==============================================>---------------] 76% est: 0s

## Warning: Removed 8 rows containing non-finite values (stat_density).

## plot: [4,5] [=================================================>------------] 80% est: 0s

## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, : Removed 8 rows
## containing missing values

## plot: [5,1] [===================================================>----------] 84% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [5,2] [======================================================>-------] 88% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [5,3] [========================================================>-----] 92% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [5,4] [===========================================================>--] 96% est: 0s

## Warning: Removed 8 rows containing missing values (geom_point).

## plot: [5,5] [==============================================================]100% est: 0s

## Warning: Removed 8 rows containing non-finite values (stat_density).
```

correlogram with ggpairs()



```r
corrplot(cor(filterbeermerged), type="upper", order="original")
```



#9 Knock their socks off! Find one other useful inference from #the data that you feel Budweiser may be able to find value in.

Using the beer market data and combining with US Census API data, we are able to create factors to compare each state to other states to find which states are underserved.
We then use this data to determine of the underserved states, what products should we sell to them.

```
###Get population from US Census website


#go get Key from US Census
US_Census_KEY = "3094ca397d1d50a4e3a230346dbaf7d801f753d4" #get from US Census website

#Pull Json data
Json <- "https://api.census.gov/data/2018/acs/acs1?get=NAME,B01001_001E&for=state:*"


#put in Dataframe
get_json <- jsonlite::fromJSON(Json, flatten = TRUE)
str(get_json)
```

```
##  chr [1:53, 1:3] "NAME" "Maine" "North Carolina" "Georgia" "Alaska" "Alabama" "Vermont" ...
```

```
Pop_df <- as.data.frame(get_json)
str(Pop_df)
```

```
## 'data.frame':    53 obs. of  3 variables:
##  $ V1: chr  "NAME" "Maine" "North Carolina" "Georgia" ...
##  $ V2: chr  "B01001_001E" "1338404" "10383620" "10519475" ...
##  $ V3: chr  "state" "23" "37" "13" ...
```

```
colnames(Pop_df)
```

```
## [1] "V1" "V2" "V3"
```

```
head(Pop_df)
```

```
##               V1          V2    V3
## 1           NAME B01001_001E state
## 2          Maine     1338404    23
## 3 North Carolina    10383620    37
## 4        Georgia    10519475    13
## 5         Alaska      737438    02
## 6        Alabama     4887871    01
```

```
#clean up by renaming columns and dropping unneeded columns/rows
names(Pop_df)[1] <- "State"
names(Pop_df)[2] <- "Population"
head(Pop_df)
```

```
##            State  Population    V3
## 1           NAME B01001_001E state
## 2          Maine     1338404    23
## 3 North Carolina    10383620    37
## 4        Georgia    10519475    13
## 5         Alaska      737438    02
## 6        Alabama     4887871    01
```

```
#clean up by dropping unneeded columns/rows
Pop_df <- select(Pop_df, -3)
Pop_df <- Pop_df[-c(1),]

#change factor to numeric
Pop_df$Population <- as.numeric(as.character(Pop_df$Population))

