CIND 123 - Data Analytics: Basic Methods

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Assignment 1 (10%)

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Instructions

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. Review this website for more details on using R Markdown http://rmarkdown.rstudio.com.

Use RStudio for this assignment. Complete the assignment by inserting your `R` code wherever you see the string "#INSERT YOUR ANSWER HERE".

When you click the **Knit** button, a document (PDF, Word, or HTML format) will be generated that includes both the assignment content as well as the output of any embedded R code chunks.

NOTE: YOU SHOULD NEVER HAVE `install.packages` IN YOUR CODE; OTHERWISE, THE `Knit` OPTION WILL GIVE AN ERROR. COMMENT OUT ALL PACKAGE INSTALLATIONS.

Submit **both** the `rmd` and generated `output` files. Failing to submit both files will be subject to mark deduction. PDF or HTML is preferred.

Sample Question and Solution

Use `seq()` to create the vector $(3, 5 \ldots, 29)$.

```
seq(3, 30, 2)
```

```
##  [1]  3  5  7  9 11 13 15 17 19 21 23 25 27 29
```

```
seq(3, 29, 2)
```

```
##  [1]  3  5  7  9 11 13 15 17 19 21 23 25 27 29
```

Question 1 (32 points)

Q1a (8 points)

Create and print a vector `x` with all integers from 4 to 115 and a vector `y` containing multiples of 4 in the same range. Hint: use `seq()`function. Calculate the difference in lengths of the vectors `x` and `y`. Hint: use length()

```
x <- 4:115
x
```

```
##   [1]   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21
##  [19]  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39
##  [37]  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57
##  [55]  58  59  60  61  62  63  64  65  66  67  68  69  70  71  72  73  74  75
##  [73]  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90  91  92  93
##  [91]  94  95  96  97  98  99 100 101 102 103 104 105 106 107 108 109 110 111
## [109] 112 113 114 115
```

```
y <- seq(from = 4, to = 115, by = 4)
y
```

```
##  [1]   4   8  12  16  20  24  28  32  36  40  44  48  52  56  60  64  68  72  76
## [20]  80  84  88  92  96 100 104 108 112
```

```
#Difference in length
length(x)-length(y)
```

```
## [1] 84
```

Q1b (8 points)

Create a new vector, `y_square`, with the square of elements at indices 1, 3, 7, 12, 17, 20, 22, and 24 from the variable `y`. Hint: Use indexing rather than a `for` loop. Calculate the mean and median of the FIRST five values from `y_square`.

```
y_square <- y[c(1, 3, 7, 12, 17, 20, 22, 24)]**2
y_square
```

```
## [1]   16  144  784 2304 4624 6400 7744 9216
```

```
mean(y_square[1:5])
```

```
## [1] 1574.4
```

```
median(y_square[1:5])
```

```
## [1] 784
```

Q1c (8 points)

For a given factor variable of `factorVar <- factor(c(1, 6, 5.4, 3.2))`, would it be correct to use the following commands to convert factor to number?

`as.numeric(factorVar)`

If not, explain your answer and provide the correct one.

```
# When assigning a numeric vector into a factor variable, the factor will first recognize the different
factorVar <- factor(c(1, 6, 5.4, 3.2))
factorVar
```

```
## [1] 1   6   5.4 3.2
## Levels: 1 3.2 5.4 6
```

```
#The factor internally assigns an integer number starting from 1 to each corresponding category in the

#Because these values are now internally assigned a number corresponding to their level, the as.numeric

numericVar <- as.numeric(factorVar)
numericVar
```

```
## [1] 1 4 3 2
```

```
class(numericVar)
```

```
## [1] "numeric"
```

```
#To display the factor variable as numeric variables, we would need to first convert the factor to a ch

numericVar2 <- as.numeric(as.character(factorVar))
numericVar2
```

```
## [1] 1.0 6.0 5.4 3.2
```

```
class(numericVar2)
```

```
## [1] "numeric"
```

