Introduction to R

Blake Pappas

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Basic

What is in the Workspace?

```
ls()
```

```
## character(0)
```

Where is My `R` Working Directory?

```
getwd()
```

```
## [1] "C:/Users/Blake/Desktop/ABC Analytics/Portfolio/Git/Repositories/R/Statistical Methods II/Introdu
```

What is in My Working Directory?

```
dir()
```

```
## [1] "A-Quick-Introduction-to-R.Rmd" "A Quick Introduction to R.pdf"
## [3] "A Quick Introduction to R.Rmd" "BoulderTemperature.RData"
## [5] "BT.RData"
```

"*c*" Combines Sets of Numbers (or Datasets)

```
x <- c(2, 3, 20)
```

Note: `R` is case sensitive. Type "X" in `R` console and then click "Enter" to see what happens.

Now Re-Check Workspace

```r
ls()
```

```
## [1] "x"
```

```r
# Print Out x
x
```

```
## [1]  2  3 20
```

Reassign "x" to Another Name

```r
x2 <- x
ls()
```

```
## [1] "x"  "x2"
```

Remove "x" and Create Another Object "x3"

```r
rm(x)
x3 <- c(3, 4, 5)
```

Question: How Would You Combine "x2" and "x3" to Make a New Data Set ?

```r
x4 <- x2 + x3
x4
```

```
## [1]  5  7 25
```

Arithemtic

Add Numbers in R

```r
A <- 2
B <- 10
Y <- A + B

A <- c(2, 3, 4)
B <- c(10, 100, 1000)
Y <- A + B
Y # Note that the numbers have been added row by row like a spreadsheet
```

```
## [1]   12  103 1004
```

Some Other Operations

```r
2^4
```

```
## [1] 16
```

```r
2 * (1 + 4)
```

```
## [1] 10
```

```r
sqrt(81)
```

```
## [1] 9
```

```r
exp(2)
```

```
## [1] 7.389056
```

Generating a Sequence

```r
1:10
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10
```

```r
-5:5
```

```
##  [1] -5 -4 -3 -2 -1  0  1  2  3  4  5
```