view(Pop_df)
head(Pop_df)
```

```
##            State Population
## 2          Maine    1338404
## 3 North Carolina   10383620
## 4        Georgia   10519475
## 5         Alaska     737438
## 6        Alabama    4887871
## 7        Vermont     626299
```

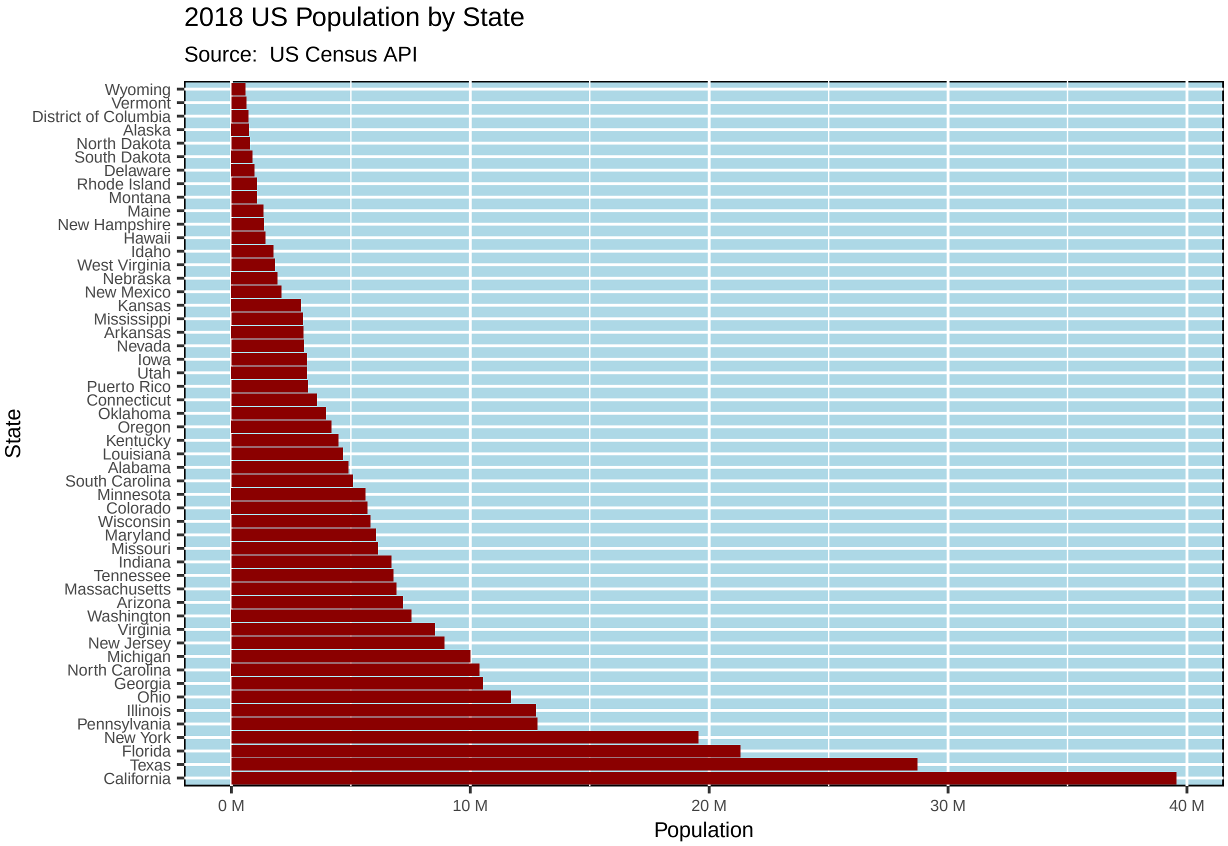
```
summary(Pop_df)
```

```
##     State             Population
##  Length:52          Min.   :  577737
##  Class :character   1st Qu.: 1792926
##  Mode  :character   Median : 4329558
##                     Mean   : 6353127
##                     3rd Qu.: 7262632
##                     Max.   :39557045
```

```
#take a look at data
Pop_df[order(Pop_df$Population),]
```

```
##                   State Population
## 17              Wyoming     577737
## 7               Vermont     626299
## 25 District of Columbia     702455
## 5                Alaska     737438
## 14         North Dakota     760077
## 37         South Dakota     882235
## 51             Delaware     967171
## 39         Rhode Island    1057315
## 53              Montana    1062305
## 2                 Maine    1338404
## 49        New Hampshire    1356458
## 36               Hawaii    1420491
## 34                Idaho    1754208
## 9         West Virginia    1805832
## 33             Nebraska    1929268
## 35           New Mexico    2095428
## 42               Kansas    2911510
## 19          Mississippi    2986530
## 50             Arkansas    3013825
## 8                Nevada    3034392
## 48                 Iowa    3156145
## 26                 Utah    3161105
## 12          Puerto Rico    3195153
## 20          Connecticut    3572665
## 10             Oklahoma    3943079
## 16               Oregon    4190713
## 45             Kentucky    4468402
## 46            Louisiana    4659978
## 6               Alabama    4887871
## 15       South Carolina    5084127
## 52            Minnesota    5611179
## 43             Colorado    5695564
## 11            Wisconsin    5813568
## 22             Maryland    6042718
## 30             Missouri    6126452
## 44              Indiana    6691878
## 41            Tennessee    6770010
## 24        Massachusetts    6902149
## 40              Arizona    7171646
## 38           Washington    7535591
## 13             Virginia    8517685
## 28           New Jersey    8908520
## 32          Michigan    9995915
## 3     North Carolina   10383620
## 4            Georgia   10519475
## 29              Ohio   11689442
## 47          Illinois   12741080
## 31      Pennsylvania   12807060
## 27          New York   19542209
## 23           Florida   21299325
## 21             Texas   28701845
## 18        California   39557045
```

