Data Analysis of Body Fat

Johnny Ferrara

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```r
my_data <- read.table("fat.dat.txt", header = FALSE, sep = "")
colnames(my_data) <- c("ID", "BodyFat_Brozek", "BodyFat_Siri", "Density",
"Age", "Weight", "Height",
                       "Adiposity", "FatFreeWeight", "Neck", "Chest",
"Abdomen", "Hip", "Thigh",
                       "Knee", "Ankle", "Biceps", "Forearm", "Wrist")

# Data Cleaning
my_data <- my_data[!my_data$ID %in% c(48, 76, 96), ]
my_data$Height[my_data$ID == 42] <- 69.5
my_data$BodyFat_Brozek[my_data$ID == 182] <-
max(my_data$BodyFat_Brozek[my_data$ID == 182], 0)
my_data$BodyFat_Siri[my_data$ID == 182] <-
max(my_data$BodyFat_Siri[my_data$ID == 182], 0)

summary_stats <- summary(my_data)
print(summary_stats)
```

```
##        ID          BodyFat_Brozek  BodyFat_Siri      Density          Age
##  Min.   :  1.0   Min.   : 0.0   Min.   : 0.00   Min.   :0.995   Min.
:22.00
##  1st Qu.: 64.0   1st Qu.:12.8   1st Qu.:12.50   1st Qu.:1.041   1st
Qu.:35.00
##  Median :128.0   Median :19.1   Median :19.30   Median :1.055   Median
:43.00
##  Mean   :127.1   Mean   :19.0   Mean   :19.21   Mean   :1.055   Mean
:44.81
##  3rd Qu.:190.0   3rd Qu.:24.6   3rd Qu.:25.30   3rd Qu.:1.070   3rd
Qu.:54.00
##  Max.   :252.0   Max.   :45.1   Max.   :47.50   Max.   :1.109   Max.
:81.00
##      Weight          Height         Adiposity      FatFreeWeight       Neck
##  Min.   :118.5   Min.   :64.00   Min.   :18.10   Min.   :105.9   Min.
:31.1
##  1st Qu.:159.2   1st Qu.:68.25   1st Qu.:23.10   1st Qu.:131.4   1st
Qu.:36.4
##  Median :176.8   Median :70.00   Median :25.10   Median :141.7   Median
:38.0
##  Mean   :179.0   Mean   :70.29   Mean   :25.46   Mean   :143.7   Mean
:38.0
##  3rd Qu.:197.0   3rd Qu.:72.25   3rd Qu.:27.40   3rd Qu.:153.8   3rd
Qu.:39.4
```

