Beers and Breweries Analysis

Case Study 01 - MSDS 6306 Section 402

Luke Pierce lepierce@smu.edu
Lokesh Maganti lmaganti@smu.edu
Andrew Walch awalch@smu.edu
MJKelleher mikek@smu.edu

February 14, 2018

Contents

Codebook

1. Raw Data
    - Beer Names and Metrics
        - Variable names
            * Beer
                · The name of the beer
                · String
                · Contains non UTF-8 characters
                · No NA's
            * Beer_ID
                · Unique Identifier of the beer
                · Integer - Range: (1 - 2692)
                · No NA's
            * ABV
                · Alcohol by volume of the beer
                · Real Number - Range (0.001 - 0.128)
                · Contains NA's
            * IBU
                · International Bitterness Units of the beer
                · Integer - Range (4 - 138)
                · Contains NA's
            * Brew_ID
                · Brewery ID associated with the beer
                · Integer - Range (1 - 558)
                · No NA's
            * Style
                · Style of the beer
                · String
                · Contains non UTF-8 characters
                · No NA's
            * Ounces
                · Ounces of the beer

- Real Number - Values: (8.4, 12.0, 16.0, 16.9, 19.2, 24.0, 32.0)
- Contains NA's

- Breweries By State
  - Variable names
    - Brew_ID
      - Unique identifier of the brewery
      - Integer (1 - 558)
      - No NA's
    - Brewery
      - Name of the brewery
      - String
      - Contains non UTF-8 characters
      - No NA's
    - City
      - City where the brewery is located
      - String
      - No NA's
    - State
      - US state where the brewery is located
      - 2 Characters
      - No NA's
      - 51 Unique Values

2. Final Merged Data
   - Beer Names and Metrics
     - Info
       - Dataframe: beer
       - CSV name: data/tidy/beer.csv
     - Variable names
       - Beer
         - The name of the beer
         - String
         - UTF-8 characters only
         - No NA's
       - Beer_ID
         - Unique Identifier of the beer
         - Integer - Range: (1 - 2692)
         - No NA's
       - ABV
         - Alcohol by volume of the beer
         - Real Number - Range (0.001 - 0.128)
         - Contains NA's
       - IBU
         - International Bitterness Units of the beer
         - Integer - Range (4 - 138)
         - Contains NA's
       - Brew_ID
         - Brewery ID associated with the beer
         - Integer - Range (1 - 558)
         - No NA's
       - Style
         - Style of the beer
         - String
         - UTF-8 characters only
         - No NA's

    - Ounces
      - Ounces of the beer
      - Real Number - Values: (8.4, 12.0, 16.0, 16.9, 19.2, 24.0, 32.0)
      - No NA's
- Breweries By State
  - Info
    - Dataframe: brewery
    - CSV name: data/tidy/brewery.csv
  - Variable names
    - Brew_ID
      - Unique identifier of the brewery
      - Integer (1 - 558)
      - No NA's
    - Brewery
      - Name of the brewery
      - String
      - UTF-8 characters only
      - No NA's
    - City
      - City where the brewery is located
      - String
      - No NA's
    - State
      - US state where the brewery is located
      - 2 Characters
      - No NA's
      - 51 Unique Values
- Combined Beer and Brewery Names and Metrics
  - Info
    - Dataframe: beerbrew
    - CSV name: data/tidy/beerbrew.csv
  - Variable names
    - Beer_ID
      - Integer - Range: (1 - 2692)
      - No NA's
    - Beer
      - String - Range: (1 - 1372)
      - No NA's
    - Style
      - String
      - No NA's
    - Ounces
      - Real Number - Values: (8.4, 12.0, 16.0, 16.9, 19.2, 24.0, 32.0)
      - No NA's
    - ABV
      - Real Number - Range (0.027 - 0.125)
      - No NA's
    - IBU
      - Integer - Range (4 - 138)
      - No NA's
    - Brew_ID
      - Integer - Range (1 - 547)
      - No NA's

            - Brewery
                - String
                - No NA’s
            - City
                - String
                - No NA’s
            - State
                - 2 Characters - 50 Unique Values
                - No NA’s
    - Breweries by State
        - Info
            - Dataframe: breweryByState
            - CSV name: data/tidy/BreweryByState.csv
        - Variable names
            - State
                - 2 Characters - 50 Unique Values
                - No NA’s
            - Breweries
                - Integer - Range (1 - 47)
                - No NA’s

3. Data Modifications
    - Load the Beer and Breweries datasets, rename the columns, sort beer dataset
        - Define variables to be used throughout the document
        - Define base/root URL to load the data
        - Define the String URL’s for the Beer and Brewery datasets
        - Load the Beer and Brewery Datasets
    - Convert UTF-8 format character data in Dataframes for Beer and Brewery
        - Convert UTF-8 format in “beer$Name”
        - Convert UTF-8 format in “beer$Style”
        - Convert UTF-8 format in “beer$Style”
    - Modify column/variable names on the Dataframes for Beer and Brewery
        - Rename column “Name” to “Beer” in beer df
        - Rename column “Brewery_id”" to “Brew_ID” in beer df
        - Rename column “Name” to “Brewery” in brewery df
        - Arrange beer df by Brew_ID
        - Remove duplicates with all columns other than Brew_ID as criteria for removal
        - Remove row.names column

4. Tidy dataset
    - beer
    - beerbrew
        - Merge data frames
        - Sort columns
        - NA removal (all)
    - brewery
    - BreweryByState
        - Count breweries per state
        - Remove Washington DC
        - Rename column “Brewery_id”" to “Brew_ID” in beer df
        - Sort by most to least