Question: How Would You Generate the Values in Order from 5 to 1?

```r
5:1
```

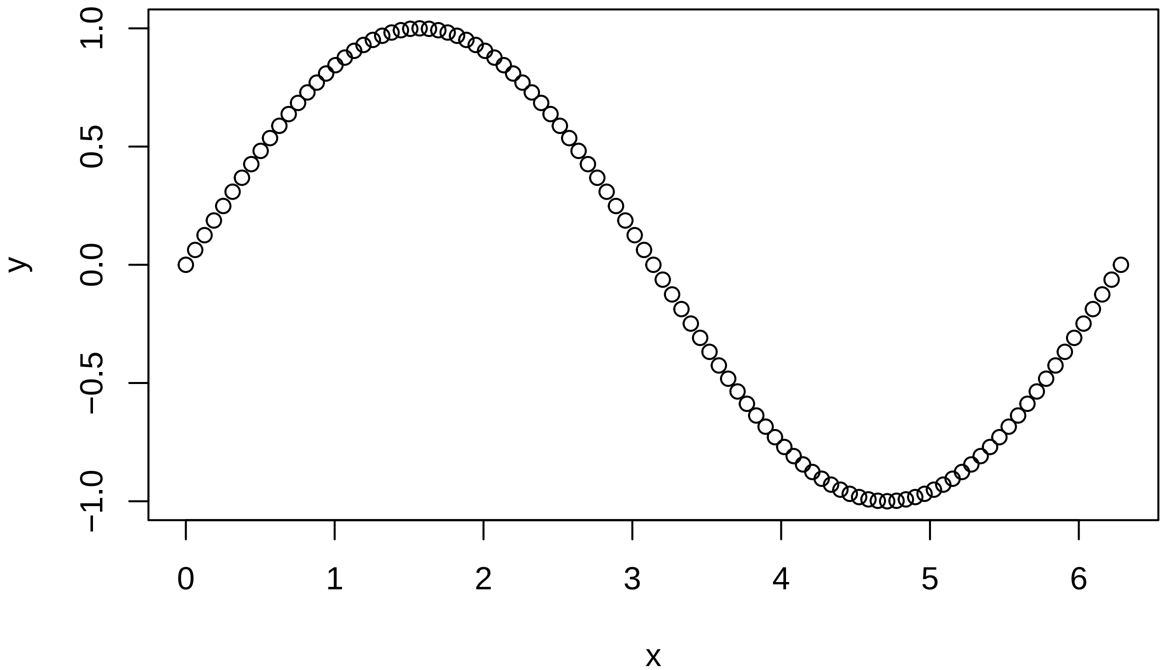
```
## [1] 5 4 3 2 1
```

Generating Sin Wave

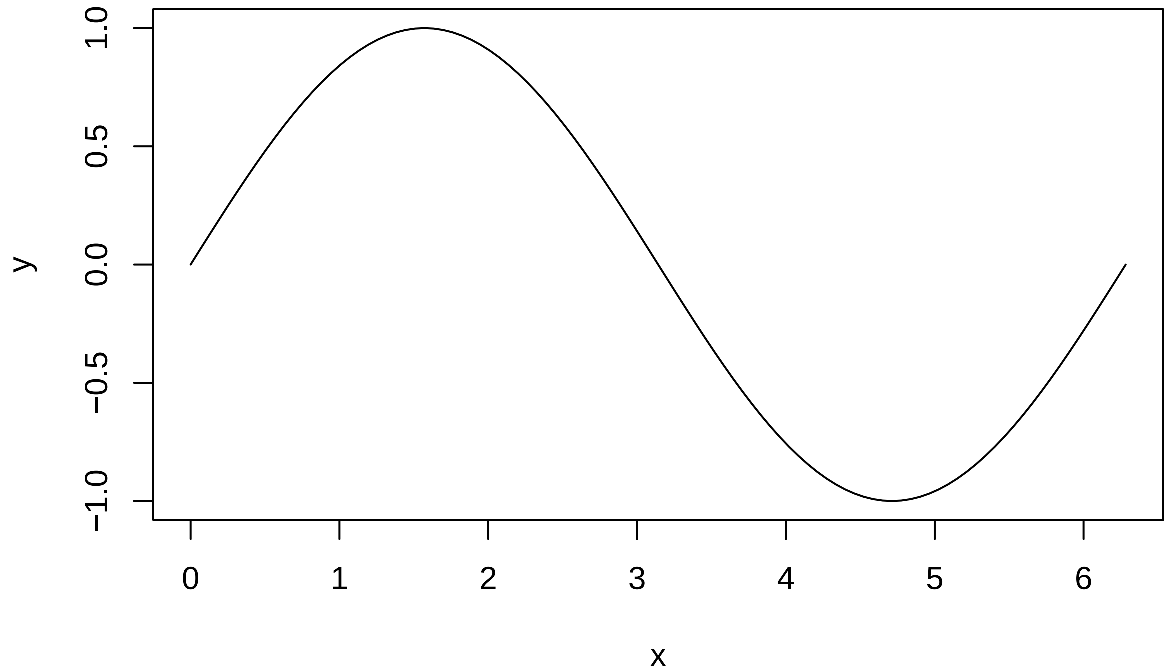
```r
x <- 0:100

# Hundred Values Between 0 and 2 * pi
x <-  2 * pi * (x / 100)
y <- sin(x)

# Plot the Sin Wave
plot(x, y)
```




```r
# Change the Plot to Connect Points with a Line Instead of Points
plot(x, y, type = "l")
```



