Assignment 2

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Assignment 2

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Notes

```r
# Libraries

# NOTE: if you do not have any of the below libraries installed, un-comment the line and run it
#install.packages("rmarkdown")
library(rmarkdown)

#install.packages("ggplot2")
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.4.1
```

```r
#install.packages("patchwork")
library(patchwork)
```

```
## Warning: package 'patchwork' was built under R version 4.4.1
```

```r
#install.packages("dplyr")
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.4.1

##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
# install.packages("tidyr")
library(tidyr)
```

```
## Warning: package 'tidyr' was built under R version 4.4.1
```

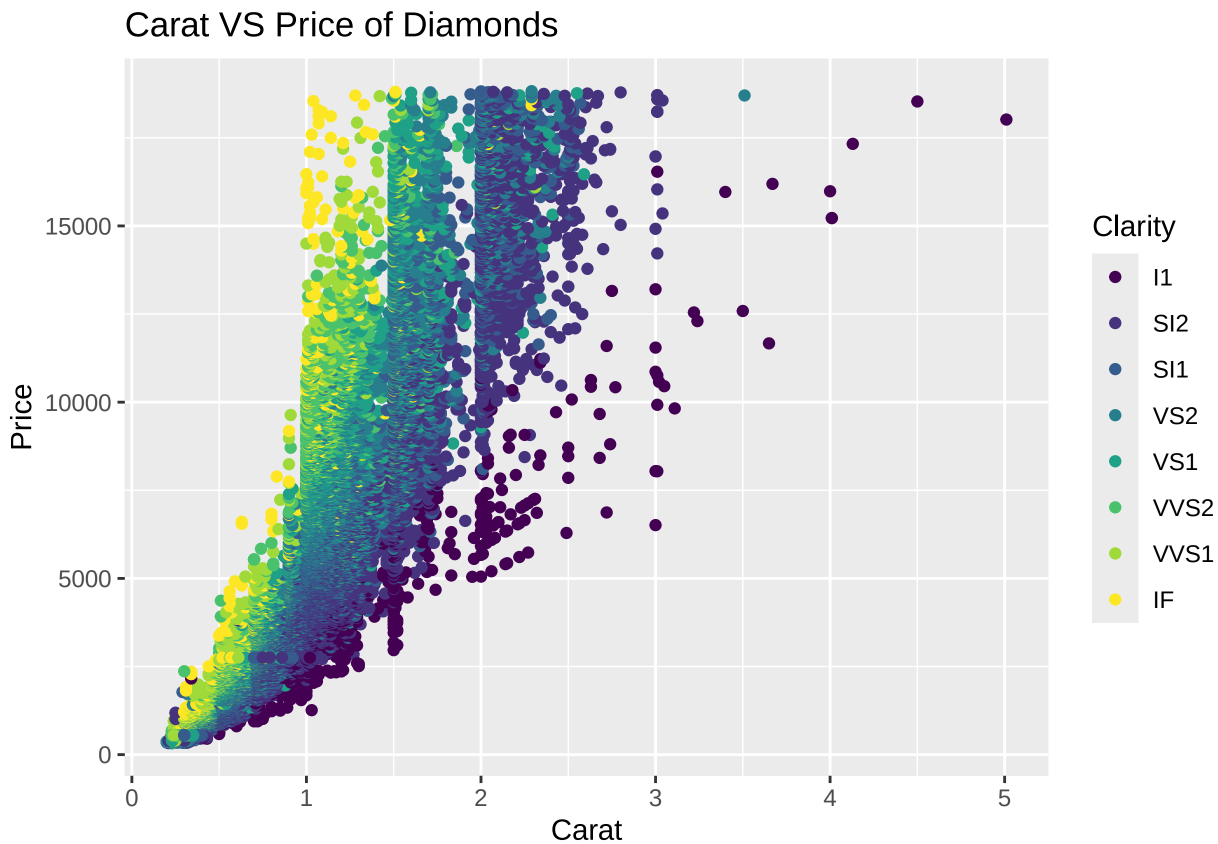
```r
# TODO:
# - Format ctrl + shift + a
# Make sure all questions are completed
# double check questions
# install.packages("ggplot2")
```

Solutions

---

1. Advanced ggplot2 Visualizations

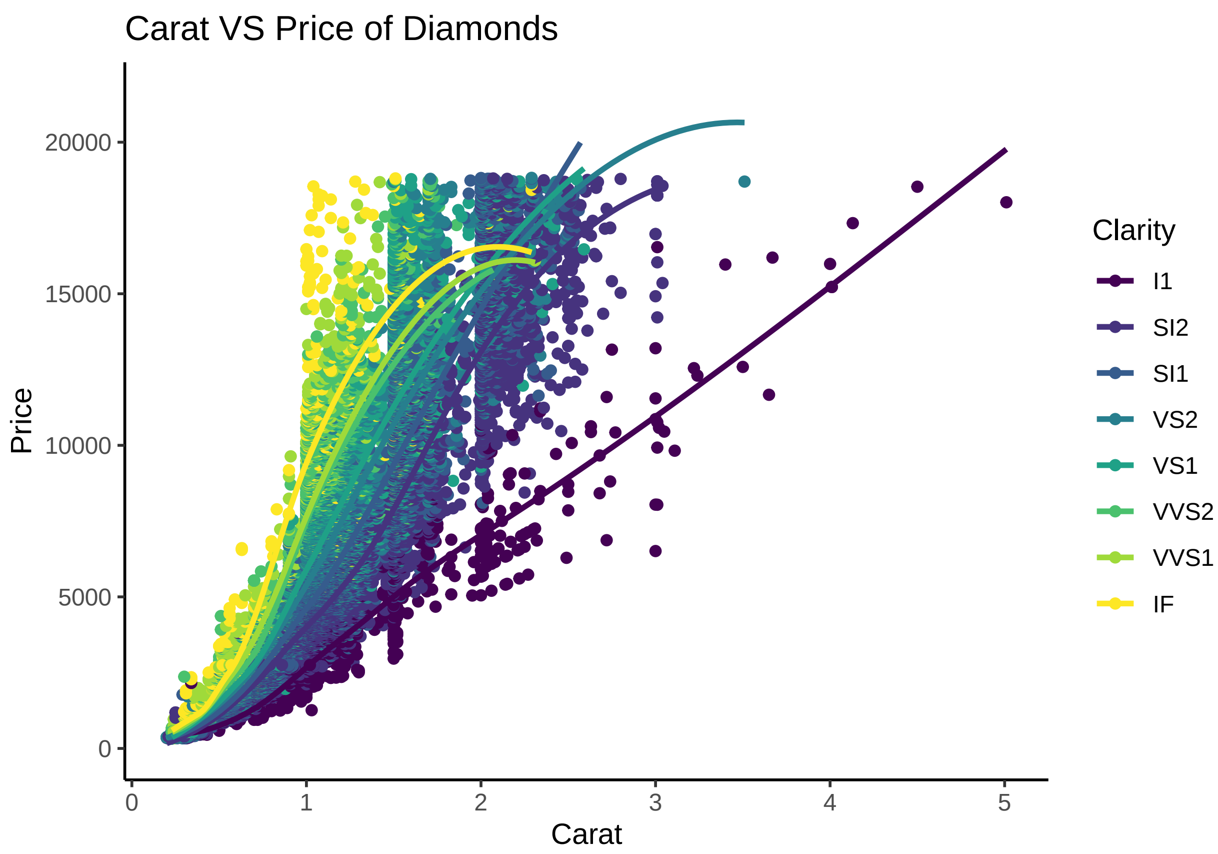
A. Load the diamonds dataset from the ggplot2 package. Create a scatter plot of carat vs price with points colored by clarity.