5. Recipe for Tidy Dataset
    - Commented R script file

  - Tidy_Recipe.R

Introduction

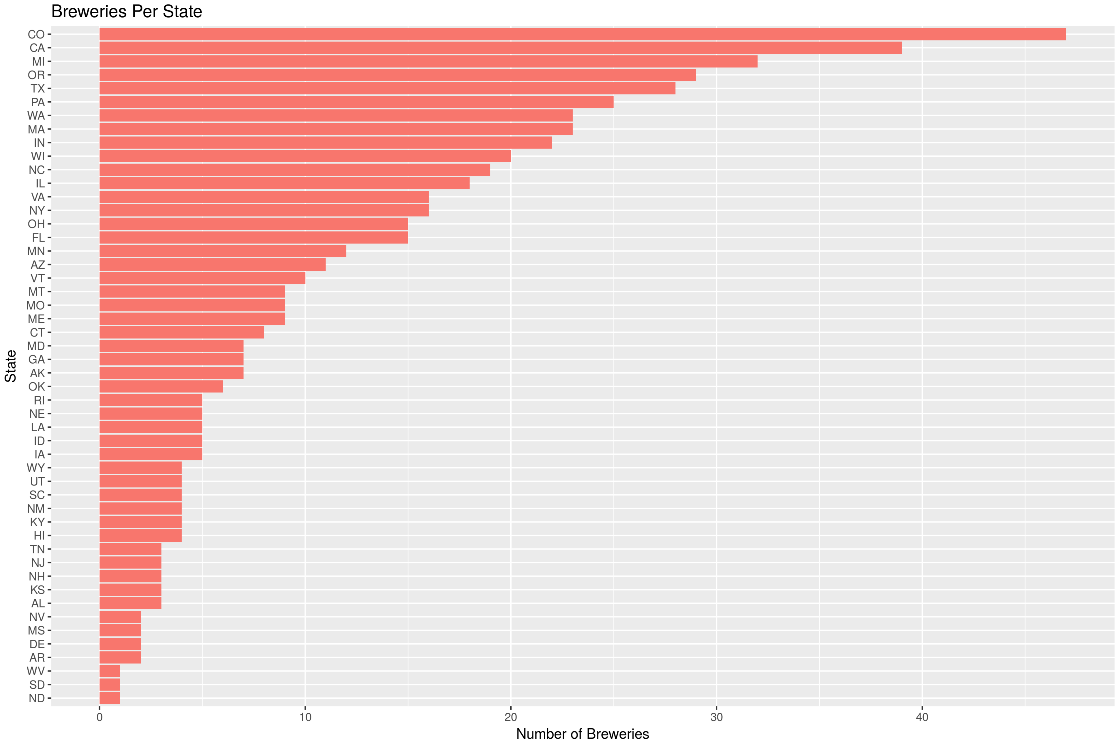
This project analyzes several aspects of Beer and Brewery data from several breweries in the United States. The bulk of the analyses center around bitterness and alcohol content, with the ultimate goal of trying to identify a causal relationship between the two.

Before we can do this our data must be merged and cleaned. This process results in a "tidy" dataset, the steps of which are outline above. In short, this involves renaming some of the data fields, as well as fixing many data deficiencies that would otherwise cause problems with the analysis. Additionally, we ensure that the analysis is limited to breweries in the United States only. The District of Columbia is not included.

In all, the analysis answers 7 main questions, which are addressed below in this report.

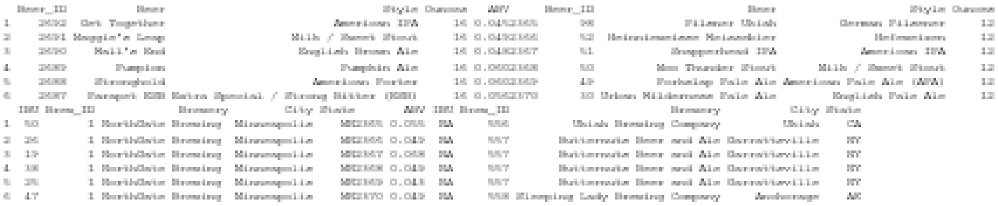
Answers to Data Analysis Questions

1. *How many breweries are present in each state?*



  -

2. *After merging the Beer and Breweries datasets, what are the first and last 6 observations in the datasets?*