```
#graph Population
#in ppt
library(scales)
Pop_df  %>%
  ggplot(aes(x = reorder(State, -Population), y = Population)) +
  geom_bar(stat = "identity", fill = "darkred") +
  #theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  scale_y_continuous(labels = unit_format(unit = "M", scale = 1e-6)) +
  labs(title = "2018 US Population by State",
       subtitle = "Source:  US Census API") +
  xlab("State") + coord_flip() +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
   theme(text = element_text(size=8,color= ’black’))
```



2018 US Population by State

Source: US Census API

```r
#pull out abbr from Coordinates map
StateNames <- stateCoords %>% select(abbr, full) %>% distinct(abbr, full)

#get style count by State
StyleCnt <- beerBrew %>% mutate(State=gsub(" ","",State)) %>%
  select(State, StyleCat3) %>%
  filter(!is.na(StyleCat3)) %>% group_by(State, StyleCat3) %>% tally( name = "Count")

#add Abbr to State Names
StatePop = merge(StateNames,Pop_df,by.x="full",by.y="State")

#Merge Population and Beer Data
Revenue_DF = merge(StatePop,StatebeerBrew,by.x="abbr",by.y="state")
str(Revenue_DF)
```

```
## ’data.frame’:    51 obs. of  6 variables:
##  $ abbr      : chr  "AK" "AL" "AR" "AZ" ...
##  $ full      : chr  "Alaska" "Alabama" "Arkansas" "Arizona" ...
##  $ Population: num  737438 4887871 3013825 7171646 39557045 ...
##  $ State     : chr  "AK" "AL" "AR" "AZ" ...
##  $ Beers     : int  25 10 5 47 183 265 27 8 2 58 ...
##  $ Breweries : int  7 3 2 11 39 47 8 1 2 15 ...
```