```
## Max.    :363.1    Max.     :77.50    Max.     :48.90    Max.     :240.5    Max.
:51.2
##      Chest          Abdomen            Hip             Thigh
## Min.   : 79.3    Min.    : 69.40    Min.   : 85.00    Min.    :47.20
## 1st Qu.: 94.6    1st Qu.: 85.20    1st Qu.: 95.60    1st Qu.:56.10
## Median : 99.7    Median : 91.00    Median : 99.30    Median :59.00
## Mean   :100.9    Mean    : 92.62    Mean   : 99.92    Mean    :59.44
## 3rd Qu.:105.3    3rd Qu.: 99.70    3rd Qu.:103.50    3rd Qu.:62.50
## Max.   :136.2    Max.    :148.10    Max.   :147.70    Max.    :87.30
##       Knee           Ankle            Biceps           Forearm          Wrist
## Min.   :33.00    Min.    :19.10    Min.   :24.8    Min.    :21.00    Min.
:15.80
## 1st Qu.:36.90    1st Qu.:22.00    1st Qu.:30.3    1st Qu.:27.30    1st
Qu.:17.60
## Median :38.50    Median :22.80    Median :32.1    Median :28.70    Median
:18.30
## Mean   :38.59    Mean    :23.11    Mean   :32.3    Mean    :28.67    Mean
:18.22
## 3rd Qu.:39.90    3rd Qu.:24.00    3rd Qu.:34.4    3rd Qu.:30.00    3rd
Qu.:18.80
## Max.   :49.10    Max.    :33.90    Max.   :45.0    Max.    :34.90    Max.
:21.40
```
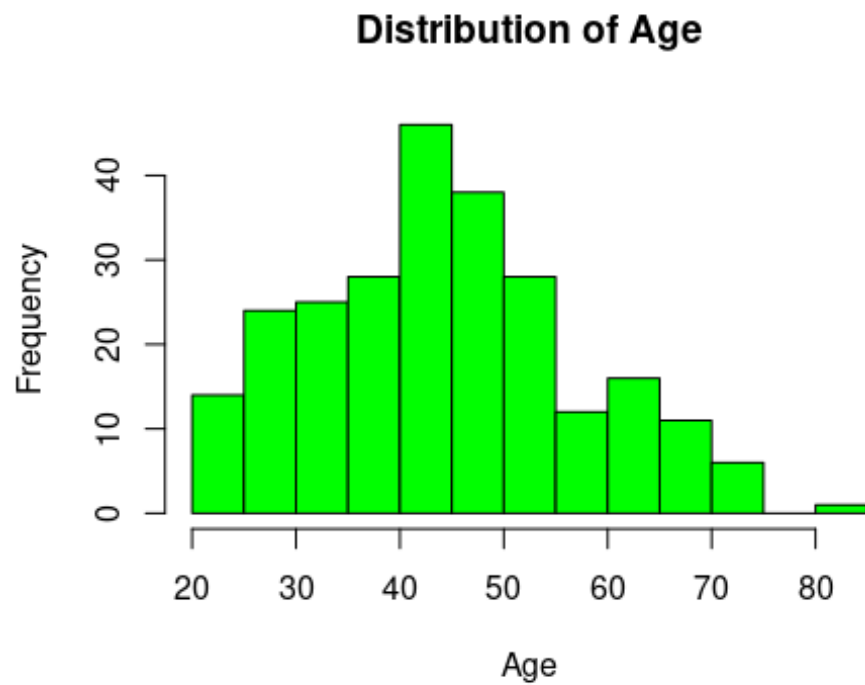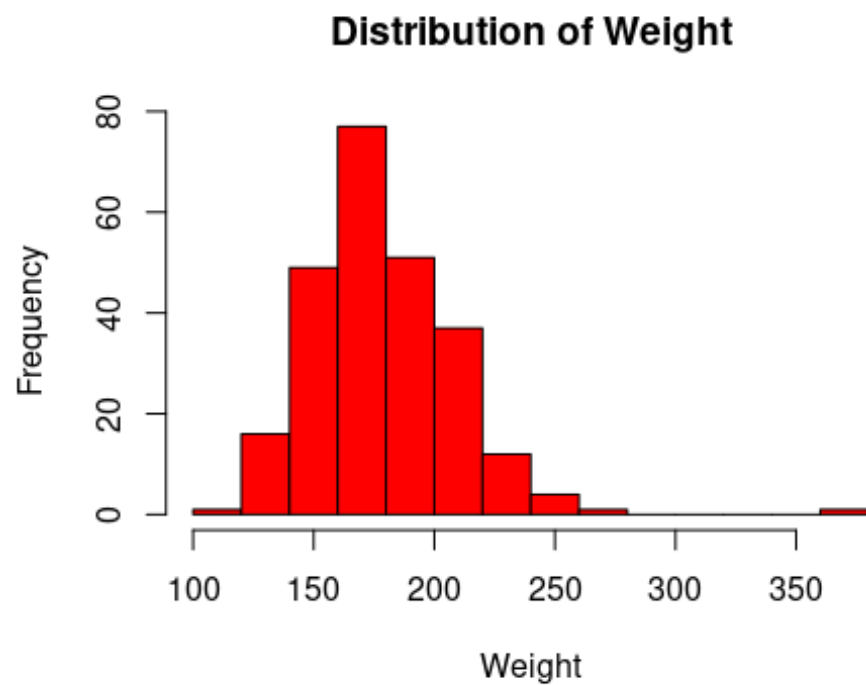
```r
# Histograms
hist(my_data$BodyFat_Brozek, main = "Distribution of BodyFat_Brozek", xlab =
"Body Fat Percentage", col = "blue")
```
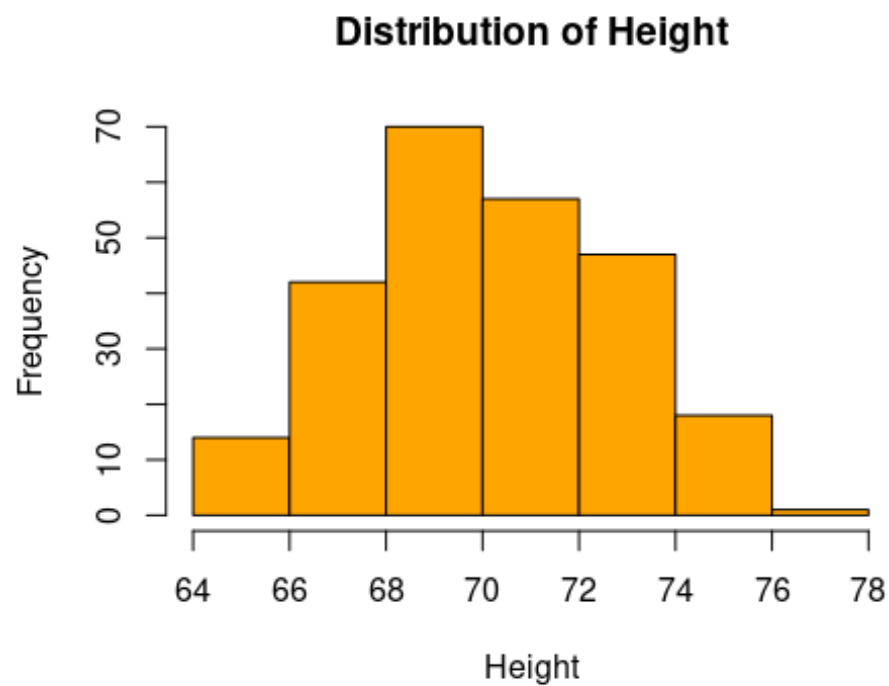

Distribution of BodyFat_Brozek
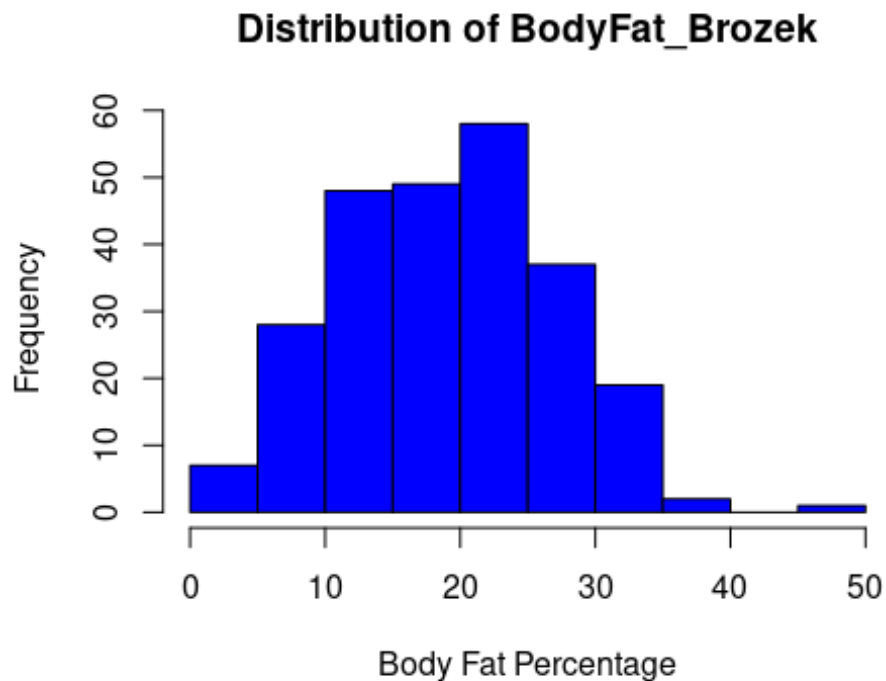
```r
hist(my_data$Age, main = "Distribution of Age", xlab = "Age", col = "green")
```

Distribution of Age