B. Modify the scatter plot to include a smoothing line (e.g., LOESS) and customize the theme for better readability.

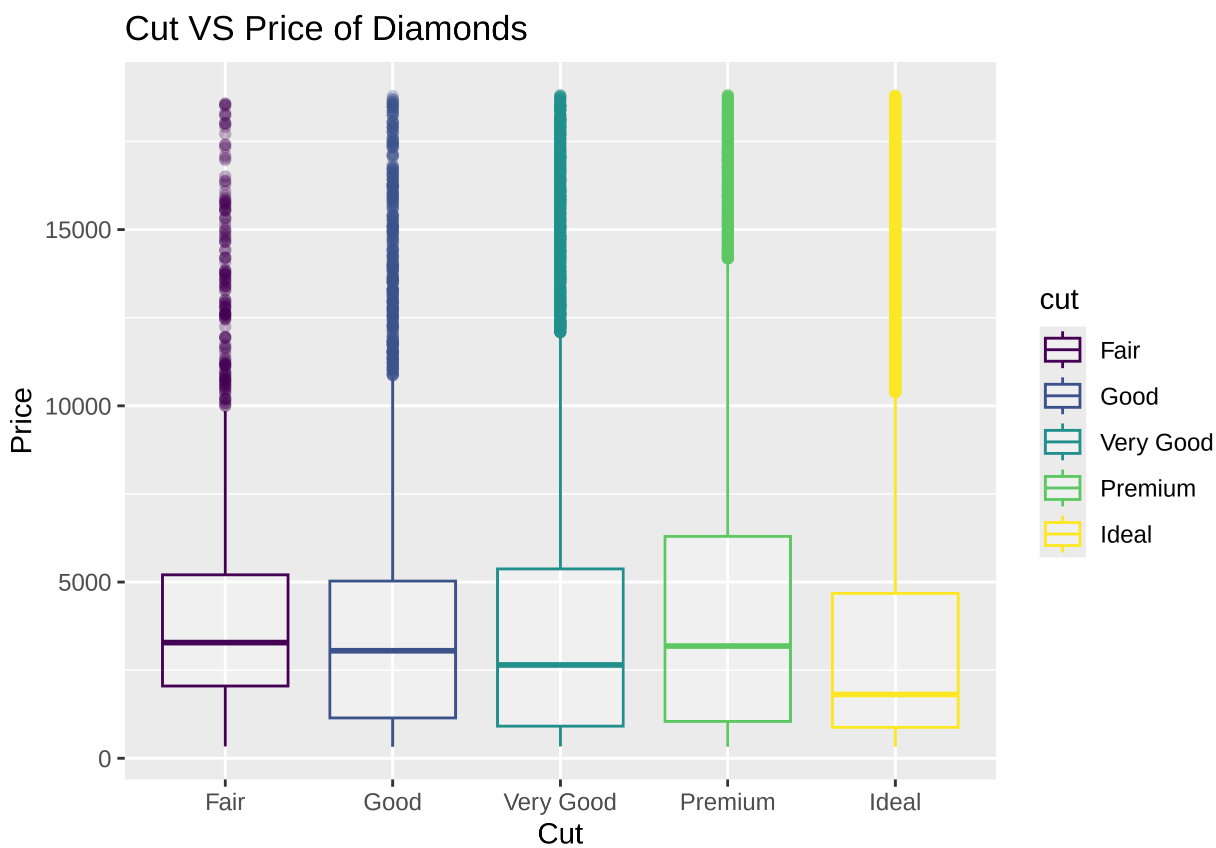
```r
scatPlot <- scatPlot +
  geom_smooth(fill = NA, method = "loess") +
  theme_classic()

scatPlot
```

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



C. Create a boxplot of price by cut, with different fill colors for each cut.

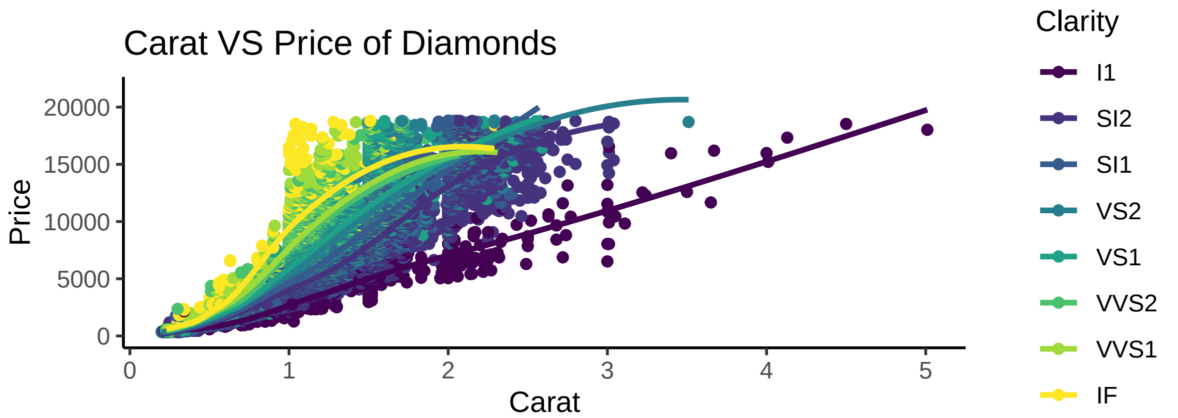
```
boxPlot <- ggplot(diamonds, aes(x = cut, y = price, colour = cut)) +
  geom_boxplot(alpha = 0.3) +
  labs(x = "Cut", y = "Price", title = "Cut VS Price of Diamonds")

boxPlot
```

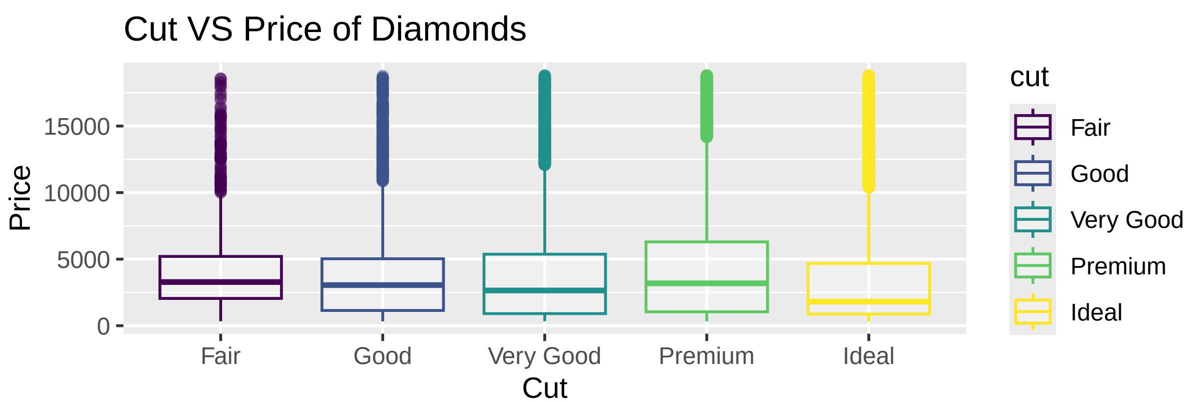


D. Combine the scatter plot and boxplot into a single visualization using patchwork.

```
combinedPlot <- scatPlot / boxPlot
combinedPlot
```

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





---

2. Advanced Group Manipulations

A. Load the mtcars dataset. Group the data by the number of cylinders and calculate the mean mpg for each group.

```
data("mtcars")

mtcarsDS <- mtcars

meanMpg <- tapply(mtcarsDS$mpg, mtcarsDS$cyl, mean)

meanMpg
```

```
##        4        6        8
## 26.66364 19.74286 15.10000
```

B. Add a column to the original dataset indicating whether each car's mpg is above or below the mean mpg of its cylinder group.

```r
mtcarsDS$posMean <- ifelse(mtcarsDS$mpg > meanMpg[as.character(mtcarsDS$cyl)],
                          "above",
                          ifelse(mtcarsDS$mpg < meanMpg[as.character(mtcarsDS$cyl)], "below", "same"))

mtcarsDS
```

```
##                      mpg cyl  disp  hp drat    wt  qsec vs am gear carb posMean
## Mazda RX4           21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4   above
## Mazda RX4 Wag       21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4   above
## Datsun 710          22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1   below
## Hornet 4 Drive      21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1   above
## Hornet Sportabout   18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2   above
## Valiant             18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1   below
## Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4   below
## Merc 240D           24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2   below
## Merc 230            22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2   below
## Merc 280            19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4   below
## Merc 280C           17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4   below
## Merc 450SE          16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3   above
## Merc 450SL          17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3   above
## Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3   above
## Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4   below
## Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4   below
## Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4   below
## Fiat 128            32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1   above
## Honda Civic         30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2   above
## Toyota Corolla      33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1   above
## Toyota Corona       21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1   below
## Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2   above
## AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2   above
## Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4   below
## Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2   above
## Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1   above
## Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2   below
## Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2   above
## Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4   above
## Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6   below
## Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8   below
## Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2   below
```