```r
Revenue_DF[order(Revenue_DF$Beers/log(Revenue_DF$Population)),]
```

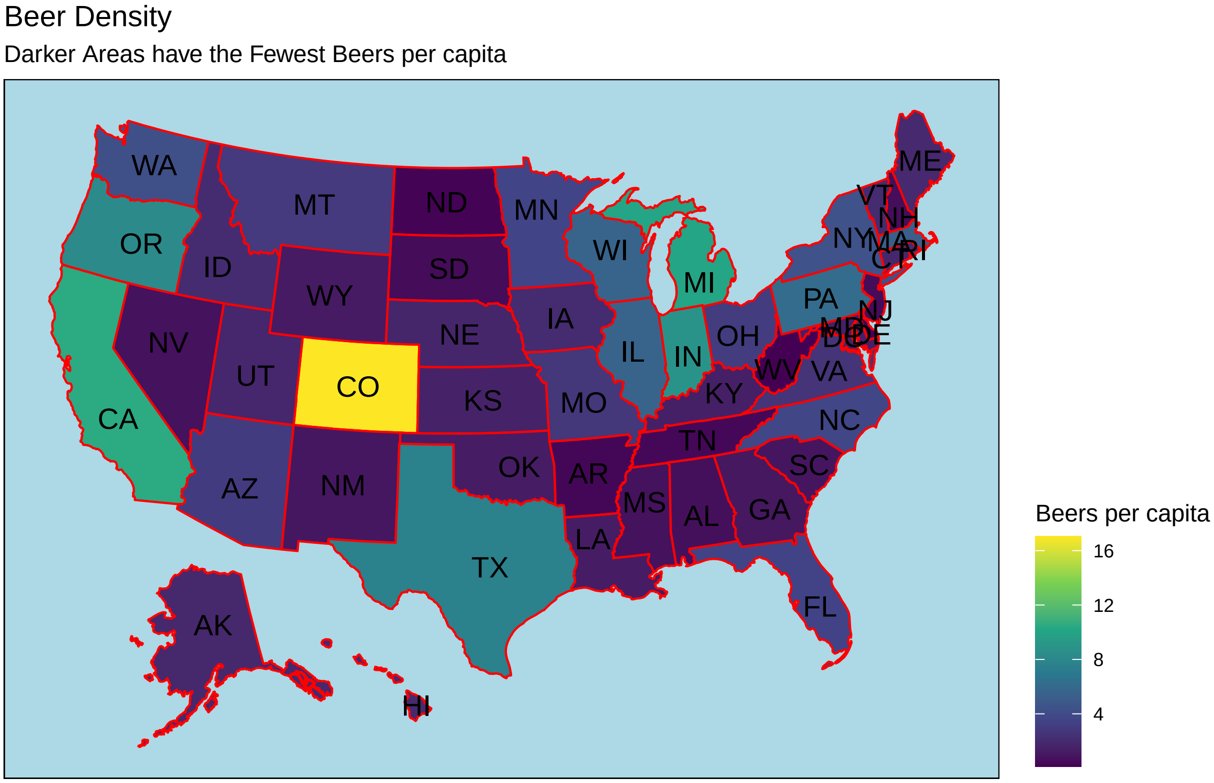
```
##    abbr                 full Population State Beers Breweries
## 50   WV        West Virginia    1805832    WV     2         1
## 9    DE             Delaware     967171    DE     2         2
## 29   ND         North Dakota     760077    ND     3         1
## 3    AR             Arkansas    3013825    AR     5         2
## 43   TN            Tennessee    6770010    TN     6         3
## 32   NJ           New Jersey    8908520    NJ     8         3
## 42   SD         South Dakota     882235    SD     7         1
## 31   NH        New Hampshire    1356458    NH     8         3
## 8    DC District of Columbia     702455    DC     8         1
## 2    AL              Alabama    4887871    AL    10         3
## 34   NV               Nevada    3034392    NV    11         2
## 26   MS          Mississippi    2986530    MS    11         2
## 41   SC       South Carolina    5084127    SC    14         4
## 33   NM           New Mexico    2095428    NM    14         4
## 11   GA              Georgia   10519475    GA    16         7
## 51   WY              Wyoming     577737    WY    15         4
## 19   LA            Louisiana    4659978    LA    19         5
## 37   OK             Oklahoma    3943079    OK    19         6
## 21   MD             Maryland    6042718    MD    21         7
## 18   KY             Kentucky    4468402    KY    21         4
## 17   KS               Kansas    2911510    KS    23         3
## 30   NE             Nebraska    1929268    NE    25         5
## 45   UT                 Utah    3161105    UT    26         4
## 7    CT          Connecticut    3572665    CT    27         8
## 1    AK               Alaska     737438    AK    25         7
## 12   HI               Hawaii    1420491    HI    27         4
## 22   ME                Maine    1338404    ME    27         9
## 40   RI         Rhode Island    1057315    RI    27         5
## 13   IA                 Iowa    3156145    IA    30         5
## 47   VT              Vermont     626299    VT    27        10
## 14   ID                Idaho    1754208    ID    30         5
## 46   VA             Virginia    8517685    VA    40        16
## 25   MO             Missouri    6126452    MO    42         9
## 27   MT              Montana    1062305    MT    40         9
## 4    AZ              Arizona    7171646    AZ    47        11
## 36   OH                 Ohio   11689442    OH    49        15
## 10   FL              Florida   21299325    FL    58        15
## 24   MN            Minnesota    5611179    MN    55        12
## 28   NC       North Carolina   10383620    NC    59        19
## 48   WA           Washington    7535591    WA    68        23
## 35   NY             New York   19542209    NY    74        16
## 20   MA        Massachusetts    6902149    MA    82        23
## 15   IL             Illinois   12741080    IL    91        18
## 49   WI            Wisconsin    5813568    WI    87        20
## 39   PA         Pennsylvania   12807060    PA   100        25
## 44   TX                Texas   28701845    TX   130        28
## 38   OR               Oregon    4190713    OR   125        29
## 16   IN              Indiana    6691878    IN   139        22
## 23   MI             Michigan    9995915    MI   162        32
## 5    CA           California   39557045    CA   183        39
## 6    CO             Colorado    5695564    CO   265        47
```