```r
hist(my_data$Weight, main = "Distribution of Weight", xlab = "Weight", col =
"red")
```

Distribution of Weight


```r
hist(my_data$Height, main = "Distribution of Height", xlab = "Height", col =
"orange")
```

Distribution of Height

```r
# Correlation Matrix
library(corrplot)

## corrplot 0.92 loaded

correlation_matrix <- cor(my_data[, sapply(my_data, is.numeric)])
corrplot(correlation_matrix, method = "circle")
```
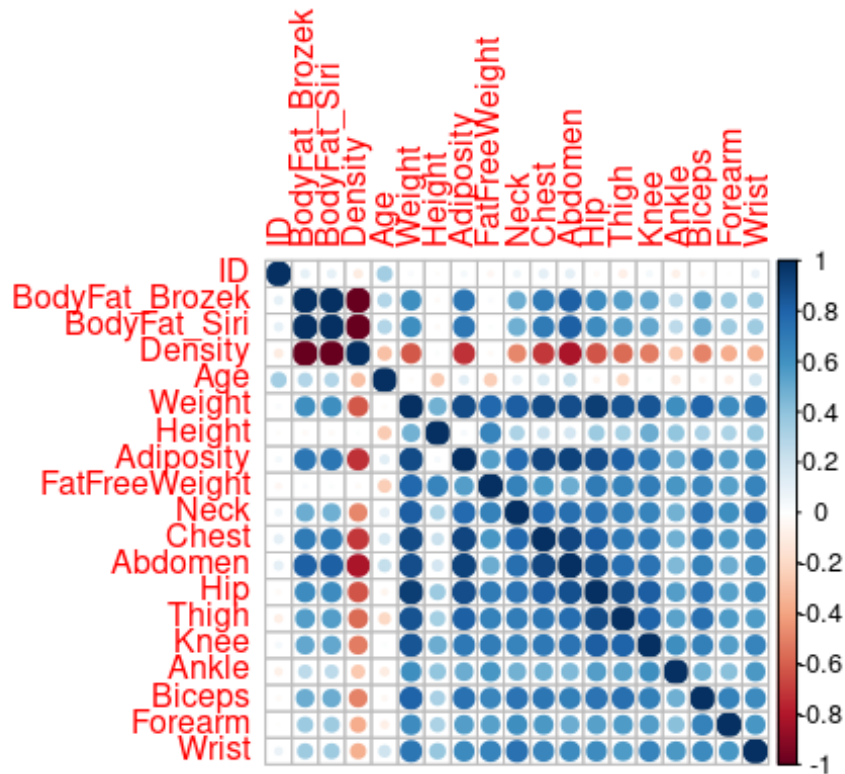


```r
# Linear Regression Models
model_Brozek <- lm(BodyFat_Brozek ~ Density + Age + Weight + Height +
Adiposity + FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
Ankle + Biceps + Forearm + Wrist, data = my_data)
model_Siri <- lm(BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee + Ankle + Biceps
+ Forearm + Wrist, data = my_data)

# Stepwise Regression
stepwise_model_Brozek <- step(model_Brozek, direction = "both")

## Start:  AIC=-787.86
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##      FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
##      Ankle + Biceps + Forearm + Wrist
##
##                Df Sum of Sq    RSS      AIC
## - Thigh         1      0.01   9.18  -789.67
## - Hip           1      0.01   9.19  -789.66
```