Q1d (8 points)

A comma-separated values file `dataset.csv` consists of missing values represented by Not A Number (`null`) and question mark (`?`). How can you read this type of files in R? NOTE: Please make sure you have saved the `dataset.csv` file at your current working directory.

```
#I would set the header to false because the first row of the dataset has no header, and if "null" and

dataset <- read.csv("dataset.csv", sep = ",", header = FALSE, stringsAsFactor = FALSE, na.strings= c("nu

dataset
```

```
##      V1  V2  V3  V4  V5  V6  V7  V8  V9 V10
## 1     1   2   3   4   5   6   7   8   9  10
## 2    11  12  13  14  15  16  17  18  19  20
## 3    21  22  23  24  25  26  27  28  29  30
## 4    31  32  33  34  35  36  37  38  39  40
## 5    41  42  43  44  45  NA  47  48  49  50
## 6    51  52  53  NA  55  56  57  NA  59  60
## 7    61  62  63  64  65  66  67  68  69  70
## 8    71  72  NA  74  75  76  77  78  79  80
## 9    81  82  83  84  85  86  87  88  89  NA
## 10   91  92  93  94  95  96  97  98  99 100
## 11   NA 102 103 104 105 106 107 108 109 110
## 12  111 112 113 114 115 116 117 118 119 120
## 13  121 122 123 124 125 126 127 128 129 130
## 14  131 132 133 134 135 136 137 138 139  NA
## 15  141 142 143 144 145 146 147 148 149 150
## 16  151 152 153 154 155 156 157 158 159 160
## 17  161 162 163 164  NA 166 167 168 169 170
```

Question 2 (32 points)

Q2a (8 points)

Compute:

$$\sum_{n=5}^{20} \frac{(-1)^n}{(n!)^2}$$

Hint: Use `factorial(n)` to compute $n!$.

```r
sum_function <- function(n){
            return(sum((-1)**n / factorial(n)**2))
            }
sum_function(5:20)
```

```
## [1] -6.755419e-05
```

Q2b (8 points)

Compute:

$$\prod_{n=1}^{5} \left(4n + \frac{1}{2^n}\right)$$

NOTE: The symbol Π represents multiplication.

```r
prod_function <- function(n) {
           return(prod(4*n + (1/(2**n))))
            }
prod_function(1:5)
```

```
## [1] 144833.6
```

Q2c (8 points)

Describe what the following R command does: `c(0:5)[NA]`

```
c(0:5)[NA]
```

```
## [1] NA NA NA NA NA NA
```

```
#This command is asking R to conduct indexing on a vector made of a sequence of numbers between 0 to 5
```

Q2d (8 points)

Describe the purpose of `is.vector()`, `is.character()`, `is.numeric()`, and `is.na()` functions? Please use `x <- c("a", "b", NA, 2)` to explain your description.

```
x <- c("a", "b", NA, 2)

#The is.vector() function evaluates the object to let us know whether it is a vector and will returns a
is.vector(x)
```

```
## [1] TRUE
```

```
#The is.character function evaluates whether an object contains the character data type as either True
is.character(x)
```

```
## [1] TRUE
```

```
#The is.numeric function returns the logical value of True when the object in question contains values
is.numeric(x)
```

```
## [1] FALSE
```

```
x
```

```
## [1] "a" "b" NA  "2"
```

```
class(x)
```

```
## [1] "character"
```

```
#The is.na() function returns True or False based on the respective position of present or missing valu
is.na(x)
```

```
## [1] FALSE FALSE  TRUE FALSE
```

Question 3 (36 points)

The airquality dataset contains daily air quality measurements in New York from May to September 1973. The variables include Ozone level, Solar radiation, wind speed, temperature in Fahrenheit, month, and day. Please see the detailed description using help("airquality").