```
#add metrics
Revenue_DF = Revenue_DF %>% mutate(LogPop = log(Population),
                                   brewsPerLogPop = Beers/log(Population),
                                   beersPerLogPop = Beers/log(Population))

colnames(Revenue_DF)[1] <- "state"
#put in DataFrame for table

Revenue_DF[order(Revenue_DF$beersPerLogPop),]
```

```
##    state                 full Population State Beers Breweries   LogPop brewsPerLogPop
## 50    WV        West Virginia    1805832    WV     2         1 14.40653      0.1388259
## 9     DE             Delaware     967171    DE     2         2 13.78213      0.1451154
## 29    ND         North Dakota     760077    ND     3         1 13.54118      0.2215465
## 3     AR             Arkansas    3013825    AR     5         2 14.91872      0.3351494
## 43    TN            Tennessee    6770010    TN     6         3 15.72801      0.3814849
## 32    NJ           New Jersey    8908520    NJ     8         3 16.00252      0.4999213
## 42    SD         South Dakota     882235    SD     7         1 13.69021      0.5113141
## 31    NH        New Hampshire    1356458    NH     8         3 14.12039      0.5665567
## 8     DC District of Columbia     702455    DC     8         1 13.46234      0.5942505
## 2     AL              Alabama    4887871    AL    10         3 15.40227      0.6492551
## 34    NV               Nevada    3034392    NV    11         2 14.92552      0.7369927
## 26    MS          Mississippi    2986530    MS    11         2 14.90962      0.7377786
## 41    SC       South Carolina    5084127    SC    14         4 15.44163      0.9066398
## 33    NM           New Mexico    2095428    NM    14         4 14.55527      0.9618510
## 11    GA              Georgia   10519475    GA    16         7 16.16874      0.9895639
## 51    WY              Wyoming     577737    WY    15         4 13.26687      1.1306356
## 19    LA            Louisiana    4659978    LA    19         5 15.35452      1.2374205
## 37    OK             Oklahoma    3943079    OK    19         6 15.18747      1.2510311
## 21    MD             Maryland    6042718    MD    21         7 15.61436      1.3449154
## 18    KY             Kentucky    4468402    KY    21         4 15.31254      1.3714249
## 17    KS               Kansas    2911510    KS    23         3 14.88418      1.5452646
## 30    NE             Nebraska    1929268    NE    25         5 14.47265      1.7273960
## 45    UT                 Utah    3161105    UT    26         4 14.96643      1.7372210
## 7     CT          Connecticut    3572665    CT    27         8 15.08882      1.7894041
## 1     AK               Alaska     737438    AK    25         7 13.51094      1.8503528
## 12    HI               Hawaii    1420491    HI    27         4 14.16651      1.9059030
## 22    ME                Maine    1338404    ME    27         9 14.10699      1.9139450
## 40    RI         Rhode Island    1057315    RI    27         5 13.87124      1.9464730
## 13    IA                 Iowa    3156145    IA    30         5 14.96486      2.0046961
## 47    VT              Vermont     626299    VT    27        10 13.34758      2.0228381
## 14    ID                Idaho    1754208    ID    30         5 14.37753      2.0865896
## 46    VA             Virginia    8517685    