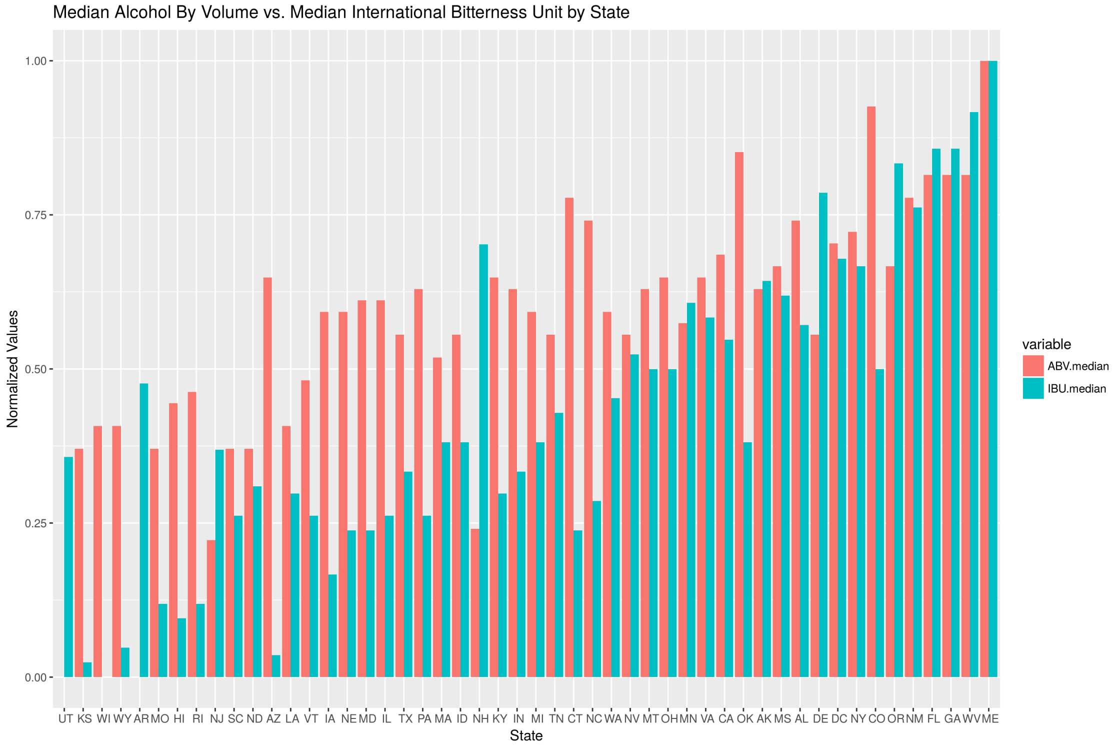
```
  Beer_ID         Beer                               Style Ounces   ABV     Beer_ID                      Beer                   Style Ounces
1    2692  Get Together                       American IPA     16 0.0452365      98              Pilsner Ukiah        German Pilsener     12
2    2691 Maggie's Leap                 Milk / Sweet Stout     16 0.0492366      52  Heinnieweisse Weissebier             Hefeweizen     12
3    2690    Wall's End                  English Brown Ale     16 0.0482367      51           Snapperhead IPA           American IPA     12
4    2689       Pumpion                        Pumpkin Ale     16 0.0602368      50         Moo Thunder Stout     Milk / Sweet Stout     12
5    2688    Stronghold                    American Porter     16 0.0602369      49          Porkslap Pale Ale American Pale Ale (APA)     12
6    2687   Parapet ESB Extra Special / Strong Bitter (ESB)     16 0.0562370      30 Urban Wilderness Pale Ale       English Pale Ale     12
  IBU Brew_ID           Brewery        City State       ABV IBU Brew_ID                   Brewery          City State
1  50       1 NorthGate Brewing  Minneapolis    MN2365 0.055  NA     556        Ukiah Brewing Company         Ukiah    CA
2  26       1 NorthGate Brewing  Minneapolis    MN2366 0.049  NA     557       Butternuts Beer and Ale Garrattsville    NY
3  19       1 NorthGate Brewing  Minneapolis    MN2367 0.068  NA     557       Butternuts Beer and Ale Garrattsville    NY
4  38       1 NorthGate Brewing  Minneapolis    MN2368 0.049  NA     557       Butternuts Beer and Ale Garrattsville    NY
5  25       1 NorthGate Brewing  Minneapolis    MN2369 0.043  NA     557       Butternuts Beer and Ale Garrattsville    NY
6  47       1 NorthGate Brewing  Minneapolis    MN2370 0.049  NA     558 Sleeping Lady Brewing Company     Anchorage    AK
```

-

3. *How many **NA** values are contained in each column?*

```
There were 62 NA's in the ABV (Alcohol By Volume) column and 998 NA's in the IBU (International Bitterne

Beer_ID    Beer   Style  Ounces     ABV     IBU Brew_ID Brewery    City   State
   0       0       0       0      62     998       0       0       0       0
```

4. *What is the median alcohol content and international bitterness unit for each state? This also includes a bar chart of this data.*