C. Create a summary table showing the mean and median hp and wt for each combination of cyl and gear.

```r
summaryTable <- mtcars %>%
  group_by(cyl, gear) %>%
  summarise(
    meanHp = mean(hp),
    medianHp = median(hp),
    meanWt = mean(wt),
    medianWt = median(wt),
  )
```

```
## 'summarise()' has grouped output by 'cyl'. You can override using the '.groups'
## argument.
```

```r
summaryTable
```

```
## # A tibble: 8 x 6
## # Groups:   cyl [3]
##     cyl  gear meanHp medianHp meanWt medianWt
##   <dbl> <dbl>  <dbl>    <dbl>  <dbl>    <dbl>
## 1     4     3    97       97    2.46     2.46
## 2     4     4    76       66    2.38     2.26
## 3     4     5   102      102    1.83     1.83
## 4     6     3   108.     108.   3.34     3.34
## 5     6     4   116.     116.   3.09     3.16
## 6     6     5   175      175    2.77     2.77
## 7     8     3   194.     180    4.10     3.81
## 8     8     5   300.     300.   3.37     3.37
```

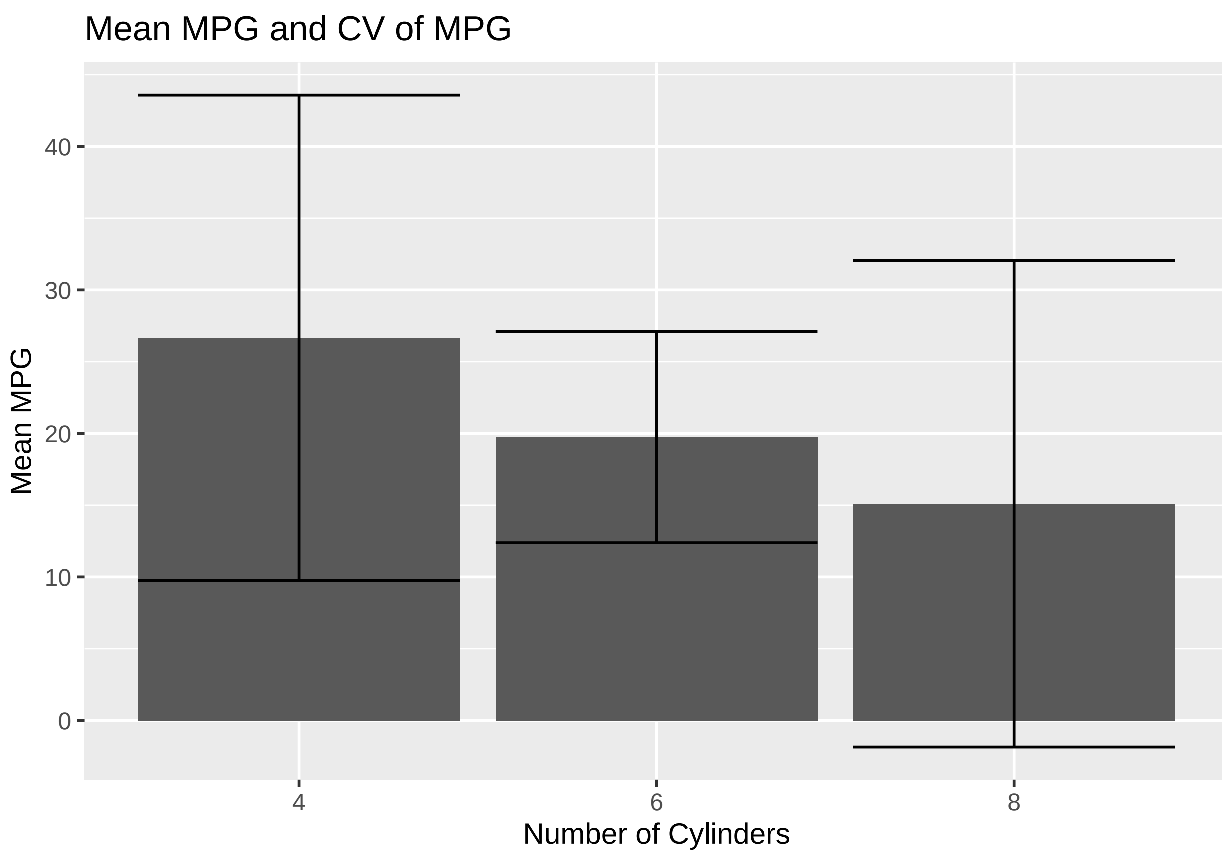
D. Write a function to calculate the coefficient of variation (CV) for a given numeric column and apply this function to mpg, hp, and wt for each cylinder group.

```r
getCV <- function(x) {
  cv <- sd(x) / mean(x) * 100
  return(cv)
}

cvs <- mtcars %>%
  group_by(cyl) %>%
  summarise(cvMpg = getCV(mpg),
            cvHp = getCV(hp),
            cvWt = getCV(wt))

cvs
```

```
## # A tibble: 3 x 4
##     cyl cvMpg  cvHp  cvWt
##   <dbl> <dbl> <dbl> <dbl>
## 1     4 16.9   25.3  24.9
## 2     6  7.36  19.8  11.4
## 3     8 17.0   24.4  19.0
```

E. Plot the mean mpg and CV of mpg for each cylinder group using a bar plot with error bars.

```r
plotData <- mtcars %>%
  group_by(cyl) %>%
  summarise(meanMpg = mean(mpg), cvMpg = getCV(mpg))

ggplot(plotData, aes(x = factor(cyl), y = meanMpg)) +
  geom_bar(stat = "identity") +
  geom_errorbar(aes(ymin = meanMpg - cvMpg, ymax = meanMpg + cvMpg), ) +
  labs(x = "Number of Cylinders", y = "Mean MPG", title = "Mean MPG and CV of MPG")
```