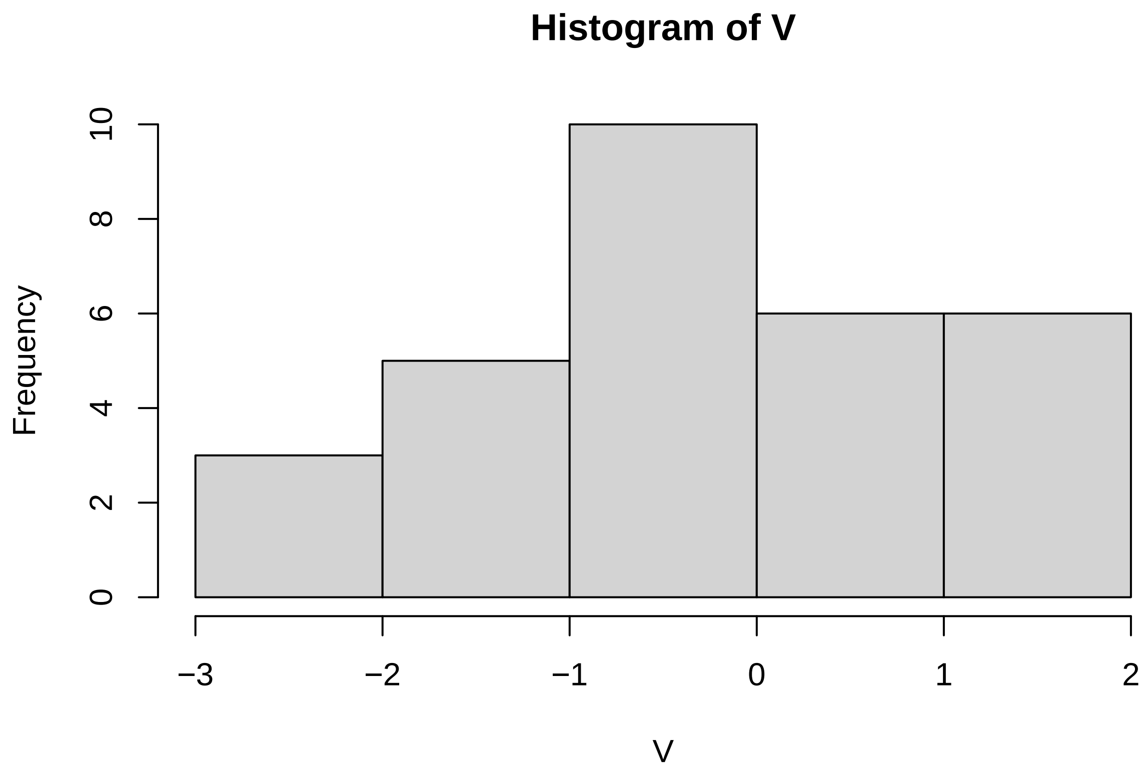

```r
# Another Way of Creating the x
x <- seq(0, 2 * pi, length.out = 101)
```

Use R to Generate Random Values

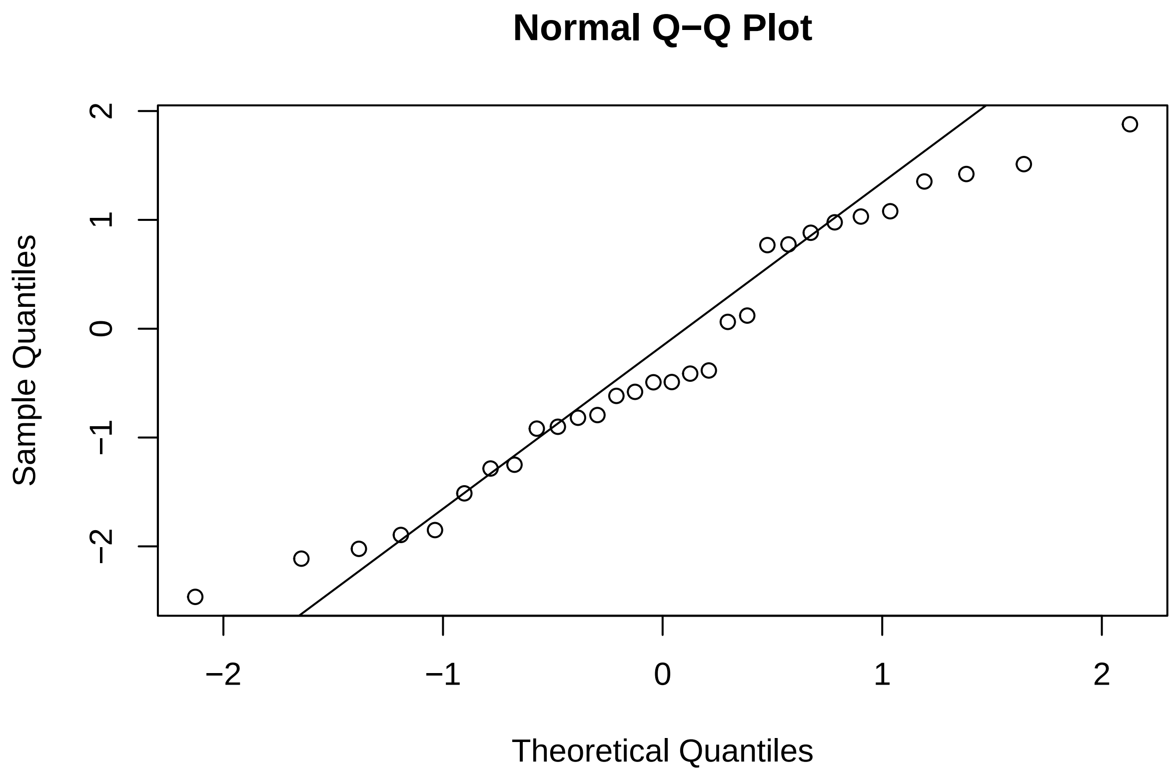
```r
# Generating 10 Random Numbers Between 0 and 1
U <- runif(10)
U
```

```
##  [1] 0.38775924 0.56784158 0.75351334 0.14582535 0.45286681 0.61415090
##  [7] 0.70007691 0.26090569 0.77237393 0.04697387
```

```r
# Generating 30 Random Numbers from a Standard Normal Distribution
V <- rnorm(n = 30, mean = 0, sd = 1)
hist(V)
```




```r
qqnorm(V)
qqline(V)
```