```
## - Chest             1       0.02    9.19 -789.44
## - Biceps            1       0.02    9.20 -789.31
## - Ankle             1       0.02    9.20 -789.27
## - Wrist             1       0.03    9.20 -789.14
## - Age               1       0.06    9.24 -788.28
## - Abdomen           1       0.06    9.24 -788.16
## - Knee              1       0.07    9.25 -788.02
## <none>                              9.18 -787.86
## - Neck              1       0.10    9.28 -787.22
## - Forearm           1       0.10    9.28 -787.08
## - Weight            1       0.63    9.81 -773.28
## - Adiposity         1       1.04   10.22 -763.14
## - Height            1       1.26   10.44 -757.89
## - FatFreeWeight     1       7.11   16.29 -647.03
## - Density           1     369.88  379.06  136.64
##
## Step:  AIC=-789.67
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Chest + Abdomen + Hip + Knee + Ankle +
##     Biceps + Forearm + Wrist
##
##                   Df Sum of Sq    RSS      AIC
## - Hip              1       0.00    9.19 -791.57
## - Chest            1       0.01    9.20 -791.36
## - Biceps           1       0.02    9.20 -791.22
## - Ankle            1       0.02    9.21 -791.05
## - Wrist            1       0.03    9.21 -790.90
## - Age              1       0.05    9.24 -790.28
## - Abdomen          1       0.06    9.25 -789.96
## <none>                             9.18 -789.67
## - Knee             1       0.09    9.27 -789.33
## - Neck             1       0.10    9.28 -789.10
## - Forearm          1       0.10    9.29 -788.85
## + Thigh            1       0.01    9.18 -787.86
## - Weight           1       0.63    9.82 -775.12
## - Adiposity        1       1.06   10.24 -764.54
## - Height           1       1.34   10.52 -757.82
## - FatFreeWeight    1       7.79   16.98 -638.71
## - Density          1     404.18  413.37  156.21
##
## Step:  AIC=-791.57
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Chest + Abdomen + Knee + Ankle + Biceps +
##     Forearm + Wrist
##
##                   Df Sum of Sq    RSS      AIC
## - Biceps           1       0.02    9.21 -793.13
## - Chest            1       0.02    9.21 -793.08
## - Ankle            1       0.02    9.21 -792.99
## - Wrist            1       0.03    9.22 -792.82
```

```
## - Age                  1       0.06    9.25 -791.99
## - Abdomen              1       0.07    9.26 -791.61
## <none>                                 9.19 -791.57
## - Knee                 1       0.08    9.27 -791.33
## - Neck                 1       0.09    9.28 -791.10
## - Forearm              1       0.10    9.29 -790.82
## + Hip                  1       0.00    9.18 -789.67
## + Thigh                1       0.00    9.19 -789.66
## - Weight               1       0.66    9.84 -776.40
## - Adiposity            1       1.12   10.30 -765.04
## - Height               1       1.35   10.54 -759.42
## - FatFreeWeight        1       7.80   16.99 -640.58
## - Density              1     404.53  413.72  154.43
##
## Step:  AIC=-793.13
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Chest + Abdomen + Knee + Ankle + Forearm +
##     Wrist
##
##                   Df Sum of Sq     RSS      AIC
## - Chest            1       0.02    9.22 -794.63
## - Ankle            1       0.02    9.22 -794.62
## - Wrist            1       0.03    9.23 -794.34
## - Age              1       0.06    9.26 -793.55
## - Abdomen          1       0.06    9.27 -793.44
## <none>                            9.21 -793.13
## - Knee             1       0.08    9.29 -792.88
## - Neck             1       0.10    9.30 -792.50
## + Biceps           1       0.02    9.19 -791.57
## - Forearm          1       0.13    9.34 -791.55
## + Hip              1       0.00    9.20 -791.22
## + Thigh            1       0.00    9.20 -791.16
## - Weight           1       0.67    9.88 -777.56
## - Adiposity        1       1.11   10.31 -766.81
## - Height           1       1.33   10.54 -761.42
## - FatFreeWeight    1       7.92   17.13 -640.49
## - Density          1     423.06  432.27  163.35
##
## Step:  AIC=-794.63
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Abdomen + Knee + Ankle + Forearm +
##     Wrist
##
##                   Df Sum of Sq     RSS      AIC
## - Ankle            1       0.02    9.24 -796.08
## - Wrist            1       0.03    9.25 -795.80
## - Abdomen          1       0.05    9.28 -795.24
## - Knee             1       0.07    9.30 -794.66
## <none>                            9.22 -794.63
## - Age              1       0.08    9.30 -794.60
```