---

3. Data Reshaping with tidyr

A. Load the airquality dataset. Reshape the dataset from wide to long format, using gather() for the measurements (Ozone, Solar.R, Wind, Temp).

```
data("airquality")
airqualityData <- airquality
airqualityData <- airqualityData %>% gather(key = "variable", value = "value", Ozone:Temp)

airqualityData
```

```
##     Month Day variable value
## 1       5   1    Ozone  41.0
## 2       5   2    Ozone  36.0
## 3       5   3    Ozone  12.0
## 4       5   4    Ozone  18.0
## 5       5   5    Ozone    NA
## 6       5   6    Ozone  28.0
## 7       5   7    Ozone  23.0
## 8       5   8    Ozone  19.0
## 9       5   9    Ozone   8.0
```

```
## 10       5  10    Ozone    NA
## 11       5  11    Ozone   7.0
## 12       5  12    Ozone  16.0
## 13       5  13    Ozone  11.0
## 14       5  14    Ozone  14.0
## 15       5  15    Ozone  18.0
## 16       5  16    Ozone  14.0
## 17       5  17    Ozone  34.0
## 18       5  18    Ozone   6.0
## 19       5  19    Ozone  30.0
## 20       5  20    Ozone  11.0
## 21       5  21    Ozone   1.0
## 22       5  22    Ozone  11.0
## 23       5  23    Ozone   4.0
## 24       5  24    Ozone  32.0
## 25       5  25    Ozone    NA
## 26       5  26    Ozone    NA
## 27       5  27    Ozone    NA
## 28       5  28    Ozone  23.0
## 29       5  29    Ozone  45.0
## 30       5  30    Ozone 115.0
## 31       5  31    Ozone  37.0
## 32       6   1    Ozone    NA
## 33       6   2    Ozone    NA
## 34       6   3    Ozone    NA
## 35       6   4    Ozone    NA
## 36       6   5    Ozone    NA
## 37       6   6    Ozone    NA
## 38       6   7    Ozone  29.0
## 39       6   8    Ozone    NA
## 40       6   9    Ozone  71.0
## 41       6  10    Ozone  39.0
## 42       6  11    Ozone    NA
## 43       6  12    Ozone    NA
## 44       6  13    Ozone  23.0
## 45       6  14    Ozone    NA
## 46       6  15    Ozone    NA
## 47       6  16    Ozone  21.0
## 48       6  17    Ozone  37.0
## 49       6  18    Ozone  20.0
## 50       6  19    Ozone  12.0
## 51       6  20    Ozone  13.0
## 52       6  21    Ozone    NA
## 53       6  22    Ozone    NA
## 54       6  23    Ozone    NA
## 55       6  24    Ozone    NA
## 56       6  25    Ozone    NA
## 57       6  26    Ozone    NA
## 58       6  27    Ozone    NA
## 59       6  28    Ozone    NA
## 60       6  29    Ozone    NA
## 61       6  30    Ozone    NA
## 62       7   1    Ozone 135.0
## 63       7   2    Ozone  49.0
```

```
## 64       7   3    Ozone  32.0
## 65       7   4    Ozone    NA
## 66       7   5    Ozone  64.0
## 67       7   6    Ozone  40.0
## 68       7   7    Ozone  77.0
## 69       7   8    Ozone  97.0
## 70       7   9    Ozone  97.0
## 71       7  10    Ozone  85.0
## 72       7  11    Ozone    NA
## 73       7  12    Ozone  10.0
## 74       7  13    Ozone  27.0
## 75       7  14    Ozone    NA
## 76       7  15    Ozone   7.0
## 77       7  16    Ozone  48.0
## 78       7  17    Ozone  35.0
## 79       7  18    Ozone  61.0
## 80       7  19    Ozone  79.0
## 81       7  20    Ozone  63.0
## 82       7  21    Ozone  16.0
## 83       7  22    Ozone    NA
## 84       7  23    Ozone    NA
## 85       7  24    Ozone  80.0
## 86       7  25    Ozone 108.0
## 87       7  26    Ozone  20.0
## 88       7  27    Ozone  52.0
## 89       7  28    Ozone  82.0
## 90       7  29    Ozone  50.0
## 91       7  30    Ozone  64.0
## 92       7  31    Ozone  59.0
## 93       8   1    Ozone  39.0
## 94       8   2    Ozone   9.0
## 95       8   3    Ozone  16.0
## 96       8   4    Ozone  78.0
## 97       8   5    Ozone  35.0
## 98       8   6    Ozone  66.0
## 99       8   7    Ozone 122.0
## 100      8   8    Ozone  89.0
## 101      8   9    Ozone 110.0
## 102      8  10    Ozone    NA
## 103      8  11    Ozone    NA
## 104      8  12    Ozone  44.0
## 105      8  13    Ozone  28.0
## 106      8  14    Ozone  65.0
## 107      8  15    Ozone    NA
## 108      8  16    Ozone  22.0
## 109      8  17    Ozone  59.0
## 110      8  18    Ozone  23.0
## 111      8  19    Ozone  31.0
## 112      8  20    Ozone  44.0
## 113      8  21    Ozone  21.0
## 114      8  22    Ozone   9.0
## 115      8  23    Ozone    NA
## 116      8  24    Ozone  45.0
## 117      8  25    Ozone 168.0
```

```
## 118      8  26    Ozone  73.0
## 119      8  27    Ozone    NA
## 120      8  28    Ozone  76.0
## 121      8  29    Ozone 118.0
## 122      8  30    Ozone  84.0
## 123      8  31    Ozone  85.0
## 124      9   1    Ozone  96.0
## 125      9   2    Ozone  78.0
## 126      9   3    Ozone  73.0
## 127      9   4    Ozone  91.0
## 128      9   5    Ozone  47.0
## 129      9   6    Ozone  32.0
## 130      9   7    Ozone  20.0
## 131      9   8    Ozone  23.0
## 132      9   9    Ozone  21.0
## 133      9  10    Ozone  24.0
## 134      9  11    Ozone  44.0
## 135      9  12    Ozone  21.0
## 136      9  13    Ozone  28.0
## 137      9  14    Ozone   9.0
## 138      9  15    Ozone  13.0
## 139      9  16    Ozone  46.0
## 140      9  17    Ozone  18.0
## 141      9  18    Ozone  13.0
## 142      9  19    Ozone  24.0
## 143      9  20    Ozone  16.0
## 144      9  21    Ozone  13.0
## 145      9  22    Ozone  23.0
## 146      9  23    Ozone  36.0
## 147      9  24    Ozone   7.0
## 148      9  25    Ozone  14.0
## 149      9  26    Ozone  30.0
## 150      9  27    Ozone    NA
## 151      9  28    Ozone  14.0
## 152      9  29    Ozone  18.0
## 153      9  30    Ozone  20.0
## 154      5   1  Solar.R 190.0
## 155      5   2  Solar.R 118.0
## 156      5   3  Solar.R 149.0
## 157      5   4  Solar.R 313.0
## 158      5   5  Solar.R    NA
## 159      5   6  Solar.R    NA
## 160      5   7  Solar.R 299.0
## 161      5   8  Solar.R  99.0
## 162      5   9  Solar.R  19.0
## 163      5  10  Solar.R 194.0
## 164      5  11  Solar.R    NA
## 165      5  12  Solar.R 256.0
## 166      5  13  Solar.R 290.0
## 167      5  14  Solar.R 274.0
## 168      5  15  Solar.R  65.0
## 169      5  16  Solar.R 334.0
## 170      5  17  Solar.R 307.0
## 171      5  18  Solar.R  78.0
```

```
## 172      5  19  Solar.R 322.0
## 173      5  20  Solar.R  44.0
## 174      5  21  Solar.R   8.0
## 175      5  22  Solar.R 320.0
## 176      5  23  Solar.R  25.0
## 177      5  24  Solar.R  92.0
## 178      5  25  Solar.R  66.0
## 179      5  26  Solar.R 266.0
## 180      5  27  Solar.R    NA
## 181      5  28  Solar.R  13.0
## 182      5  29  Solar.R 252.0
## 183      5  30  Solar.R 223.0
## 184      5  31  Solar.R 279.0
## 185      6   1  Solar.R 286.0
## 186      6   2  Solar.R 287.0
## 187      6   3  Solar.R 242.0
## 188      6   4  Solar.R 186.0
## 189      6   5  Solar.R 220.0
## 190      6   6  Solar.R 264.0
## 191      6   7  Solar.R 127.0
## 192      6   8  Solar.R 273.0
## 193      6   9  Solar.R 291.0
## 194      6  10  Solar.R 323.0
## 195      6  11  Solar.R 259.0
## 196      6  12  Solar.R 250.0
## 197      6  13  Solar.R 148.0
## 198      6  14  Solar.R 332.0
## 199      6  15  Solar.R 322.0
## 200      6  16  Solar.R 191.0
## 201      6  17  Solar.R 284.0
## 202      6  18  Solar.R  37.0
## 203      6  19  Solar.R 120.0
## 204      6  20  Solar.R 137.0
## 205      6  21  Solar.R 150.0
## 206      6  22  Solar.R  59.0
## 207      6  23  Solar.R  91.0
## 208      6  24  Solar.R 250.0
## 209      6  25  Solar.R 135.0
## 210      6  26  Solar.R 127.0
## 211      6  27  Solar.R  47.0
## 212      6  28  Solar.R  98.0
## 213      6  29  Solar.R  31.0
## 214      6  30  Solar.R 138.0
## 215      7   1  Solar.R 269.0
## 216      7   2  Solar.R 248.0
## 217      7   3  Solar.R 236.0
## 218      7   4  Solar.R 101.0
## 219      7   5  Solar.R 175.0
## 220      7   6  Solar.R 314.0
## 221      7   7  Solar.R 276.0
## 222      7   8  Solar.R 267.0
## 223      7   9  Solar.R 272.0
## 224      7  10  Solar.R 175.0
## 225      7  11  Solar.R 139.0
```

```
## 226     7  12  Solar.R 264.0
## 227     7  13  Solar.R 175.0
## 228     7  14  Solar.R 291.0
## 229     7  15  Solar.R  48.0
## 230     7  16  Solar.R 260.0
## 231     7  17  Solar.R 274.0
## 232     7  18  Solar.R 285.0
## 233     7  19  Solar.R 187.0
## 234     7  20  Solar.R 220.0
## 235     7  21  Solar.R   7.0
## 236     7  22  Solar.R 258.0
## 237     7  23  Solar.R 295.0
## 238     7  24  Solar.R 294.0
## 239     7  25  Solar.R 223.0
## 240     7  26  Solar.R  81.0
## 241     7  27  Solar.R  82.0
## 242     7  28  Solar.R 213.0
## 243     7  29  Solar.R 275.0
## 244     7  30  Solar.R 253.0
## 245     7  31  Solar.R 254.0
## 246     8   1  Solar.R  83.0
## 247     8   2  Solar.R  24.0
## 248     8   3  Solar.R  77.0
## 249     8   4  Solar.R    NA
## 250     8   5  Solar.R    NA
## 251     8   6  Solar.R    NA
## 252     8   7  Solar.R 255.0
## 253     8   8  Solar.R 229.0
## 254     8   9  Solar.R 207.0
## 255     8  10  Solar.R 222.0
## 256     8  11  Solar.R 137.0
## 257     8  12  Solar.R 192.0
## 258     8  13  Solar.R 273.0
## 259     8  14  Solar.R 157.0
## 260     8  15  Solar.R  64.0
## 261     8  16  Solar.R  71.0
## 262     8  17  Solar.R  51.0
## 263     8  18  Solar.R 115.0
## 264     8  19  Solar.R 244.0
## 265     8  20  Solar.R 190.0
## 266     8  21  Solar.R 259.0
## 267     8  22  Solar.R  36.0
## 268     8  23  Solar.R 255.0
## 269     8  24  Solar.R 212.0
## 270     8  25  Solar.R 238.0
## 271     8  26  Solar.R 215.0
## 272     8  27  Solar.R 153.0
## 273     8  28  Solar.R 203.0
## 274     8  29  Solar.R 225.0
## 275     8  30  Solar.R 237.0
## 276     8  31  Solar.R 188.0
## 277     9   1  Solar.R 167.0
## 278     9   2  Solar.R 197.0
## 279     9   3  Solar.R 183.0
```

```