Install the airquality data set on your computer using the command install.packages("datasets"). Then load the datasets package into your session.

```
library(datasets)
```

Q3a (4 points)

Display the first 10 rows of the airquality data set.

```
data("airquality")
head(airquality, 10)
```

```
##    Ozone Solar.R Wind Temp Month Day
## 1     41     190  7.4   67     5   1
## 2     36     118  8.0   72     5   2
## 3     12     149 12.6   74     5   3
## 4     18     313 11.5   62     5   4
## 5     NA      NA 14.3   56     5   5
## 6     28      NA 14.9   66     5   6
## 7     23     299  8.6   65     5   7
## 8     19      99 13.8   59     5   8
## 9      8      19 20.1   61     5   9
## 10    NA     194  8.6   69     5  10
```

Q3b (8 points)

Compute the average of the first four variables (Ozone, Solar.R, Wind and Temp) for the fifth month using the sapply() function. Hint: You might need to consider removing the NA values; otherwise, the average will not be computed.

```
airquality
```

```
##     Ozone Solar.R Wind Temp Month Day
## 1      41     190  7.4   67     5   1
## 2      36     118  8.0   72     5   2
## 3      12     149 12.6   74     5   3
## 4      18     313 11.5   62     5   4
## 5      NA      NA 14.3   56     5   5
## 6      28      NA 14.9   66     5   6
## 7      23     299  8.6   65     5   7
## 8      19      99 13.8   59     5   8
## 9       8      19 20.1   61     5   9
## 10     NA     194  8.6   69     5  10
## 11      7      NA  6.9   74     5  11
## 12     16     256  9.7   69     5  12
## 13     11     290  9.2   66     5  13
## 14     14     274 10.9   68     5  14
## 15     18      65 13.2   58     5  15
## 16     14     334 11.5   64     5  16
## 17     34     307 12.0   66     5  17
## 18      6      78 18.4   57     5  18
## 19     30     322 11.5   68     5  19
## 20     11      44  9.7   62     5  20
## 21      1       8  9.7   59     5  21
## 22     11     320 16.6   73     5  22
## 23      4      25  9.7   61     5  23
## 24     32      92 12.0   61     5  24
## 25     NA      66 16.6   57     5  25
## 26     NA     266 14.9   58     5  26
## 27     NA      NA  8.0   57     5  27
## 28     23      13 12.0   67     5  28
## 29     45     252 14.9   81     5  29
## 30    115     223  5.7   79     5  30
## 31     37     279  7.4   76     5  31
## 32     NA     286  8.6   78     6   1
## 33     NA     287  9.7   74     6   2
## 34     NA     242 16.1   67     6   3
## 35     NA     186  9.2   84     6   4
## 36     NA     220  8.6   85     6   5
## 37     NA     264 14.3   79     6   6
## 38     29     127  9.7   82     6   7
## 39     NA     273  6.9   87     6   8
## 40     71     291 13.8   90     6   9
## 41     39     323 11.5   87     6  10
## 42     NA     259 10.9   93     6  11
## 43     NA     250  9.2   92     6  12
## 44     23     148  8.0   82     6  13
## 45     NA     332 13.8   80     6  14
## 46     NA     322 11.5   79     6  15
## 47     21     191 14.9   77     6  16
## 48     37     284 20.7   72     6  17
## 49     20      37  9.2   65     6  18
## 50     12     120 11.5   73     6  19
## 51     13     137 10.3   76     6  20
## 52     NA     150  6.3   77     6  21
## 53     NA      59  1.7   76     6  22
## 54     NA      91  4.6   76     6  23
## 55     NA     250  6.3   76     6  24
## 56     NA     135  8.0   75     6  25
## 57     NA     127  8.0   78     6  26
## 58     NA      47 10.3   73     6  27
## 59     NA      98 11.5   80     6  28
## 60     NA      31 14.9   77     6  29
## 61     NA     138  8.0   83     6  30
## 62    135     269  4.1   84     7   1
## 63     49     248  9.2   85     7   2
## 64     32     236  9.2   81     7   3
## 65     NA     101 