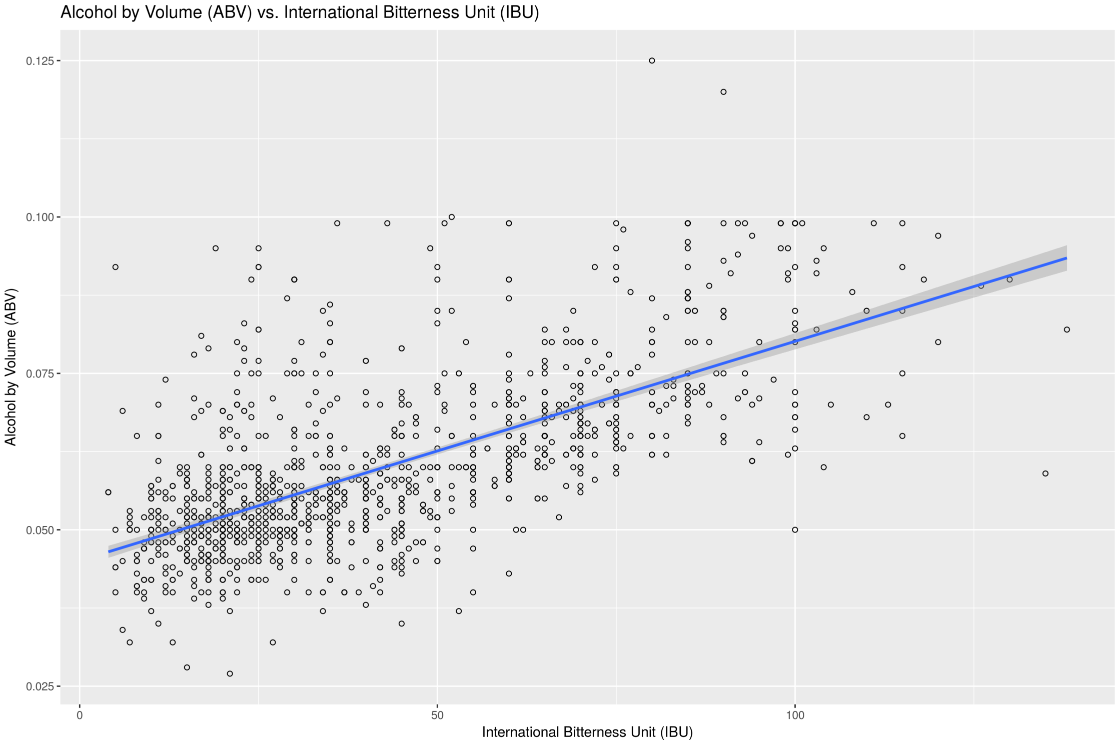


•

5. *Which state has the maximum alcoholic **ABV** beer? Which state has the most bitter **IBU** beer?*
   - The beer with the highest alcoholic content (with an ABV value of 0.125 or 12.5%) is “London Balling English Barleywine”, brewed by Against the Grain Brewery in Louisville, KY. The bitterest beer (with an IBU value of 138) is “Bitter Bitch Imperial IPA American Double”, brewed by the Astoria Brewing Company in Astoria, OR.
6. *What are the summary statistics for the **ABV** variable?*

```
The summary statistics for the ABV (Alcohol By Volume) variable are listed below:
Min.     1st Qu.  Median   Mean     3rd Qu.  Max.
0.02700  0.05000  0.05700  0.06007  0.06800  0.12500
```

7. *Is there an apparent relationship between bitterness of the beer and its alcoholic content? What does a scatter plot of this data look like?*
   - “Alcohol by Volume (ABV) vs. International Bitterness Unit (IBU)” scatter plot. The scatter plot above was derived by plotting median values of ABV (Alcohol By Volume) against median values of IBU (International Bitterness Units). The linear regression line includes a shaded 95% confidence interval. There is good evidence for a positive correlation between ABV and IBU values in this data set.



-
- When looking at the scatterplot of ABV vs IBU, there looks to be a linear relationship between the two variables. A correlation analysis would be recommended to measure this relationship.
- When performing the linear correlation analysis we have found a moderate positive linear correlation between ABV and IBU (p-value $<$ 0.0001 95% confidence interval, 2-sided t-test). R-squared for the fit is 44.8%. So ABV is able to predict almost 45% of the IBU scores. This indicates there are other factors involved not accounted for in this analysis, and might suggest further investigation.

Conclusion

TODO: Add conclusion here

Appendix

Source Code

Required Libraries

1. deplyr - To Install: `install.packages("deplyr")`
2. ggplot2 - To Install: `install.packages("ggplot2")`
3. doBy - To Install: `install.packages("doBy")`
4. stringr - To Install: `install.packages("stringr")`
5. reshape2 - To Install: `install.packages("reshape2")`
6. gridExtra - To Install: `install.packages("gridExtra")`

Case Study Solution

```
#
# NOTE:
# If you add any libraries to this file, make sure you add the library to the
```