## 280     9   4  Solar.R 189.0
## 281     9   5  Solar.R  95.0
## 282     9   6  Solar.R  92.0
## 283     9   7  Solar.R 252.0
## 284     9   8  Solar.R 220.0
## 285     9   9  Solar.R 230.0
## 286     9  10  Solar.R 259.0
## 287     9  11  Solar.R 236.0
## 288     9  12  Solar.R 259.0
## 289     9  13  Solar.R 238.0
## 290     9  14  Solar.R  24.0
## 291     9  15  Solar.R 112.0
## 292     9  16  Solar.R 237.0
## 293     9  17  Solar.R 224.0
## 294     9  18  Solar.R  27.0
## 295     9  19  Solar.R 238.0
## 296     9  20  Solar.R 201.0
## 297     9  21  Solar.R 238.0
## 298     9  22  Solar.R  14.0
## 299     9  23  Solar.R 139.0
## 300     9  24  Solar.R  49.0
## 301     9  25  Solar.R  20.0
## 302     9  26  Solar.R 193.0
## 303     9  27  Solar.R 145.0
## 304     9  28  Solar.R 191.0
## 305     9  29  Solar.R 131.0
## 306     9  30  Solar.R 223.0
## 307     5   1     Wind   7.4
## 308     5   2     Wind   8.0
## 309     5   3     Wind  12.6
## 310     5   4     Wind  11.5
## 311     5   5     Wind  14.3
## 312     5   6     Wind  14.9
## 313     5   7     Wind   8.6
## 314     5   8     Wind  13.8
## 315     5   9     Wind  20.1
## 316     5  10     Wind   8.6
## 317     5  11     Wind   6.9
## 318     5  12     Wind   9.7
## 319     5  13     Wind   9.2
## 320     5  14     Wind  10.9
## 321     5  15     Wind  13.2
## 322     5  16     Wind  11.5
## 323     5  17     Wind  12.0
## 324     5  18     Wind  18.4
## 325     5  19     Wind  11.5
## 326     5  20     Wind   9.7
## 327     5  21     Wind   9.7
## 328     5  22     Wind  16.6
## 329     5  23     Wind   9.7
## 330     5  24     Wind  12.0
## 331     5  25     Wind  16.6
## 332     5  26     Wind  14.9
## 333     5  27     Wind   8.0
```

```
## 334     5  28     Wind  12.0
## 335     5  29     Wind  14.9
## 336     5  30     Wind   5.7
## 337     5  31     Wind   7.4
## 338     6   1     Wind   8.6
## 339     6   2     Wind   9.7
## 340     6   3     Wind  16.1
## 341     6   4     Wind   9.2
## 342     6   5     Wind   8.6
## 343     6   6     Wind  14.3
## 344     6   7     Wind   9.7
## 345     6   8     Wind   6.9
## 346     6   9     Wind  13.8
## 347     6  10     Wind  11.5
## 348     6  11     Wind  10.9
## 349     6  12     Wind   9.2
## 350     6  13     Wind   8.0
## 351     6  14     Wind  13.8
## 352     6  15     Wind  11.5
## 353     6  16     Wind  14.9
## 354     6  17     Wind  20.7
## 355     6  18     Wind   9.2
## 356     6  19     Wind  11.5
## 357     6  20     Wind  10.3
## 358     6  21     Wind   6.3
## 359     6  22     Wind   1.7
## 360     6  23     Wind   4.6
## 361     6  24     Wind   6.3
## 362     6  25     Wind   8.0
## 363     6  26     Wind   8.0
## 364     6  27     Wind  10.3
## 365     6  28     Wind  11.5
## 366     6  29     Wind  14.9
## 367     6  30     Wind   8.0
## 368     7   1     Wind   4.1
## 369     7   2     Wind   9.2
## 370     7   3     Wind   9.2
## 371     7   4     Wind  10.9
## 372     7   5     Wind   4.6
## 373     7   6     Wind  10.9
## 374     7   7     Wind   5.1
## 375     7   8     Wind   6.3
## 376     7   9     Wind   5.7
## 377     7  10     Wind   7.4
## 378     7  11     Wind   8.6
## 379     7  12     Wind  14.3
## 380     7  13     Wind  14.9
## 381     7  14     Wind  14.9
## 382     7  15     Wind  14.3
## 383     7  16     Wind   6.9
## 384     7  17     Wind  10.3
## 385     7  18     Wind   6.3
## 386     7  19     Wind   5.1
## 387     7  20     Wind  11.5
```

```
## 388      7  21     Wind   6.9
## 389      7  22     Wind   9.7
## 390      7  23     Wind  11.5
## 391      7  24     Wind   8.6
## 392      7  25     Wind   8.0
## 393      7  26     Wind   8.6
## 394      7  27     Wind  12.0
## 395      7  28     Wind   7.4
## 396      7  29     Wind   7.4
## 397      7  30     Wind   7.4
## 398      7  31     Wind   9.2
## 399      8   1     Wind   6.9
## 400      8   2     Wind  13.8
## 401      8   3     Wind   7.4
## 402      8   4     Wind   6.9
## 403      8   5     Wind   7.4
## 404      8   6     Wind   4.6
## 405      8   7     Wind   4.0
## 406      8   8     Wind  10.3
## 407      8   9     Wind   8.0
## 408      8  10     Wind   8.6
## 409      8  11     Wind  11.5
## 410      8  12     Wind  11.5
## 411      8  13     Wind  11.5
## 412      8  14     Wind   9.7
## 413      8  15     Wind  11.5
## 414      8  16     Wind  10.3
## 415      8  17     Wind   6.3
## 416      8  18     Wind   7.4
## 417      8  19     Wind  10.9
## 418      8  20     Wind  10.3
## 419      8  21     Wind  15.5
## 420      8  22     Wind  14.3
## 421      8  23     Wind  12.6
## 422      8  24     Wind   9.7
## 423      8  25     Wind   3.4
## 424      8  26     Wind   8.0
## 425      8  27     Wind   5.7
## 426      8  28     Wind   9.7
## 427      8  29     Wind   2.3
## 428      8  30     Wind   6.3
## 429      8  31     Wind   6.3
## 430      9   1     Wind   6.9
## 431      9   2     Wind   5.1
## 432      9   3     Wind   2.8
## 433      9   4     Wind   4.6
## 434      9   5     Wind   7.4
## 435      9   6     Wind  15.5
## 436      9   7     Wind  10.9
## 437      9   8     Wind  10.3
## 438      9   9     Wind  10.9
## 439      9  10     Wind   9.7
## 440      9  11     Wind  14.9
## 441      9  12     Wind  15.5
```

```
## 442     9  13     Wind   6.3
## 443     9  14     Wind  10.9
## 444     9  15     Wind  11.5
## 445     9  16     Wind   6.9
## 446     9  17     Wind  13.8
## 447     9  18     Wind  10.3
## 448     9  19     Wind  10.3
## 449     9  20     Wind   8.0
## 450     9  21     Wind  12.6
## 451     9  22     Wind   9.2
## 452     9  23     Wind  10.3
## 453     9  24     Wind  10.3
## 454     9  25     Wind  16.6
## 455     9  26     Wind   6.9
## 456     9  27     Wind  13.2
## 457     9  28     Wind  14.3
## 458     9  29     Wind   8.0
## 459     9  30     Wind  11.5
## 460     5   1     Temp  67.0
## 461     5   2     Temp  72.0
## 462     5   3     Temp  74.0
## 463     5   4     Temp  62.0
## 464     5   5     Temp  56.0
## 465     5   6     Temp  66.0
## 466     5   7     Temp  65.0
## 467     5   8     Temp  59.0
## 468     5   9     Temp  61.0
## 469     5  10     Temp  69.0
## 470     5  11     Temp  74.0
## 471     5  12     Temp  69.0
## 472     5  13     Temp  66.0
## 473     5  14     Temp  68.0
## 474     5  15     Temp  58.0
## 475     5  16     Temp  64.0
## 476     5  17     Temp  66.0
## 477     5  18     Temp  57.0
## 478     5  19     Temp  68.0
## 479     5  20     Temp  62.0
## 480     5  21     Temp  59.0
## 481     5  22     Temp  73.0
## 482     5  23     Temp  61.0
## 483     5  24     Temp  61.0
## 484     5  25     Temp  57.0
## 485     5  26     Temp  58.0
## 486     5  27     Temp  57.0
## 487     5  28     Temp  67.0
## 488     5  29     Temp  81.0
## 489     5  30     Temp  79.0
## 490     5  31     Temp  76.0
## 491     6   1     Temp  78.0
## 492     6   2     Temp  74.0
## 493     6   3     Temp  67.0
## 494     6   4     Temp  84.0
## 495     6   5     Temp  85.0
```

```
## 496      6   6      Temp  79.0
## 497      6   7      Temp  82.0
## 498      6   8      Temp  87.0
## 499      6   9      Temp  90.0
## 500      6  10      Temp  87.0
## 501      6  11      Temp  93.0
## 502      6  12      Temp  92.0
## 503      6  13      Temp  82.0
## 504      6  14      Temp  80.0
## 505      6  15      Temp  79.0
## 506      6  16      Temp  77.0
## 507      6  17      Temp  72.0
## 508      6  18      Temp  65.0
## 509      6  19      Temp  73.0
## 510      6  20      Temp  76.0
## 511      6  21      Temp  77.0
## 512      6  22      Temp  76.0
## 513      6  23      Temp  76.0
## 514      6  24      Temp  76.0
## 515      6  25      Temp  75.0
## 516      6  26      Temp  78.0
## 517      6  27      Temp  73.0
## 518      6  28      Temp  80.0
## 519      6  29      Temp  77.0
## 520      6  30      Temp  83.0
## 521      7   1      Temp  84.0
## 522      7   2      Temp  85.0
## 523      7   3      Temp  81.0
## 524      7   4      Temp  84.0
## 525      7   5      Temp  83.0
## 526      7   6      Temp  83.0
## 527      7   7      Temp  88.0
## 528      7   8      Temp  92.0
## 529      7   9      Temp  92.0
## 530      7  10      Temp  89.0
## 531      7  11      Temp  82.0
## 532      7  12      Temp  73.0
## 533      7  13      Temp  81.0
## 534      7  14      Temp  91.0
## 535      7  15      Temp  80.0
## 536      7  16      Temp  81.0
## 537      7  17      Temp  82.0
## 538      7  18      Temp  84.0
## 539      7  19      Temp  87.0
## 540      7  20      Temp  85.0
## 541      7  21      Temp  74.0
## 542      7  22      Temp  81.0
## 543      7  23      Temp  82.0
## 544      7  24      Temp  86.0
## 545      7  25      Temp  85.0
## 546      7  26      Temp  82.0
## 547      7  27      Temp  86.0
## 548      7  28      Temp  88.0
## 549      7  29      Temp  86.0
```

```
## 550      7  30      Temp  83.0
## 551      7  31      Temp  81.0
## 552      8   1      Temp  81.0
## 553      8   2      Temp  81.0
## 554      8   3      Temp  82.0
## 555      8   4      Temp  86.0
## 556      8   5      Temp  85.0
## 557      8   6      Temp  87.0
## 558      8   7      Temp  89.0
## 559      8   8      Temp  90.0
## 560      8   9      Temp  90.0
## 561      8  10      Temp  92.0
## 562      8  11      Temp  86.0
## 563      8  12      Temp  86.0
## 564      8  13      Temp  82.0
## 565      8  14      Temp  80.0
## 566      8  15      Temp  79.0
## 567      8  16      Temp  77.0
## 568      8  17      Temp  79.0
## 569      8  18      Temp  76.0
## 570      8  19      Temp  78.0
## 571      8  20      Temp  78.0
## 572      8  21      Temp  77.0
## 573      8  22      Temp  72.0
## 574      8  23      Temp  75.0
## 575      8  24      Temp  79.0
## 576      8  25      Temp  81.0
## 577      8  26      Temp  86.0
## 578      8  27      Temp  88.0
## 579      8  28      Temp  97.0
## 580      8  29      Temp  94.0
## 581      8  30      Temp  96.0
## 582      8  31      Temp  94.0
## 583      9   1      Temp  91.0
## 584      9   2      Temp  92.0
## 585      9   3      Temp  93.0
## 586      9   4      Temp  93.0
## 587      9   5      Temp  87.0
## 588      9   6      Temp  84.0
## 589      9   7      Temp  80.0
## 590      9   8      Temp  78.0
## 591      9   9      Temp  75.0
## 592      9  10      Temp  73.0
## 593      9  11      Temp  81.0
## 594      9  12      Temp  76.0
## 595      9  13      Temp  77.0
## 596      9  14      Temp  71.0
## 597      9  15      Temp  71.0
## 598      9  16      Temp  78.0
## 599      9  17      Temp  67.0
## 600      9  18      Temp  76.0
## 601      9  19      Temp  68.0
## 602      9  20      Temp  82.0
## 603      9  21      Temp  64.0
```

```
## 604      9  22      Temp  71.0
## 605      9  23      Temp  81.0
## 606      9  24      Temp  69.0
## 607      9  25      Temp  63.0
## 608      9  26      Temp  70.0
## 609      9  27      Temp  77.0
## 610      9  28      Temp  75.0
## 611      9  29      Temp  76.0
## 612      9  30      Temp  68.0
```