10.9   84     7   4
## 66     64     175  4.6   83     7   5
## 67     40     314 10.9   83     7   6
## 68     77     276  5.1   88     7   7
## 69     97     267  6.3   92     7   8
## 70     97     272  5.7   92     7   9
## 71     85     175  7.4   89     7  10
## 72     NA     139  8.6   82     7  11
## 73     10     264 14.3   73     7  12
## 74     27     175 14.9   81     7  13
## 75     NA     291 14.9   91     7  14
## 76      7      48 14.3   80     7  15
## 77     48     260  6.9   81     7  16
## 78     35     274 10.3   82     7  17
## 79     61     285  6.3   84     7  18
## 80     79     187  5.1   87     7  19
## 81     63     220 11.5   85     7  20
## 82     16       7  6.9   74     7  21
## 83     NA     258  9.7   81     7  22
## 84     NA     295 11.5   82     7  23
## 85     80     294  8.6   86     7  24
## 86    108     223  8.0   85     7  25
## 87     20      81  8.6   82     7  26
## 88     52      82 12.0   86     7  27
## 89     82     213  7.4   88     7  28
## 90     50     275  7.4   86     7  29
## 91     64     253  7.4   83     7  30
## 92     59     254  9.2   81     7  31
## 93     39      83  6.9   81     8   1
## 94      9      24 13.8   81     8   2
## 95     16      77  7.4   82     8   3
## 96     78      NA  6.9   86     8   4
## 97     35      NA  7.4   85     8   5
## 98     66      NA  4.6   87     8   6
## 99    122     255  4.0   89     8   7
## 100    89     229 10.3   90     8   8
## 101   110     207  8.0   90     8   9
## 102    NA     222  8.6   92     8  10
## 103    NA     137 11.5   86     8  11
## 104    44     192 11.5   86     8  12
## 105    28     273 11.5   82     8  13
## 106    65     157  9.7   80     8  14
## 107    NA      64 11.5   79     8  15
## 108    22      71 10.3   77     8  16
## 109    59      51  6.3   79     8  17
## 110    23     115  7.4   76     8  18
## 111    31     244 10.9   78     8  19
## 112    44     190 10.3   78     8  20
## 113    21     259 15.5   77     8  21
## 114     9      36 14.3   72     8  22
## 115    NA     255 12.6   75     8  23
## 116    45     212  9.7   79     8  24
## 117   168     238  3.4   81     8  25
## 118    73     215  8.0   86     8  26
## 119    NA     153  5.7   88     8  27
## 120    76     203  9.7   97     8  28
## 121   118     225  2.3   94     8  29
## 122    84     237  6.3   96     8  30
## 123    85     188  6.3   94     8  31
## 124    96     167  6.9   91     9   1
## 125    78     197  5.1   92     9   2
## 126    73     183  2.8   93     9   3
## 127    91     189  4.6   93     9   4
## 128    47      95  7.4   87     9   5
## 129    32      92 15.5   84     9   6
## 130    20     252 10.9   80     9   7
## 131    23     220 10.3   78     9   8
## 132    21     230 10.9   75     9   9
## 133    24     259  9.7   73     9  10
## 134    44     236 14.9   81     9  11
## 135    21     259 15.5   76     9  12
## 136    28     238  6.3   77     9  13
## 137     9      24 10.9   71     9  14
## 138    13     112 11.5   71     9  15
## 139    46     237  6.9   78     9  16
## 140    18     224 13.8   67     9  17
## 141    13      27 10.3   76     9  18
## 142    24     238 10.3   68     9  19
## 143    16     201  8.0   82     9  20
## 144    13     238 12.6   64     9  21
## 145    23      14  9.2   71     9  22
## 146    36     139 10.3   81     9  23
## 147     7      49 10.3   69     9  24
## 148    14      20 16.6   63     9  25
## 149    30     193  6.9   70     9  26
## 150    NA     145 13.2   77     9  27
## 151    14     191 14.3   75     9  28
## 152    18     131  8.0   76     9  29
## 153    20     223 11.5   68     9  30
```

```
airquality_m5<-subset((airquality), Month==5)
airquality_m5
```