Subsetting

Load a Data Set

```
load("BT.RData") # Uses CWD

# Copy for Easy Typing
BT <- BoulderJuneTemperature$Temp
BAll <- BoulderJuneTemperature
head(BT)
```

```
## [1] 65.51667 68.58333 69.21667 68.58333 70.91667 64.25000
```

```
head(BAll, 10)
```

```
##    Year     Temp
## 1  1984 65.51667
## 2  1985 68.58333
## 3  1986 69.21667
## 4  1987 68.58333
## 5  1988 70.91667
## 6  1989 64.25000
## 7  1990 69.95000
```

```
## 8  1991 66.56667
## 9  1992 62.90000
## 10 1993 64.66667
```

Print the First 10 Values

```r
BT[1:10]
```

```
##  [1] 65.51667 68.58333 69.21667 68.58333 70.91667 64.25000 69.95000 66.56667
##  [9] 62.90000 64.66667
```

An Indicator for All Values Over 70

```r
ind70 <- BT > 70
ind70
```

```
##  [1] FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE
## [13] FALSE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE  TRUE FALSE
## [25] FALSE FALSE FALSE FALSE  TRUE FALSE
```

```r
# Temperatures with Values Over 70
BT[ind70]
```

```
## [1] 70.91667 70.05000 70.36667 71.56667 74.13333
```

```r
# The Years with Values Over 70
BAll$Year[ind70]
```

```
## [1] 1988 1994 2002 2006 2012
```

Question: How many years exceed 70 degrees?

Working with This Data as a Matrix

```r
dim(BAll)
```

```
## [1] 30  2
```

```r
# This Is the First Row and First Column
BAll[1, 1]
```

```
## [1] 1984
```

```r
# First Row
BAll[1,]
```

```
##   Year     Temp
## 1 1984 65.51667
```

```r
# First Column
BAll[, 1]
```

```
##  [1] 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
## [16] 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
```

```r
# Column with Year (This Is Also Column 1)
BAll[, "Year"]
```

```
##  [1] 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998
## [16] 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013
```

```r
# Second Column (You Could Also Use "Temp" to Refer to This)
BAll[, 2]
```

```
##  [1] 65.51667 68.58333 69.21667 68.58333 70.91667 64.25000 69.95000 66.56667
##  [9] 62.90000 64.66667 70.05000 62.33333 66.93333 66.40000 62.68333 64.85000
## [17] 67.40000 68.85000 70.36667 62.83333 62.70000 65.41667 71.56667 67.65000
## [25] 66.01667 63.16667 66.35000 67.56667 74.13333 69.82000
```

```r
# Rows 10 Through 20
BAll[10:20,]
```

```
##    Year     Temp
## 10 1993 64.66667
## 11 1994 70.05000
## 12 1995 62.33333
## 13 1996 66.93333
## 14 1997 66.40000
## 15 1998 62.68333
## 16 1999 64.85000
## 17 2000 67.40000
## 18 2001 68.85000
## 19 2002 70.36667
## 20 2003 62.83333
```