B. Reshape the dataset back to wide format using spread().

```
airqualityData <- airqualityData %>% spread(key = variable, value = value)

airqualityData
```

```
##      Month Day Ozone Solar.R Temp Wind
## 1        5   1    41     190   67  7.4
## 2        5   2    36     118   72  8.0
## 3        5   3    12     149   74 12.6
## 4        5   4    18     313   62 11.5
## 5        5   5    NA      NA   56 14.3
## 6        5   6    28      NA   66 14.9
## 7        5   7    23     299   65  8.6
## 8        5   8    19      99   59 13.8
## 9        5   9     8      19   61 20.1
## 10       5  10    NA     194   69  8.6
## 11       5  11     7      NA   74  6.9
## 12       5  12    16     256   69  9.7
## 13       5  13    11     290   66  9.2
## 14       5  14    14     274   68 10.9
## 15       5  15    18      65   58 13.2
## 16       5  16    14     334   64 11.5
## 17       5  17    34     307   66 12.0
## 18       5  18     6      78   57 18.4
## 19       5  19    30     322   68 11.5
## 20       5  20    11      44   62  9.7
## 21       5  21     1       8   59  9.7
## 22       5  22    11     320   73 16.6
## 23       5  23     4      25   61  9.7
## 24       5  24    32      92   61 12.0
## 25       5  25    NA      66   57 16.6
## 26       5  26    NA     266   58 14.9
## 27       5  27    NA      NA   57  8.0
## 28       5  28    23      13   67 12.0
## 29       5  29    45     252   81 14.9
## 30       5  30   115     223   79  5.7
## 31       5  31    37     279   76  7.4
## 32       6   1    NA     286   78  8.6
## 33       6   2    NA     287   74  9.7
## 34       6   3    NA     242   67 16.1
## 35       6   4    NA     186   84  9.2
```

```
## 36      6  5   NA     220  85  8.6
## 37      6  6   NA     264  79 14.3
## 38      6  7   29     127  82  9.7
## 39      6  8   NA     273  87  6.9
## 40      6  9   71     291  90 13.8
## 41      6 10   39     323  87 11.5
## 42      6 11   NA     259  93 10.9
## 43      6 12   NA     250  92  9.2
## 44      6 13   23     148  82  8.0
## 45      6 14   NA     332  80 13.8
## 46      6 15   NA     322  79 11.5
## 47      6 16   21     191  77 14.9
## 48      6 17   37     284  72 20.7
## 49      6 18   20      37  65  9.2
## 50      6 19   12     120  73 11.5
## 51      6 20   13     137  76 10.3
## 52      6 21   NA     150  77  6.3
## 53      6 22   NA      59  76  1.7
## 54      6 23   NA      91  76  4.6
## 55      6 24   NA     250  76  6.3
## 56      6 25   NA     135  75  8.0
## 57      6 26   NA     127  78  8.0
## 58      6 27   NA      47  73 10.3
## 59      6 28   NA      98  80 11.5
## 60      6 29   NA      31  77 14.9
## 61      6 30   NA     138  83  8.0
## 62      7  1  135     269  84  4.1
## 63      7  2   49     248  85  9.2
## 64      7  3   32     236  81  9.2
## 65      7  4   NA     101  84 10.9
## 66      7  5   64     175  83  4.6
## 67      7  6   40     314  83 10.9
## 68      7  7   77     276  88  5.1
## 69      7  8   97     267  92  6.3
## 70      7  9   97     272  92  5.7
## 71      7 10   85     175  89  7.4
## 72      7 11   NA     139  82  8.6
## 73      7 12   10     264  73 14.3
## 74      7 13   27     175  81 14.9
## 75      7 14   NA     291  91 14.9
## 76      7 15    7      48  80 14.3
## 77      7 16   48     260  81  6.9
## 78      7 17   35     274  82 10.3
## 79      7 18   61     285  84  6.3
## 80      7 19   79     187  87  5.1
## 81      7 20   63     220  85 11.5
## 82      7 21   16       7  74  6.9
## 83      7 22   NA     258  81  9.7
## 84      7 23   NA     295  82 11.5
## 85      7 24   80     294  86  8.6
## 86      7 25  108     223  85  8.0
## 87      7 26   20      81  82  8.6
## 88      7 27   52      82  86 12.0
## 89      7 28   82     213  88  7.4
```

```
## 90       7  29    50      275   86  7.4
## 91       7  30    64      253   83  7.4
## 92       7  31    59      254   81  9.2
## 93       8   1    39       83   81  6.9
## 94       8   2     9       24   81 13.8
## 95       8   3    16       77   82  7.4
## 96       8   4    78       NA   86  6.9
## 97       8   5    35       NA   85  7.4
## 98       8   6    66       NA   87  4.6
## 99       8   7   122      255   89  4.0
## 100      8   8    89      229   90 10.3
## 101      8   9   110      207   90  8.0
## 102      8  10    NA      222   92  8.6
## 103      8  11    NA      137   86 11.5
## 104      8  12    44      192   86 11.5
## 105      8  13    28      273   82 11.5
## 106      8  14    65      157   80  9.7
## 107      8  15    NA       64   79 11.5
## 108      8  16    22       71   77 10.3
## 109      8  17    59       51   79  6.3
## 110      8  18    23      115   76  7.4
## 111      8  19    31      244   78 10.9
## 112      8  20    44      190   78 10.3
## 113      8  21    21      259   77 15.5
## 114      8  22     9       36   72 14.3
## 115      8  23    NA      255   75 12.6
## 116      8  24    45      212   79  9.7
## 117      8  25   168      238   81  3.4
## 118      8  26    73      215   86  8.0
## 119      8  27    NA      153   88  5.7
## 120      8  28    76      203   97  9.7
## 121      8  29   118      225   94  2.3
## 122      8  30    84      237   96  6.3
## 123      8  31    85      188   94  6.3
## 124      9   1    96      167   91  6.9
## 125      9   2    78      197   92  5.1
## 126      9   3    73      183   93  2.8
## 127      9   4    91      189   93  4.6
## 128      9   5    47       95   87  7.4
## 129      9   6    32       92   84 15.5
## 130      9   7    20      252   80 10.9
## 131      9   8    23      220   78 10.3
## 132      9   9    21      230   75 10.9
## 133      9  10    24      259   73  9.7
## 134      9  11    44      236   81 14.9
## 135      9  12    21      259   76 15.5
## 136      9  13    28      238   77  6.3
## 137      9  14     9       24   71 10.9
## 138      9  15    13      112   71 11.5
## 139      9  16    46      237   78  6.9
## 140      9  17    18      224   67 13.8
## 141      9  18    13       27   76 10.3
## 142      9  19    24      238   68 10.3
## 143      9  20    16      201   82  8.0
```

```
## 144      9  21    13      238   64 12.6
## 145      9  22    23       14   71  9.2
## 146      9  23    36      139   81 10.3
## 147      9  24     7       49   69 10.3
## 148      9  25    14       20   63 16.6
## 149      9  26    30      193   70  6.9
## 150      9  27    NA      145   77 13.2
## 151      9  28    14      191   75 14.3
## 152      9  29    18      131   76  8.0
## 153      9  30    20      223   68 11.5
```