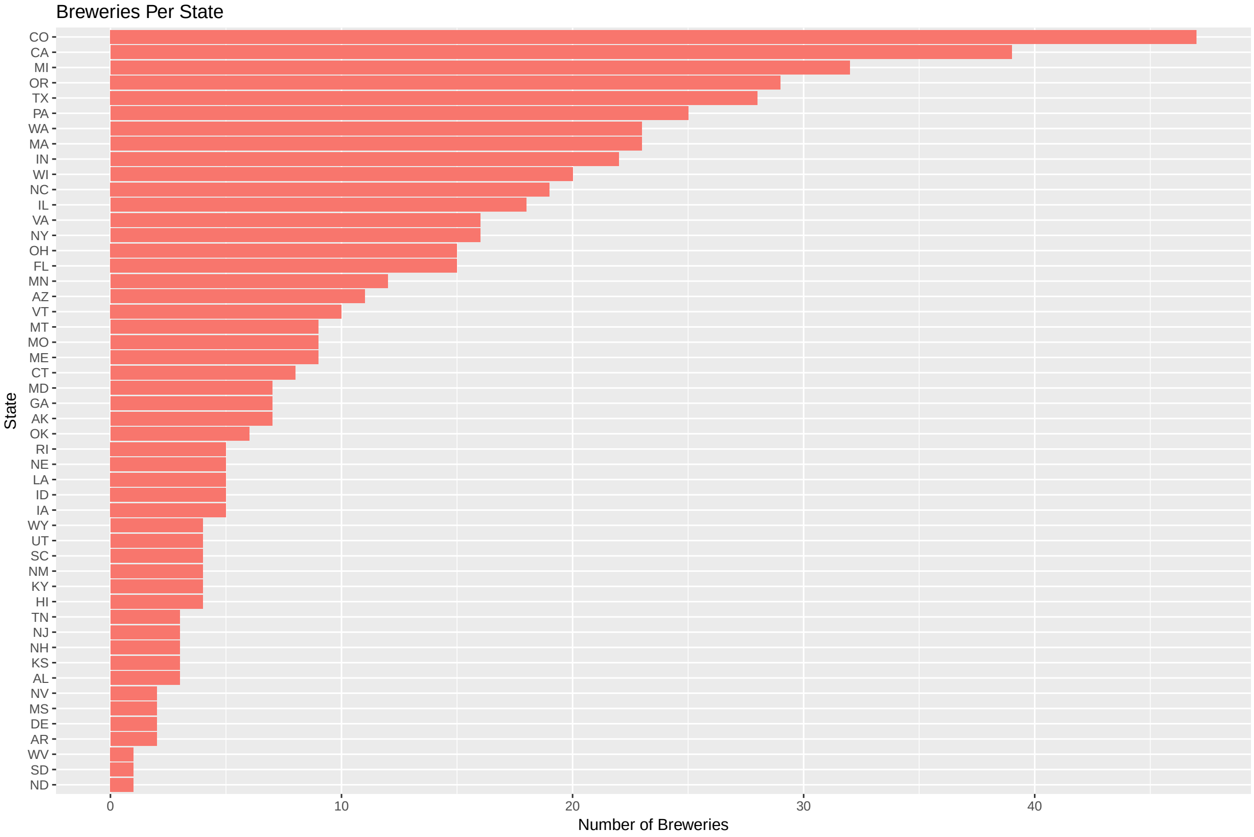
```r
# 'ENVIRONMENT' section of the file: code/00_LoadAndPrepare.R
#
library(dplyr)
library(ggplot2)
library(doBy)
library(stringr)
library(reshape2)
library(gridExtra)
library(gplots)
```

```r
#
#

#===============================================================================

## Load the Beer and Breweries datasets, rename the columns, sort beer dataset

# Define variables to be used throughout the document
# The base/root URL to load the data from
data_root_url <- "https://raw.githubusercontent.com/allthebits/msds6306-case-study-01/master/data/"

# Define the String URL's for the Beer and Brewery datasets
beer_url <- paste(data_root_url, "Beers.csv", sep="");
brewery_url <- paste(data_root_url, "Breweries.csv", sep="");

# Load the Beer and Brewery Datasets
beer <- read.csv(url(beer_url), header = TRUE, sep=",", row.names = NULL)
brewery <- read.csv(url(brewery_url), header = TRUE, sep=",", row.names = NULL)

#===============================================================================

# Convert UTF-8 format character data in Dataframes for Beer and Brewery

# Beer file

# Convert UTF-8 format in "beer$Name"
beer$Name <- str_conv(beer$Name, "UTF-8")

# Convert UTF-8 format in "beer$Style"
beer$Style <- str_conv(beer$Style, "UTF-8")

# Brewery file

# Convert UTF-8 format in "beer$Style"
brewery$Name <- str_conv(brewery$Name, "UTF-8")

# ==============================================================================

# Modify column/variable names on the Dataframes for Beer and Brewery

# in beer df rename column "Name" to "Beer"
beer <- rename(beer, Beer = Name)

# in beer df rename column "Brewery_id"" to "Brew_ID"
```

```r
beer <- rename(beer, Brew_ID = Brewery_id)

# in brewery df rename column "Name" to "Brewery"
brewery <- rename(brewery, Brewery = Name)

# Arrange beer df by Brew_ID
beer <- arrange(beer, (Brew_ID))

# Remove duplicates with all columns other than Brew_ID as criteria for removal
beer <- beer[!duplicated(beer[c('Beer', 'ABV', 'IBU', 'Style', 'Ounces')]),]

# Remove row.names column
row.names(beer) <- NULL
#
#
# Case Study 01 : Question 01) Breweries per state?
# Requires the library: 'ggplot2'

# The source path MUST include the "code" directory because the context
#   when the source statement executes is within the RMarkdown file and that
# is one directory 'up' from here
source('code/01_Question_01.tidy.R')

summary(BreweryByState)
```

```
##      State      Breweries
##   AK    : 1   Min.   : 1.00
##   AL    : 1   1st Qu.: 4.00
##   AR    : 1   Median : 7.00
##   AZ    : 1   Mean   :11.14
##   CA    : 1   3rd Qu.:16.00
##   CO    : 1   Max.   :47.00
##  (Other):44
```

```r
q1_plot <- ggplot(BreweryByState, aes(x=reorder(State, Breweries), y=(Breweries), fill = "red")) + geom

grid::grid.draw(q1_plot)
```



```
ggsave(q1_plot, filename="tmp/q1_plot.png")
```

```
## Saving 12 x 8 in image
```