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

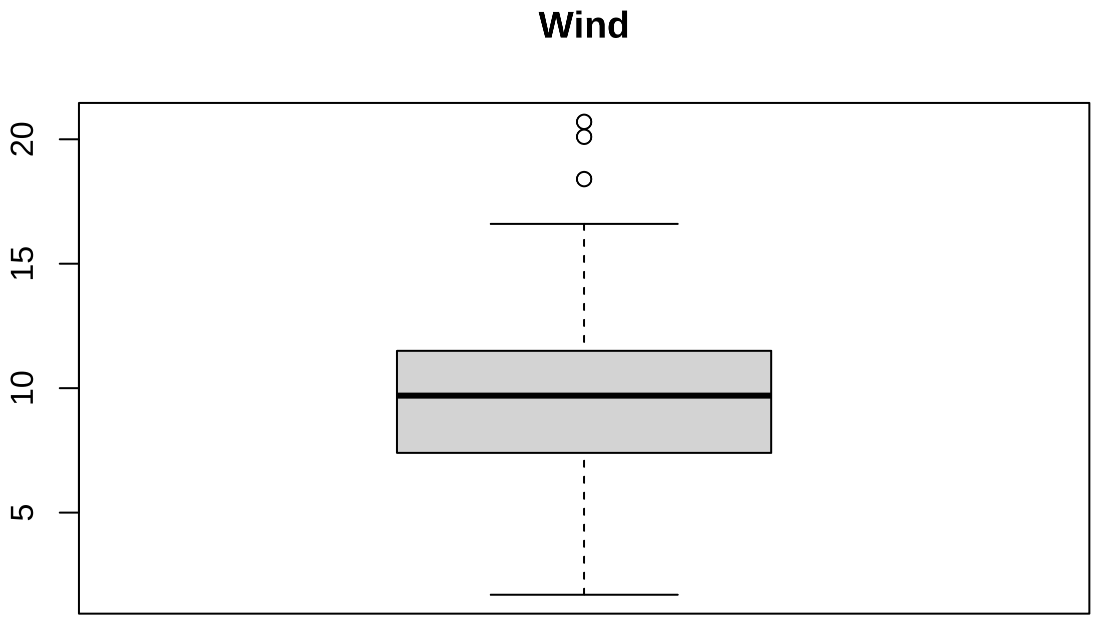
```r
sapply(airquality_m5[,-5:-6], mean, na.rm = TRUE)
```

```
##     Ozone   Solar.R      Wind      Temp 
##  23.61538 181.29630  11.62258  65.54839
```

Q3c (8 points)

Construct a boxplot for the all `Wind` and `Temp` variables, then display the values of all the outliers which lie beyond the whiskers.