C. Use separate() to split the Month column into Month and Day columns (if it were combined), and then recombine them using unite().

```r
# since its not combine the following code is commented out
# airqualityData <- airqualityData %>% separate(Date, c("Month", "Day"), sep="-")

airqualityData <- airqualityData %>% unite("Date", Month, Day, sep = "-")

airqualityData
```

```
##      Date Ozone Solar.R Temp Wind
## 1     5-1    41     190   67  7.4
## 2     5-2    36     118   72  8.0
## 3     5-3    12     149   74 12.6
## 4     5-4    18     313   62 11.5
## 5     5-5    NA      NA   56 14.3
## 6     5-6    28      NA   66 14.9
## 7     5-7    23     299   65  8.6
## 8     5-8    19      99   59 13.8
## 9     5-9     8      19   61 20.1
## 10   5-10    NA     194   69  8.6
## 11   5-11     7      NA   74  6.9
## 12   5-12    16     256   69  9.7
## 13   5-13    11     290   66  9.2
## 14   5-14    14     274   68 10.9
## 15   5-15    18      65   58 13.2
## 16   5-16    14     334   64 11.5
## 17   5-17    34     307   66 12.0
## 18   5-18     6      78   57 18.4
## 19   5-19    30     322   68 11.5
## 20   5-20    11      44   62  9.7
## 21   5-21     1       8   59  9.7
## 22   5-22    11     320   73 16.6
## 23   5-23     4      25   61  9.7
## 24   5-24    32      92   61 12.0
## 25   5-25    NA      66   57 16.6
## 26   5-26    NA     266   58 14.9
## 27   5-27    NA      NA   57  8.0
## 28   5-28    23      13   67 12.0
## 29   5-29    45     252   81 14.9
## 30   5-30   115     223   79  5.7
```

```
## 31  5-31    37      279   76  7.4
## 32   6-1    NA      286   78  8.6
## 33   6-2    NA      287   74  9.7
## 34   6-3    NA      242   67 16.1
## 35   6-4    NA      186   84  9.2
## 36   6-5    NA      220   85  8.6
## 37   6-6    NA      264   79 14.3
## 38   6-7    29      127   82  9.7
## 39   6-8    NA      273   87  6.9
## 40   6-9    71      291   90 13.8
## 41  6-10    39      323   87 11.5
## 42  6-11    NA      259   93 10.9
## 43  6-12    NA      250   92  9.2
## 44  6-13    23      148   82  8.0
## 45  6-14    NA      332   80 13.8
## 46  6-15    NA      322   79 11.5
## 47  6-16    21      191   77 14.9
## 48  6-17    37      284   72 20.7
## 49  6-18    20       37   65  9.2
## 50  6-19    12      120   73 11.5
## 51  6-20    13      137   76 10.3
## 52  6-21    NA      150   77  6.3
## 53  6-22    NA       59   76  1.7
## 54  6-23    NA       91   76  4.6
## 55  6-24    NA      250   76  6.3
## 56  6-25    NA      135   75  8.0
## 57  6-26    NA      127   78  8.0
## 58  6-27    NA       47   73 10.3
## 59  6-28    NA       98   80 11.5
## 60  6-29    NA       31   77 14.9
## 61  6-30    NA      138   83  8.0
## 62   7-1   135      269   84  4.1
## 63   7-2    49      248   85  9.2
## 64   7-3    32      236   81  9.2
## 65   7-4    NA      101   84 10.9
## 66   7-5    64      175   83  4.6
## 67   7-6    40      314   83 10.9
## 68   7-7    77      276   88  5.1
## 69   7-8    97      267   92  6.3
## 70   7-9    97      272   92  5.7
## 71  7-10    85      175   89  7.4
## 72  7-11    NA      139   82  8.6
## 73  7-12    10      264   73 14.3
## 74  7-13    27      175   81 14.9
## 75  7-14    NA      291   91 14.9
## 76  7-15     7       48   80 14.3
## 77  7-16    48      260   81  6.9
## 78  7-17    35      274   82 10.3
## 79  7-18    61      285   84  6.3
## 80  7-19    79      187   87  5.1
## 81  7-20    63      220   85 11.5
## 82  7-21    16        7   74  6.9
## 83  7-22    NA      258   81  9.7
## 84  7-23    NA      295   82 11.5
```

```
## 85   7-24    80      294   86  8.6
## 86   7-25   108      223   85  8.0
## 87   7-26    20       81   82  8.6
## 88   7-27    52       82   86 12.0
## 89   7-28    82      213   88  7.4
## 90   7-29    50      275   86  7.4
## 91   7-30    64      253   83  7.4
## 92   7-31    59      254   81  9.2
## 93    8-1    39       83   81  6.9
## 94    8-2     9       24   81 13.8
## 95    8-3    16       77   82  7.4
## 96    8-4    78       NA   86  6.9
## 97    8-5    35       NA   85  7.4
## 98    8-6    66       NA   87  4.6
## 99    8-7   122      255   89  4.0
## 100   8-8    89      229   90 10.3
## 101   8-9   110      207   90  8.0
## 102 8-10    NA      222   92  8.6
## 103 8-11    NA      137   86 11.5
## 104 8-12    44      192   86 11.5
## 105 8-13    28      273   82 11.5
## 106 8-14    65      157   80  9.7
## 107 8-15    NA       64   79 11.5
## 108 8-16    22       71   77 10.3
## 109 8-17    59       51   79  6.3
## 110 8-18    23      115   76  7.4
## 111 8-19    31      244   78 10.9
## 112 8-20    44      190   78 10.3
## 113 8-21    21      259   77 15.5
## 114 8-22     9       36   72 14.3
## 115 8-23    NA      255   75 12.6
## 116 8-24    45      212   79  9.7
## 117 8-25   168      238   81  3.4
## 118 8-26    73      215   86  8.0
## 119 8-27    NA      153   88  5.7
## 120 8-28    76      203   97  9.7
## 121 8-29   118      225   94  2.3
## 122 8-30    84      237   96  6.3
## 123 8-31    85      188   94  6.3
## 124  9-1    96      167   91  6.9
## 125  9-2    78      197   92  5.1
## 126  9-3    73      183   93  2.8
## 127  9-4    91      189   93  4.6
## 128  9-5    47       95   87  7.4
## 129  9-6    32       92   84 15.5
## 130  9-7    20      252   80 10.9
## 131  9-8    23      220   78 10.3
## 132  9-9    21      230   75 10.9
## 133 9-10    24      259   73  9.7
## 134 9-11    44      236   81 14.9
## 135 9-12    21      259   76 15.5
## 136 9-13    28      238   77  6.3
## 137 9-14     9       24   71 10.9
## 138 9-15    13      112   71 11.5
```

```
## 139 9-16    46      237   78  6.9
## 140 9-17    18      224   67 13.8
## 141 9-18    13       27   76 10.3
## 142 9-19    24      238   68 10.3
## 143 9-20    16      201   82  8.0
## 144 9-21    13      238   64 12.6
## 145 9-22    23       14   71  9.2
## 146 9-23    36      139   81 10.3
## 147 9-24     7       49   69 10.3
## 148 9-25    14       20   63 16.6
## 149 9-26    30      193   70  6.9
## 150 9-27    NA      145   77 13.2
## 151 9-28    14      191   75 14.3
## 152 9-29    18      131   76  8.0
## 153 9-30    20      223   68 11.5
```