Exercise: Plot the temperatures by year

Apply Functions in `R`

apply Functions

1. a family of functions in R which allow you to repetitively perform an action on multiple chunks of data
2. run faster than loops and often require less code.

Let's take a look at some examples

Load the Boulder Temperature Data Set Into R

```
load("BoulderTemperature.RData") # Monthly mean temperatures #Uses CWD
dim(BoulderTemperature)
```

```
## [1] 118  12
```

```
# Check Out First Row
BoulderTemperature[1,]
```

```
##      jan feb mar apr      may   jun      jul      aug      sep      oct
## 1897 NaN NaN NaN NaN 60.25806 64.65 70.56452 69.06452 66.81667 52.41935
##           nov      dec
## 1897 41.86667 30.40323
```

```
# Extract 1991 - 2010
yr <- rownames(BoulderTemperature)
index <- which(yr %in% 1991:2010)
tempData <- BoulderTemperature[index,]

# Check This Out
tempData
```

```
##           jan      feb      mar      apr      may      jun      jul      aug
## 1991 29.61290 40.96429 42.69355 47.73333 58.22581 66.56667 70.46774 69.11290
## 1992 35.28571 40.56897 43.25806 54.21667 59.06452 62.90000 68.14516 66.29032
## 1993 28.33871 30.58929 42.30645 47.56667 57.91935 64.66667 69.46774 67.37097
## 1994 35.50000 32.10714 43.82258 47.61667 60.80645 70.05000 71.14516 71.01613
## 1995 34.67742 38.28571 42.11290 44.51667 50.85484 62.33333 70.48387 73.96774
## 1996 29.70968 37.67241 37.62903 50.41667 58.87097 66.93333 71.45161 69.48387
## 1997 31.37097 32.96429 45.53226 42.81667 57.17742 66.40000 71.40323 68.85484
## 1998 36.50000 36.39286 38.54839 46.50000 58.61290 62.68333 72.75806 70.37097
## 1999 36.20968 42.10714 45.98387 44.55000 55.58065 64.85000 73.33871 69.30645
## 2000 36.41935 41.06897 42.85484 51.23333 60.98387 67.40000 74.66129 73.03226
## 2001 32.93548 32.32143 40.75806 50.63333 58.40323 68.85000 75.14516 71.85484
## 2002 33.11290 35.98214 37.27419 53.01667 56.16129 70.36667 76.90323 71.30645
## 2003 40.20968 32.08929 43.66129 50.60000 57.35484 62.83333 75.66129 72.79032
## 2004 35.40323 33.67241 48.17742 49.18333 59.96774 62.70000 69.16129 66.40323
## 2005 35.43548 37.87500 41.96774 48.40000 57.72581 65.41667 75.04839 69.70968
## 2006 40.66129 33.67857 39.38710 53.88333 60.95161 71.56667 74.37097 71.56452
## 2007 27.22581 34.58929 47.56452 47.81667 58.00000 67.65000 74.75806 73.56452
## 2008 31.62903 36.10345 40.75806 47.80000 57.03226 66.01667 75.01613 69.62903
## 2009 38.19355 39.33929 44.20968 47.30000 59.30645 63.16667 69.53226 69.48387
## 2010 33.01613 30.05357 42.37097 48.75000 53.90323 66.35000 72.45161 72.41935
##           sep      oct      nov      dec
## 1991 61.56667 52.14516 37.05000 35.48387
## 1992 64.41667 53.87097 34.00000 29.77419
## 1993 59.01667 48.61290 35.61667 35.41935
## 1994 64.83333 50.69355 36.53333 36.08065
## 1995 60.38333 51.33871 44.95000 36.24194
## 1996 60.76667 53.01613 40.58333 36.46774
```

```
## 1997 64.01667 52.66129 37.86667 33.83871
## 1998 67.20000 50.32258 44.01667 32.16129
## 1999 58.48333 51.90323 47.98333 36.91935
## 2000 63.10000 49.59677 31.31667 31.20968
## 2001 65.00000 53.83871 43.85000 34.98387
## 2002 64.06667 45.75806 40.26667 36.58065
## 2003 60.50000 57.38710 38.91667 36.35484
## 2004 62.85000 51.85484 39.66667 36.45161
## 2005 66.35000 53.09677 44.93333 33.30645
## 2006 58.40000 50.98387 43.36667 35.29032
## 2007 64.43333 55.17742 44.86667 30.06452
## 2008 60.90000 51.80645 46.20000 31.09677
## 2009 63.10000 44.46774 43.76667 26.66129
## 2010 66.55000 54.77419 39.76667 37.19355
```