VA    40        16 15.95766      2.5066339
## 25    MO             Missouri    6126452    MO    42         9 15.62813      2.6874623
## 27    MT              Montana    1062305    MT    40         9 13.87595      2.8826852
## 4     AZ              Arizona    7171646    AZ    47        11 15.78565      2.9773885
## 36    OH                 Ohio   11689442    OH    49        15 16.27420      3.0109013
## 10    FL              Florida   21299325    FL    58        15 16.87419      3.4372028
## 24    MN            Minnesota    5611179    MN    55        12 15.54027      3.5391917
## 28    NC       North Carolina   10383620    NC    59        19 16.15574      3.6519528
## 48    WA           Washington    7535591    WA    68        23 15.83515      4.2942447
## 35    NY             New York   19542209    NY    74        16 16.78809      4.4078875
## 20    MA        Massachusetts    6902149    MA    82        23 15.74734      5.2072275
## 15    IL             Illinois   12741080    IL    91        18 16.36034      5.5622309
## 49    WI            Wisconsin    5813568    WI    87        20 15.57571      5.5856219
## 39    PA         Pennsylvania   12807060    PA   100        25 16.36551      6.1104125
## 44    TX                Texas   28701845    TX   130        28 17.17247      7.5702555
## 38    OR               Oregon    4190713    OR   125        29 15.24838      8.1975914
## 16    IN              Indiana    6691878    IN   139        22 15.71641      8.8442617
## 23    MI             Michigan    9995915    MI   162        32 16.11769     10.0510699
## 5     CA           California   39557045    CA   183        39 17.49325     10.4611753
## 6     CO             Colorado    5695564    CO   265        47 15.55520     17.0361057
##    beersPerLogPop
## 50      0.1388259
## 9       0.1451154
## 29      0.2215465
## 3       0.3351494
## 43      0.3814849
## 32      0.4999213
## 42      0.5113141
## 31      0.5665567
## 8       0.5942505
## 2       0.6492551
## 34      0.7369927
## 26      0.7377786
## 41      0.9066398
## 33      0.9618510
## 11      0.9895639
## 51      1.1306356
## 19      1.2374205
## 37      1.2510311
## 21      1.3449154
## 18      1.3714249
## 17      1.5452646
## 30      1.7273960
## 45      1.7372210
## 7       1.7894041
## 1       1.8503528
## 12      1.9059030
## 22      1.9139450
## 40      1.9464730
## 13      2.0046961
## 47      2.0228381
## 14      2.0865896
## 46      2.5066339
## 25      2.6874623
## 27      2.8826852
## 4       2.9773885
## 36      3.0109013
## 10      3.4372028
## 24      3.5391917
## 28      3.6519528
## 48      4.2942447
## 35      4.4078875
## 20      5.2072275
## 15      5.5622309
## 49      5.5856219
## 39      6.1104125
## 44      7.5702555
## 38      8.1975914
## 16      8.8442617
## 23     10.0510699
## 5      10.4611753
## 6      17.0361057
```

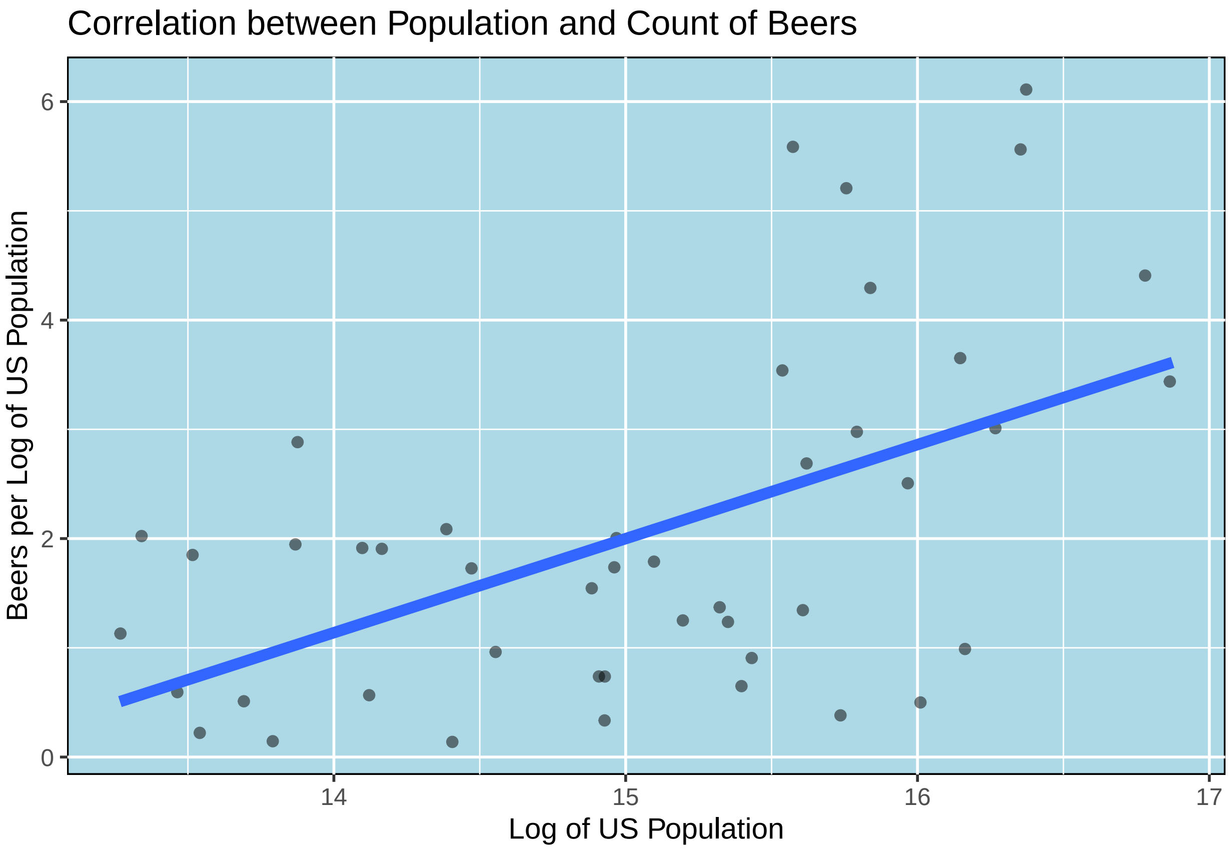
```
#put in map
plot_usmap(data=Revenue_DF,values="beersPerLogPop",labels = TRUE, offset=0.5, color = "red")  +
  scale_fill_continuous(type = "viridis", name="Beers per capita") +
  theme(legend.position = "right") +
  labs(title = "Beer Density",
       subtitle = "Darker Areas have the Fewest Beers per capita") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))
```