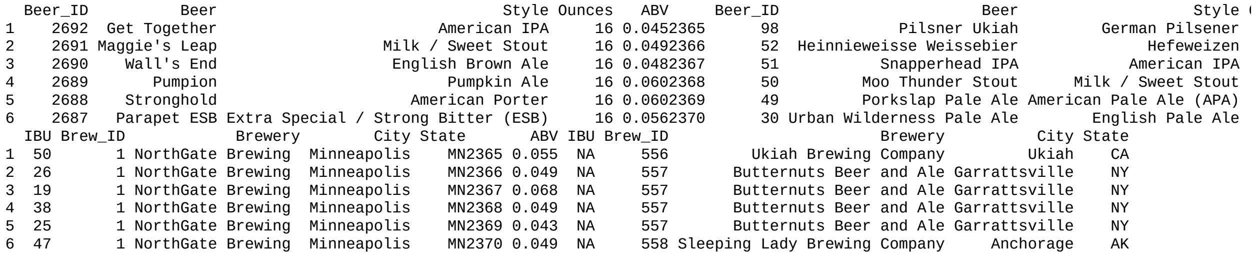
```
#
#
# Case Study 01 : Question 02) Merge beer and brewery data. Print first and last
#                 6 observations
# QC

source('code/02_Question_02.tidy.R')

summary(beerbrew)
```

```
##     Beer_ID           Beer              Style               Ounces
##  Min.   :   4.0   Length:2370        Length:2370        Min.   : 8.40
##  1st Qu.: 813.2   Class :character   Class :character   1st Qu.:12.00
##  Median :1457.5   Mode  :character   Mode  :character   Median :12.00
##  Mean   :1432.6                                         Mean   :13.59
##  3rd Qu.:2073.8                                         3rd Qu.:16.00
##  Max.   :2692.0                                         Max.   :32.00
##
##       ABV               IBU            Brew_ID        Brewery
##  Min.   :0.00100   Min.   :  4.00   Min.   :  1.0   Length:2370
##  1st Qu.:0.05000   1st Qu.: 21.00   1st Qu.: 94.0   Class :character
##  Median :0.05600   Median : 35.00   Median :206.0   Mode  :character
##  Mean   :0.05987   Mean   : 42.78   Mean   :232.8
##  3rd Qu.:0.06800   3rd Qu.: 64.00   3rd Qu.:367.8
##  Max.   :0.12800   Max.   :138.00   Max.   :558.0
##  NA's   :62        NA's   :998
##            City          State
##  Grand Rapids:  66    CO     : 259
##  Chicago     :  55    CA     : 180
##  Portland    :  53    MI     : 162
##  Indianapolis:  43    IN     : 139
##  Boulder     :  41    TX     : 130
##  San Diego   :  41    OR     : 114
##  (Other)     :2071   (Other):1386
```

```
str(beerbrew)
```

```
## 'data.frame':    2370 obs. of  10 variables:
##  $ Beer_ID: int  2692 2691 2690 2689 2688 2687 2686 2685 2684 2683 ...
##  $ Beer   : chr  "Get Together" "Maggie's Leap" "Wall's End" "Pumpion" ...
##  $ Style  : chr  "American IPA" "Milk / Sweet Stout" "English Brown Ale" "Pumpkin Ale" ...
##  $ Ounces : num  16 16 16 16 16 16 16 16 16 16 ...
##  $ ABV    : num  0.045 0.049 0.048 0.06 0.06 0.056 0.08 0.125 0.077 0.042 ...
##  $ IBU    : int  50 26 19 38 25 47 68 80 25 42 ...
##  $ Brew_ID: int  1 1 1 1 1 1 2 2 2 2 ...
##  $ Brewery: chr  "NorthGate Brewing " "NorthGate Brewing " "NorthGate Brewing " "NorthGate Brewing "
##  $ City   : Factor w/ 384 levels "Abingdon","Abita Springs",..: 228 228 228 228 228 228 200 200 200 2
##  $ State  : Factor w/ 51 levels " AK"," AL"," AR",..: 24 24 24 24 24 24 18 18 18 18 ...
```

```
# Check beerbrew

q2_out1 <- capture.output(head(beerbrew,6))
q2_out2 <- capture.output(tail(beerbrew,6))

text <- paste0(q2_out1, q2_out2)
textplot(text, valign="top")
```



```
  Beer_ID          Beer                                   Style Ounces    ABV     Beer_ID                   Beer                  Style
1    2692  Get Together                            American IPA     16 0.0452365      98           Pilsner Ukiah         German Pilsener
2    2691 Maggie's Leap                      Milk / Sweet Stout     16 0.0492366      52  Heinnieweisse Weissebier             Hefeweizen
3    2690    Wall's End                       English Brown Ale     16 0.0482367      51          Snapperhead IPA            American IPA
4    2689       Pumpion                             Pumpkin Ale     16 0.0602368      50         Moo Thunder Stout      Milk / Sweet Stout
5    2688    Stronghold                        American Porter     16 0.0602369      49         Porkslap Pale Ale American Pale Ale (APA)
6    2687    Parapet ESB Extra Special / Strong Bitter (ESB)     16 0.0562370      30 Urban Wilderness Pale Ale        English Pale Ale
  IBU Brew_ID            Brewery         City State        ABV IBU Brew_ID                      Brewery          City State
1  50       1 NorthGate Brewing  Minneapolis     MN2365 0.055  NA     556         Ukiah Brewing Company         Ukiah    CA
2  26       1 NorthGate Brewing  Minneapolis     MN2366 0.049  NA     557        Butternuts Beer and Ale Garrattsville    NY
3  19       1 NorthGate Brewing  Minneapolis     MN2367 0.068  NA     557        Butternuts Beer and Ale Garrattsville    NY
4  38       1 NorthGate Brewing  Minneapolis     MN2368 0.049  NA     557        Butternuts Beer and Ale Garrattsville    NY
5  25       1 NorthGate Brewing  Minneapolis     MN2369 0.043  NA     557        Butternuts Beer and Ale Garrattsville    NY
6  47       1 NorthGate Brewing  Minneapolis     MN2370 0.049  NA     558 Sleeping Lady Brewing Company      Anchorage    AK
```

```
png(file="tmp/q2_plot.png")
textplot(text, valign="top")
dev.off();
```

```
## pdf
##   2
```

```
#
#
# Case Study 01 : Question 03) Report NA in each column
q3_out <- capture.output(sapply(beerbrew, function(x) sum(is.na(x))))
q3_out
```

```
## [1] "Beer_ID     Beer    Style   Ounces      ABV      IBU Brew_ID Brewery     City "
## [2] "       0        0        0        0       62      998       0       0        0 "
## [3] "  State "
## [4] "      0 "
```

```
#
source('code/03_Question_03.tidy.R')
#
#
# Case Study 01 : Question 04) Median ABV and IBU by state. Plot barchart.
# Requires the library:  'doBy'

# Calculate median values for each obs of ABV and IBU by state using DoBy

MedianABV <- summaryBy(ABV ~ State, data = beerbrew, FUN = median)
MedianIBU <- summaryBy(IBU ~ State, data = beerbrew, FUN = median)

# Merge into one df
ABV_IBU_median <- dplyr::inner_join(MedianABV, MedianIBU, by = "State")

summary(ABV_IBU_median)
```

```
##      State      ABV.median        IBU.median   
##    AK     : 1   Min.   :0.04000   Min.   :19.00  
##    AL     : 1   1st Qu.:0.05262   1st Qu.:30.00  
##    AR     : 1   Median :0.05625   Median :35.00  
##    AZ     : 1   Mean   :0.05557   Mean   :37.05  
##    CA     : 1   3rd Qu.:0.05838   3rd Qu.:44.25  
##    CO     : 1   Max.   :0.06700   Max.   :61.00  
##   (Other):44
```