D. Create a summary table showing the average values for each variable by month.

```r
airqualityData <- airqualityData %>% separate(Date, c("Month", "Day"), sep =
                                               "-")

aqdSummary <- airqualityData %>%
  group_by(Month) %>%
  summarise(
    meanOzone = mean(Ozone , na.rm = TRUE),
    meanSolar.R = mean(Solar.R , na.rm = TRUE),
    meanTemp = mean(Temp , na.rm = TRUE),
    meanWind = mean(Wind , na.rm = TRUE),
  )

aqdSummary
```

```
## # A tibble: 5 x 5
##   Month meanOzone meanSolar.R meanTemp meanWind
##   <chr>     <dbl>       <dbl>    <dbl>    <dbl>
## 1 5          23.6        181.     65.5    11.6
## 2 6          29.4        190.     79.1    10.3
## 3 7          59.1        216.     83.9     8.94
## 4 8          60.0        172.     84.0     8.79
## 5 9          31.4        167.     76.9    10.2
```

---

4. Introduction to Probability

A. Simulate rolling a fair six-sided die 1000 times. Calculate the empirical probability of each outcome.

```
# TODO: Finish this question
```

B. Simulate drawing a card from a standard deck of 52 cards 1000 times. Calculate the empirical probability of drawing an Ace.

```
# TODO: add information about assignment and libraries used
```

C. Use the binomial distribution to calculate the probability of getting exactly 5 heads in 10 flips of a fair coin. Repeat for getting 5 or more heads.

```
# TODO: add information about assignment and libraries used
```

D. Generate a plot showing the probability mass function (PMF) of a binomial distribution with parameters n = 10 and p = 0.5.

```
# TODO: add information about assignment and libraries used
```

---

5. Advanced Data Manipulation and Visualization

A. Load the iris dataset and create a summary table showing the mean, median, and standard deviation of each

numerical variable grouped by Species.

```
# TODO: Finish this question
```

B. Create a pairwise scatter plot matrix using the pairs() function for the iris dataset colored by Species.

```
# TODO: add information about assignment and libraries used
```

C. Use ggplot2 to create a violin plot for Petal.Length grouped by Species.

```
# TODO: add information about assignment and libraries used
```

D. Create a heatmap of the correlation matrix for the numerical variables in the iris dataset.

```r
# TODO: add information about assignment and libraries used
```

E. Write a short analysis (5-7 sentences) interpreting the results from the summary table, scatter plot matrix, violin plot, and heatmap.

```r
# TODO: add information about assignment and libraries used
```

---

6. Data Reshaping and Aggregation

A. Load the gapminder dataset from the gapminder package. Reshape the dataset to long format, focusing on the variables year and gdpPercap.

```r
# TODO: Finish this question
```

B. Aggregate the data to calculate the average gdpPercap by continent and year.

```r
# TODO: add information about assignment and libraries used
```

C. Create a line plot of the average gdpPercap over time for each continent.

```r
# TODO: add information about assignment and libraries used
```

D. Create a faceted plot showing gdpPercap distributions by continent for the most recent year in the dataset.

```r
# TODO: add information about assignment and libraries used
```

E. Write a detailed report (6-8 sentences) analyzing the trends and patterns observed in the plots.

```r
# TODO: add information about assignment and libraries used
```

---

7. Probability

A local fraternity is conducting a raffle where 50 tickets are to be sold, one per customer. There are three prizes to be awarded. If the four organizers of the raffle each buy one ticket, what is the probability that the four organizers win

A. all of the prizes?

```
# TODO: Finish this question
```

B. exactly two of the prizes?

```
# TODO: add information about assignment and libraries used
```

C. exactly one of the prizes?

```
# TODO: add information about assignment and libraries used
```

D. none of the prizes?

```
# TODO: add information about assignment and libraries used
```