```
## Warning: Ignoring unknown parameters: offset

## Warning: Use of `map_df$x` is discouraged. Use `x` instead.

## Warning: Use of `map_df$y` is discouraged. Use `y` instead.

## Warning: Use of `map_df$group` is discouraged. Use `group` instead.

## Warning: Use of `centroid_labels$x` is discouraged. Use `x` instead.

## Warning: Use of `centroid_labels$y` is discouraged. Use `y` instead.
## Warning: Use of `centroid_labels$abbr` is discouraged. Use `abbr` instead.
```



```r
#Regression Line
#Look at data points with high residual error
#in ppt
Revenue_DF %>% filter(beersPerLogPop < 7.5) %>%
  ggplot(aes(LogPop,beersPerLogPop)) +
  geom_point(position=position_jitter(width=0.01),alpha=0.5)+
  geom_smooth(method="lm",se=FALSE,size=2) +
  labs(title="Correlation between Population and Count of Beers") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  labs(y = "Beers per Log of US Population") + labs(x = "Log of US Population")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



```
#get low values as areas to focus
#in ppt
TargetStates <- Revenue_DF %>% filter(beersPerLogPop <= 2,
  LogPop > 15) %>%
  select(State = full, Population, BeerFactor = beersPerLogPop)

view(TargetStates)
```

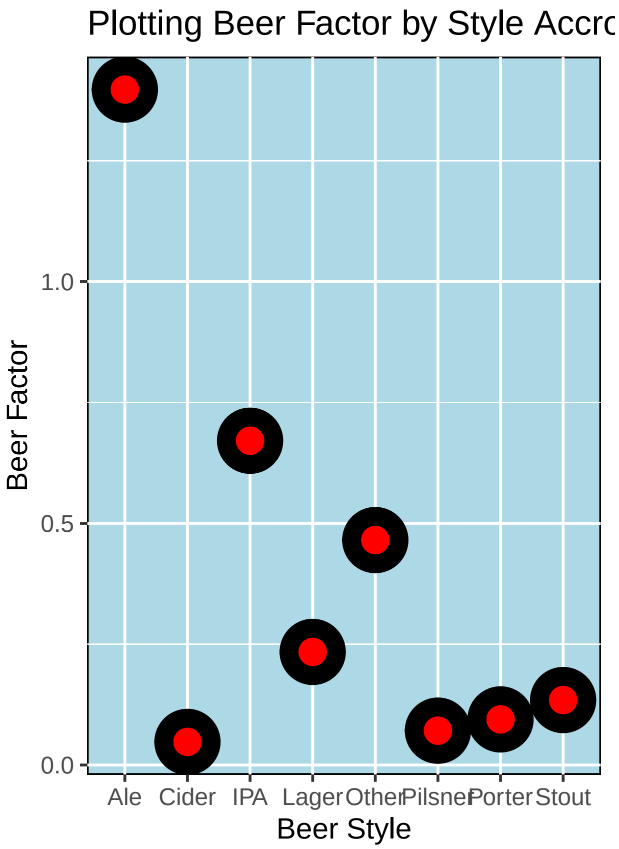
```
#which kind of beer to sell
StyleCnt$StyleCat3 <- as.factor(StyleCnt$StyleCat3)
StyleCnt$State <- as.factor(StyleCnt$State)

#str(StyleCnt)


StyleTotals <- StyleCnt %>% group_by(StyleCat3) %>% summarise(Total = sum(Count))
```