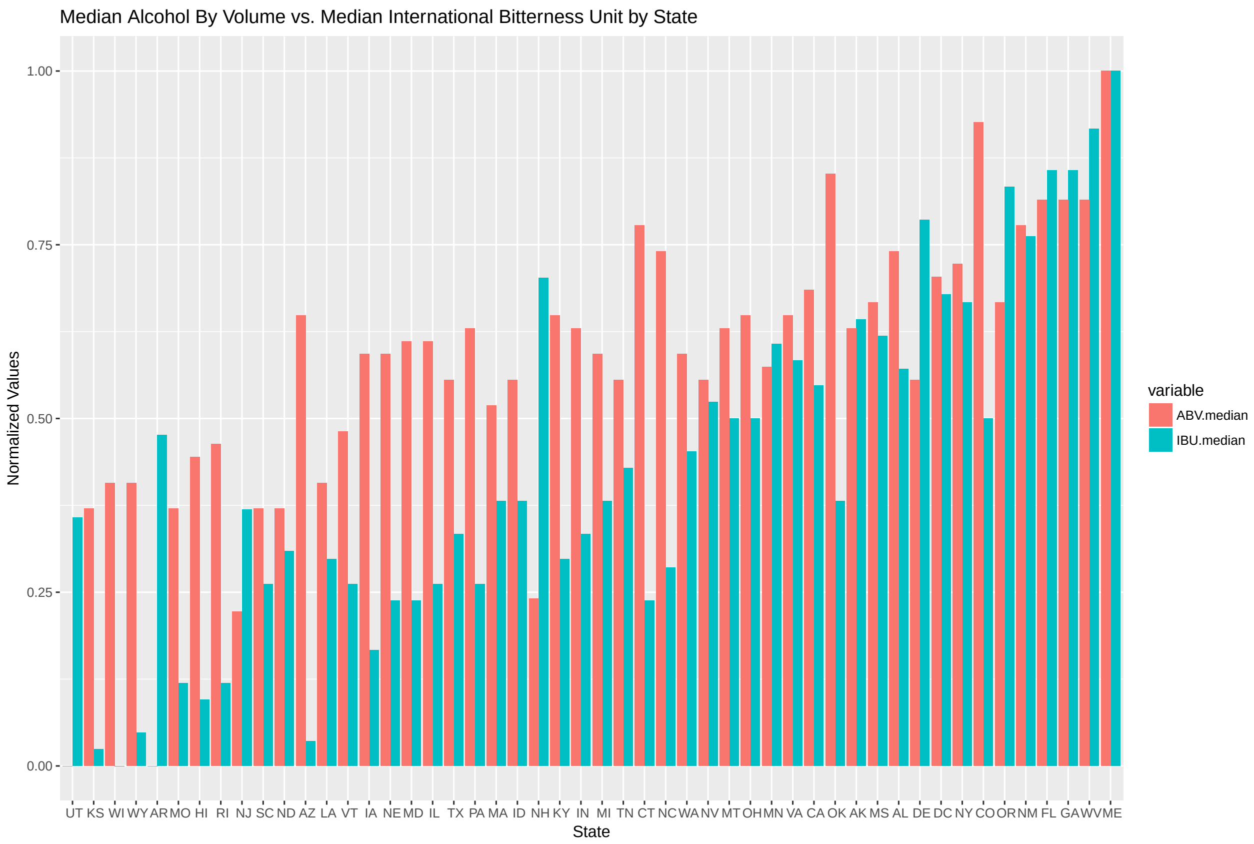
```
str(ABV_IBU_median)
```

```
## 'data.frame':    50 obs. of  3 variables:
##  $ State     : Factor w/ 51 levels " AK"," AL"," AR",..: 1 2 3 4 5 6 7 8 9 10 ...
##  $ ABV.median: num  0.057 0.06 0.04 0.0575 0.0585 0.065 0.061 0.059 0.055 0.062 ...
##  $ IBU.median: num  46 43 39 20.5 42 40 29 47.5 52 55 ...
```

```
# Normalize ABV and IBU values for direct comparison
ABV_IBU_median_norm <- as.data.frame(apply(ABV_IBU_median[, 2:3], 2, function(x) (x - min(x))/(max(x)-mi

# Add back State column
ABV_IBU_median_norm <- cbind(State = ABV_IBU_median$State, ABV_IBU_median_norm)

# Melt data frame (ABV and IBU in one column) for ggplot
ABV_IBU_median_long <- melt(ABV_IBU_median_norm)
```

```
## Using State as id variables
```

```
# Plot dual barplots with ggplot2
q4_plot <- ggplot(ABV_IBU_median_long,aes(x = reorder(State,value), y = value,fill=variable)) + geom_ba


grid::grid.draw(q4_plot)
```



```
ggsave(q4_plot, filename="tmp/q4_plot.png")
```

```
## Saving 12 x 8 in image
```

```
#
#
# Case Study 01 : Question 05) State with highest ABV? Highest IBU?
# Most alcoholic beer (Kentucky)
dplyr::top_n(beerbrew_NA, 1, ABV)
```

```
##   Beer_ID                                                 Beer
## 1    2565 Lee Hill Series Vol. 5 - Belgian Style Quadrupel Ale
##               Style Ounces   ABV IBU Brew_ID                Brewery
## 1 Quadrupel (Quad)    19.2 0.128  NA      52 Upslope Brewing Company
##      City State
## 1 Boulder    CO
```