```
## - Neck              1       0.10    9.32 -794.04
## - Forearm           1       0.12    9.35 -793.30
## + Chest             1       0.02    9.21 -793.13
## + Biceps            1       0.02    9.21 -793.08
## + Hip               1       0.01    9.21 -792.89
## + Thigh             1       0.00    9.22 -792.63
## - Weight            1       0.69    9.91 -778.74
## - Adiposity         1       1.09   10.32 -768.77
## - Height            1       1.32   10.54 -763.34
## - FatFreeWeight     1       8.18   17.40 -638.59
## - Density           1     428.33  437.55  164.37
##
## Step:  AIC=-796.08
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Abdomen + Knee + Forearm + Wrist
##
##                  Df Sum of Sq    RSS     AIC
## - Abdomen         1       0.04    9.29 -796.96
## - Wrist           1       0.05    9.29 -796.81
## - Knee            1       0.06    9.31 -796.41
## <none>                           9.24 -796.08
## - Age             1       0.08    9.33 -795.88
## - Neck            1       0.09    9.33 -795.74
## - Forearm         1       0.12    9.36 -794.93
## + Ankle           1       0.02    9.22 -794.63
## + Chest           1       0.02    9.22 -794.62
## + Biceps          1       0.01    9.23 -794.45
## + Hip             1       0.01    9.24 -794.30
## + Thigh           1       0.00    9.24 -794.08
## - Weight          1       0.68    9.92 -780.39
## - Adiposity       1       1.13   10.38 -769.28
## - Height          1       1.35   10.59 -764.15
## - FatFreeWeight   1       8.16   17.40 -640.56
## - Density         1     429.62  438.87  163.12
##
## Step:  AIC=-796.96
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Knee + Forearm + Wrist
##
##                  Df Sum of Sq    RSS     AIC
## - Wrist           1       0.04    9.33 -797.84
## - Age             1       0.05    9.34 -797.58
## - Knee            1       0.07    9.35 -797.20
## <none>                           9.29 -796.96
## - Neck            1       0.09    9.38 -796.53
## - Forearm         1       0.10    9.38 -796.40
## + Abdomen         1       0.04    9.24 -796.08
## + Hip             1       0.01    9.27 -795.33
## + Ankle           1       0.01    9.28 -795.24
## + Chest           1       0.01    9.28 -795.19
```