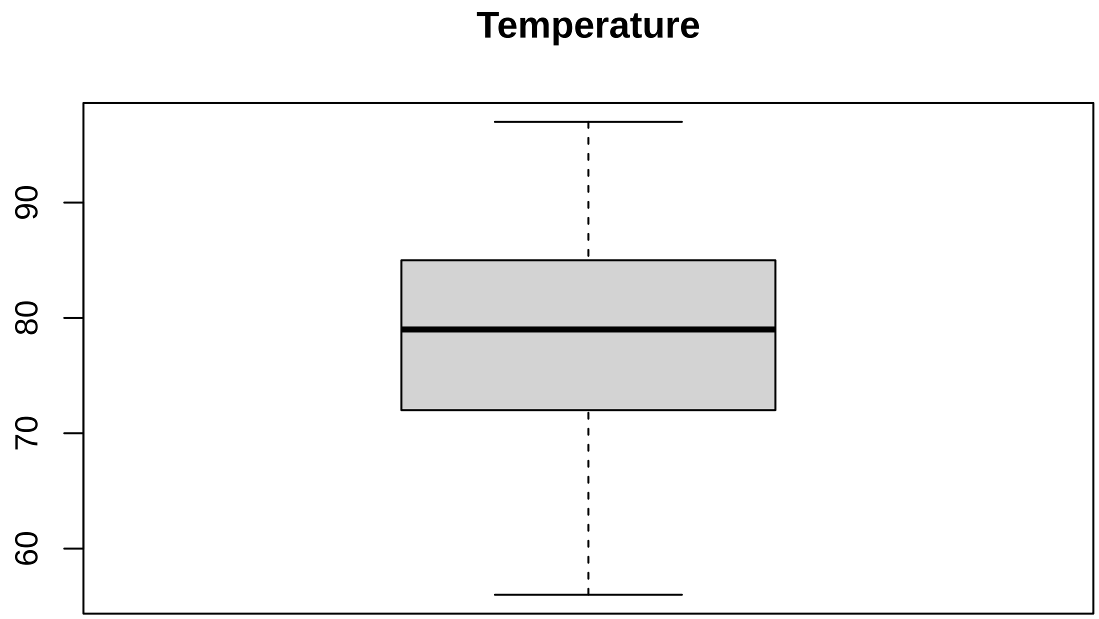
```r
#Wind boxplot followed by outliers

wind_plot<-boxplot(airquality$Wind, main = "Wind")
```



```
wind_plot$out
```

```
## [1] 20.1 18.4 20.7
```

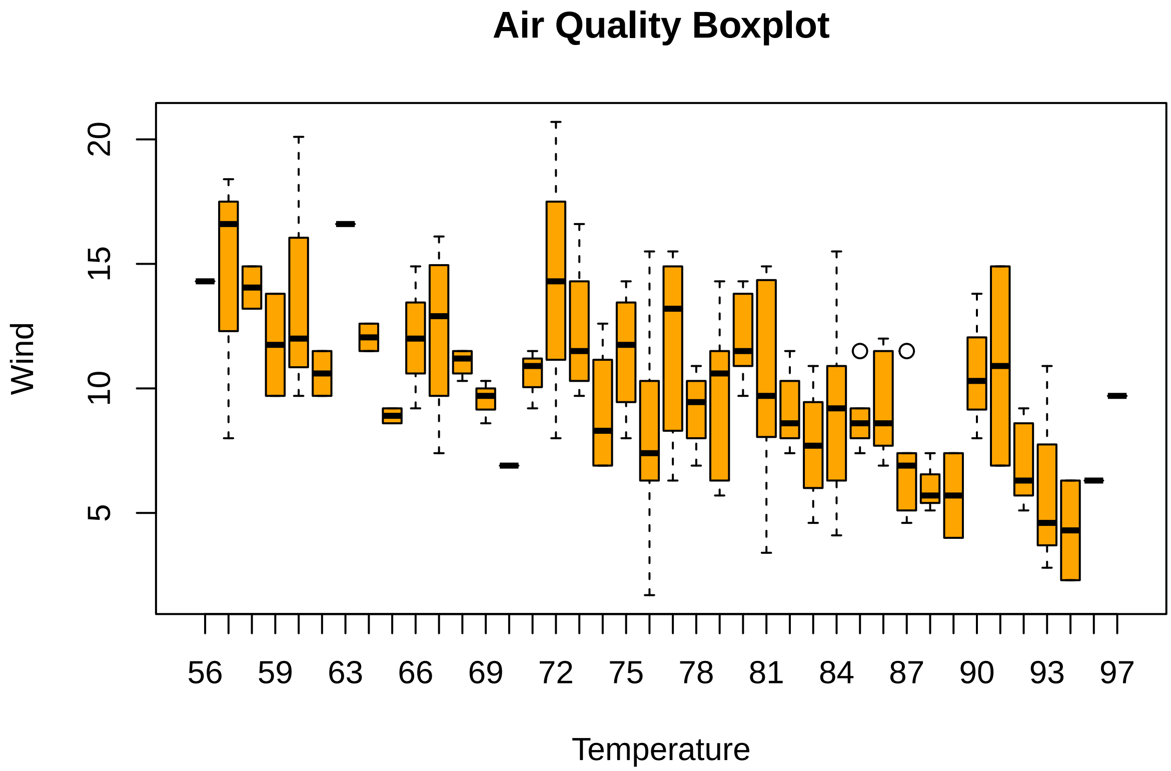
```
#Temp boxplot followed by outliers
temp_plot<-boxplot(airquality$Temp, main = "Temperature")
```



```
temp_plot$out
```

```
## numeric(0)
```

```
#Wind / Temp boxplot followed by outliers
wind_temp_plot<-boxplot(formula = Wind ~ Temp, data = airquality, main = "Air Quality Boxplot", xlab= "
```



```
wind_temp_plot$out
```

```
## [1] 11.5 11.5
```