The "*apply*" Function

```
# Means by Rows of This Table
byYear <- apply(tempData, 1, FUN = mean) # By rows, 1 = first index
byYear
```

```
##     1991     1992     1993     1994     1995     1996     1997     1998
## 50.96857 50.98260 48.90762 51.68375 50.84554 51.08345 50.40858 51.33892
##     1999     2000     2001     2002     2003     2004     2005     2006
## 52.26798 51.90642 52.38118 51.73297 52.36322 51.29098 52.43878 52.84208
##     2007     2008     2009     2010
## 52.14257 51.16565 50.71062 51.46661
```

```
#rowMeans(tempData) Will Also Do the Same

# Means by Columns
byMonth <- apply(tempData, 2, FUN = mean) # By cols, 2 = second index
byMonth
```

```
##      jan      feb      mar      apr      may      jun      jul      aug
## 34.07235 35.92127 42.54355 48.72750 57.84516 65.98500 72.56855 70.37661
##      sep      oct      nov      dec
## 62.79667 51.66532 40.77583 34.07903
```

```
#colMeans(tempData) Will Also Do the Same
```

Writing Functions in R

Finding the Interquartile Range (IQR)

```
# 75% Quantile
BT75 <- quantile(BT, 0.75)

# Question: Find the Interquartile Range 75% - 25% Quantiles and Check This Against the Built-In Functi
IQR(BT)
```

```
## [1] 4.4125
```

Building Your Own Function

Here is a function that adds the squares of two numbers. It has three parts, the *calling arguments*, the *body* where you do the work and then *returning any results*.

```r
myFun <- function(a, b) {
    result <- a^2 + b^2
    return(result)
}

test1 <- myFun(2, 3)
test1
```

```
## [1] 13
```

```r
test2 <- myFun(1:5, 11:15)
test2
```

```
## [1] 122 148 178 212 250
```

Note that the "a", "b" and result are only used inside the function and do not appear in your workspace. Also since the body is normal R code, this works for vectors automatically.

Building Your Own IQR Function

```r
myIQR <- function(y) {
  IQR <- quantile(y, 0.75, names = FALSE) - quantile(y, 0.25, names = FALSE)
  return(IQR)
}
myIQR(BT)
```

```
## [1] 4.4125
```

Modify This Function to Work with NAs

```r
test <- c(BT, NA)
myIQR <- function(y, na.rm = FALSE) {
            IQR <- quantile(y, 0.75, names = FALSE, na.rm = na.rm) -
                   quantile(y, 0.25, names = FALSE, na.rm = na.rm)
            return(IQR)
}
myIQR(test, na.rm = T)
```

```
## [1] 4.4125
```

Adding Warning Message

```
myIQR <- function(y, na.rm = FALSE) {
# An Example of Adding a Warning
    if(na.rm) {
        warning("NAs removed from the data")
    }
            IQR <- quantile(y, 0.75, names = FALSE, na.rm = na.rm) -
                   quantile(y, 0.25, names = FALSE, na.rm = na.rm)
            return(IQR)
}
myIQR(test, na.rm = T)
```

```
## Warning in myIQR(test, na.rm = T): NAs removed from the data
```

```
## [1] 4.4125
```