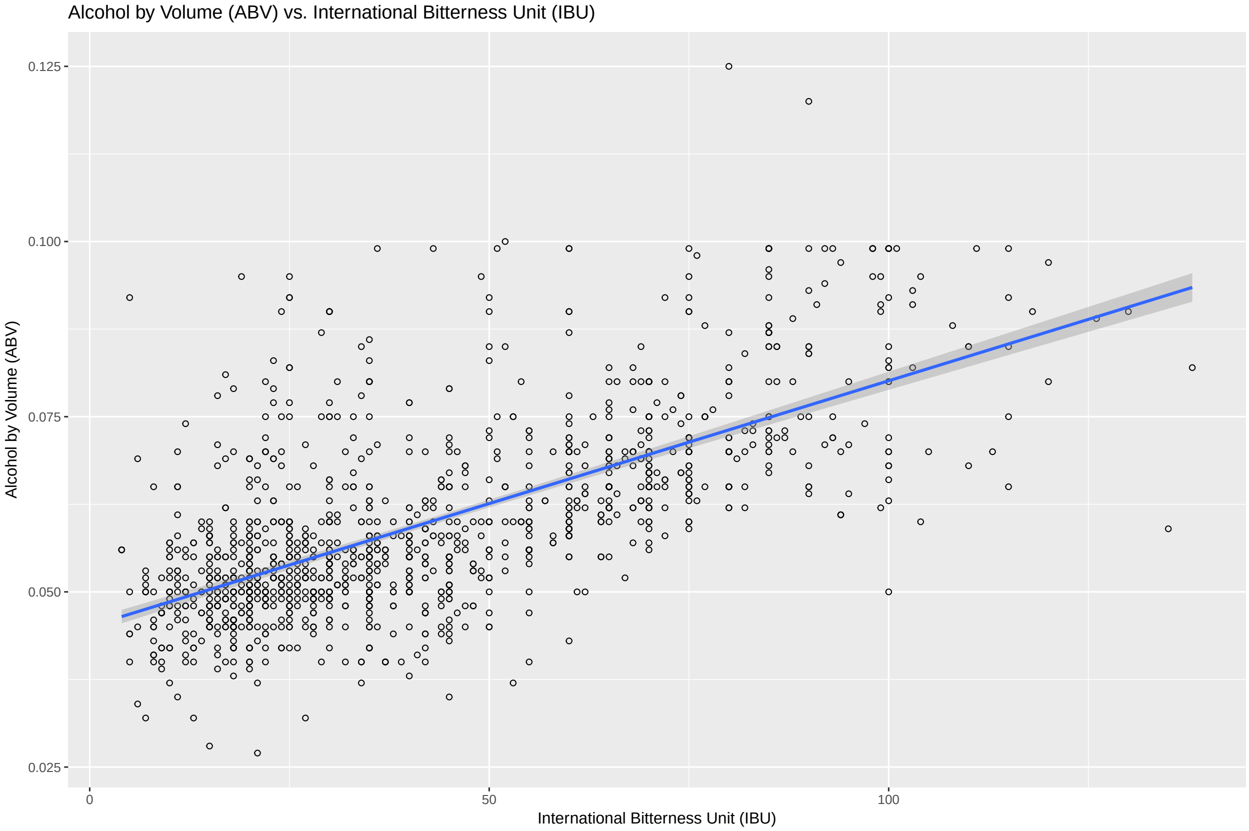
```
# Most bitter beer (Oregon)
dplyr::top_n(beerbrew_NA, 1, IBU)
```

```
##   Beer_ID                         Beer                          Style Ounces
## 1     980 Bitter Bitch Imperial IPA American Double / Imperial IPA     12
##     ABV IBU Brew_ID                 Brewery    City State
## 1 0.082 138     375 Astoria Brewing Company Astoria    OR
```

```
#
#
# Case Study 01 : Question 06) Summary Statistics for the ABV variable
summary(beerbrew$ABV)
```

```
##     Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 0.02700 0.05000 0.05700 0.06007 0.06800 0.12500
```

```
#
#
# Case Study 01 : Question 07) Is there an apparent relationship between the
#                              bitterness of the beer and its alcoholic content?
#                              Draw a scatter plot.

q7_plot <- ggplot(beerbrew, aes(x=IBU, y=ABV)) +
    geom_point(shape=1) +    # Use hollow circles
    geom_smooth(method=lm) +  # Add linear regression line (by default includes 95% confidence region)
    labs(title = "Alcohol by Volume (ABV) vs. International Bitterness Unit (IBU)") + labs(x = "Interna

grid::grid.draw(q7_plot)
```



```
ggsave(q7_plot, filename="tmp/q7_plot.png")
```

```
## Saving 12 x 8 in image
```