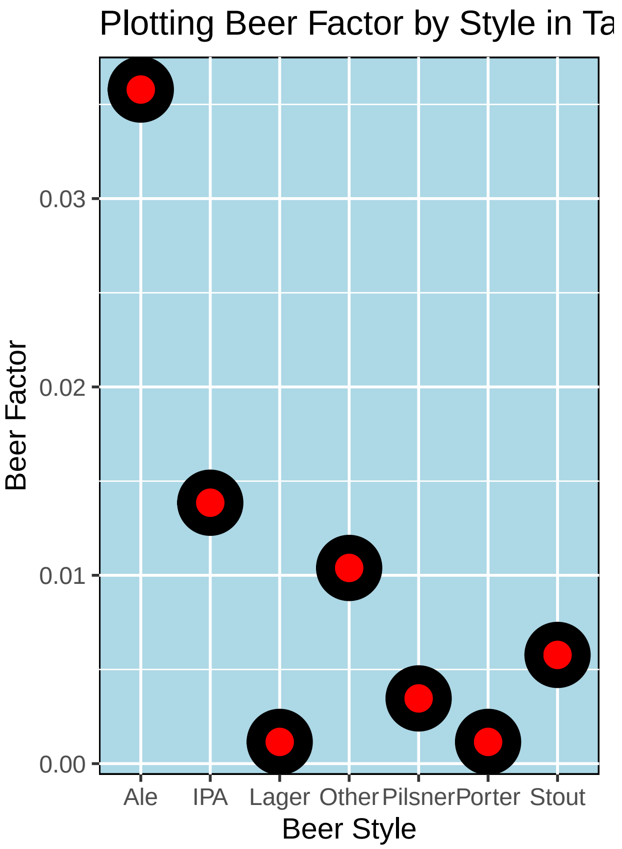
```
## ‘summarise()‘ ungrouping output (override with ‘.groups‘ argument)
```

```
StyleTotals$BeerFactor <- StyleTotals$Total/sum(Revenue_DF$LogPop)


TargetStates_LogPop <- Revenue_DF %>% filter(State == "AR" | State == "MS" |State == "AL" |
                                            State == "GA" |State == "SC" | State == "TN" ) %>%
                        select(LogPop) %>%  sum(Revenue_DF$LogPop)
str(TargetStates_LogPop)
```

```
##  num 866
```

```
#get style count by State
TargetStates_StyleCnt <- beerBrew %>% filter(State == "AR" | State == "MS" |State == "AL" |
                                               State == "GA" |State == "SC" | State == "TN" ) %>%
  mutate(State=gsub(" ","",State)) %>%
  select(State, StyleCat3) %>%
  filter(!is.na(StyleCat3)) %>% group_by(StyleCat3) %>% tally( name = "Totals")


TargetStates_StyleCnt$BeerFactor <- TargetStates_StyleCnt$Totals/TargetStates_LogPop




#Show Which Beers to Sell
#in ppt
gridExtra::grid.arrange(

StyleTotals %>% ggplot(aes(StyleCat3,BeerFactor)) +
  geom_point(shape = 21, colour = "black", fill = "red", size = 5, stroke = 5)+
  labs(title="Plotting Beer Factor by Style Accross the US") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  labs(y = "Beer Factor") + labs(x = "Beer Style"),

TargetStates_StyleCnt %>% ggplot(aes(StyleCat3,BeerFactor)) +
  geom_point(shape = 21, colour = "black", fill = "red", size = 5, stroke = 5)+
  labs(title="Plotting Beer Factor by Style in Target States") +
  theme(panel.background = element_rect(color = "black", fill = "lightblue"))+
  labs(y = "Beer Factor") + labs(x = "Beer Style"),

nrow  = 1
)
```





The conclusions that we can draw from this exercise are that differences exist between various parts of the country in terms of types, strengths, and flavors or beer. These differences have shown us that certain geographies within the US are lacking in types of beers available. We hope to use this data to create a selling opportunity for Budweiser by selling Cider in a market where Cider does not currently exists, despite being popular in other parts of the country.