Q3d (8 points)

Compute the upper quartile of the `Wind` variable with two different methods. HINT: Only show the upper quartile using indexing. For the type of quartile, please see https://www.rdocumentation.org/packages/stats/versions/3.6.2/topics/quantile.

```
#Method 1
quantile(airquality$Wind, probs = c(0.75))
```

```
##  75%
## 11.5
```

```
#Method 2
wind_2<-cbind(summary(airquality$Wind))
wind_2[5,]
```

```
## 3rd Qu.
##    11.5
```

```
#Method 3
wind_1<-data.frame(quantile(airquality$Wind))
wind_1[4,]
```

```
## [1] 11.5
```

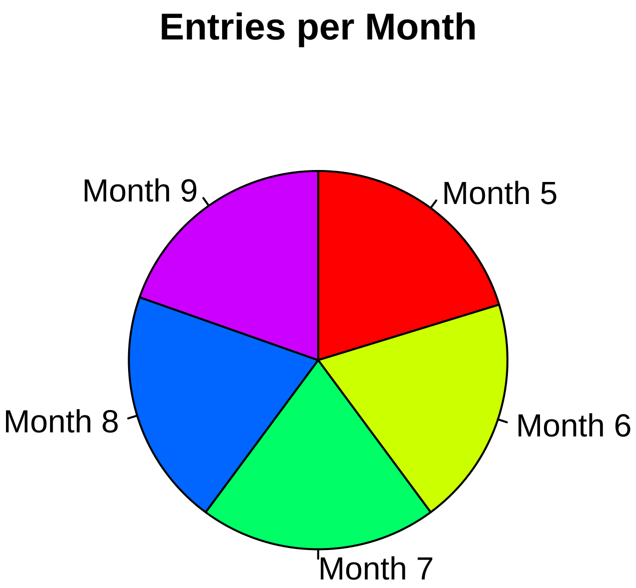
Q3e (8 points)

Construct a pie chart to describe the number of entries by `Month`. HINT: use the `table()` function to count and tabulate the number of entries within a `Month`.

```
#Tabulating number of entries in a month
month_entries<-table(airquality$Month, useNA="no")
month_entries
```

```
##
##  5  6  7  8  9
## 31 30 31 31 30
```

```
#Create labels for pie chart
lbls <- c("Month 5", "Month 6", "Month 7", "Month 8", "Month 9")

#Create pie chart
pie(month_entries, labels = lbls, edges = 200, radius = 0.8, clockwise = TRUE, col=rainbow(length(month_
```



END of Assignment #1.