```
## + Biceps            1      0.01    9.28 -795.12
## + Thigh             1      0.00    9.29 -794.96
## - Weight            1      0.71   10.00 -780.59
## - Adiposity         1      1.28   10.57 -766.75
## - Height            1      1.40   10.68 -764.03
## - FatFreeWeight  1      8.14   17.42 -642.24
## - Density           1    455.51  464.79  175.41
##
## Step:  AIC=-797.84
## BodyFat_Brozek ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Knee + Forearm
##
##                   Df Sum of Sq    RSS     AIC
## - Age             1      0.02    9.35 -799.17
## - Knee            1      0.06    9.39 -798.31
## <none>                          9.33 -797.84
## + Wrist           1      0.04    9.29 -796.96
## + Abdomen         1      0.04    9.29 -796.81
## + Ankle           1      0.02    9.30 -796.46
## - Forearm         1      0.13    9.46 -796.42
## - Neck            1      0.13    9.46 -796.38
## + Chest           1      0.01    9.32 -796.13
## + Hip             1      0.01    9.32 -796.13
## + Biceps          1      0.01    9.32 -796.02
## + Thigh           1      0.00    9.33 -795.85
## - Weight          1      0.70   10.03 -781.72
## - Adiposity       1      1.28   10.61 -767.70
## - Height          1      1.40   10.73 -764.96
## - FatFreeWeight  1      8.12   17.45 -643.92
## - Density         1    456.14  465.47  173.77
##
## Step:  AIC=-799.17
## BodyFat_Brozek ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Neck + Knee + Forearm
##
##                   Df Sum of Sq    RSS     AIC
## - Knee            1      0.07    9.42 -799.32
## <none>                          9.35 -799.17
## - Neck            1      0.11    9.46 -798.29
## + Ankle           1      0.03    9.33 -797.85
## + Age             1      0.02    9.33 -797.84
## + Chest           1      0.02    9.33 -797.75
## + Hip             1      0.02    9.33 -797.68
## + Wrist           1      0.02    9.34 -797.58
## + Abdomen         1      0.01    9.34 -797.54
## + Biceps          1      0.01    9.34 -797.40
## + Thigh           1      0.00    9.35 -797.27
## - Forearm         1      0.15    9.50 -797.18
## - Weight          1      0.73   10.08 -782.46
## - Adiposity       1      1.27   10.62 -769.41
```

```
## - Height            1      1.40  10.75 -766.53
## - FatFreeWeight      1      8.10  17.45 -645.89
## - Density            1    457.32 466.68  172.42
##
## Step:  AIC=-799.32
## BodyFat_Brozek ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Neck + Forearm
##
##                  Df Sum of Sq    RSS     AIC
## <none>                         9.42 -799.32
## + Knee            1      0.07  9.35 -799.17
## + Age             1      0.04  9.39 -798.31
## - Neck            1      0.13  9.56 -797.83
## + Abdomen         1      0.01  9.41 -797.66
## + Chest           1      0.01  9.41 -797.65
## + Ankle           1      0.01  9.41 -797.63
## + Biceps          1      0.01  9.41 -797.58
## + Hip             1      0.01  9.41 -797.55
## + Wrist           1      0.01  9.41 -797.52
## - Forearm         1      0.15  9.57 -797.50
## + Thigh           1      0.00  9.42 -797.32
## - Weight          1      0.70 10.12 -783.52
## - Adiposity       1      1.31 10.73 -768.87
## - Height          1      1.42 10.84 -766.44
## - FatFreeWeight   1      8.61 18.03 -639.68
## - Density         1    470.76 480.18  177.52

summary(stepwise_model_Brozek)

##
## Call:
## lm(formula = BodyFat_Brozek ~ Density + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Forearm, data = my_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.66176 -0.07588 -0.02224  0.04199  1.92490
##
## Coefficients:
##                 Estimate Std. Error  t value Pr(>|t|)
## (Intercept)    3.880e+02  4.494e+00   86.334  < 2e-16 ***
## Density       -3.605e+02  3.285e+00 -109.732  < 2e-16 ***
## Weight         2.196e-02  5.196e-03    4.226 3.38e-05 ***
## Height         1.571e-01  2.609e-02    6.020 6.45e-09 ***
## Adiposity      2.029e-01  3.503e-02    5.793 2.15e-08 ***
## FatFreeWeight -6.841e-02  4.609e-03  -14.841  < 2e-16 ***
## Neck           1.811e-02  9.823e-03    1.844   0.0664 .
## Forearm        1.634e-02  8.466e-03    1.930   0.0547 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## 
## Residual standard error: 0.1977 on 241 degrees of freedom
## Multiple R-squared:  0.9994, Adjusted R-squared:  0.9994
## F-statistic: 5.448e+04 on 7 and 241 DF,  p-value: < 2.2e-16

stepwise_model_Siri <- step(model_Siri, direction = "both")

## Start:  AIC=-591.31
## BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
##     Ankle + Biceps + Forearm + Wrist
## 
##                 Df Sum of Sq    RSS     AIC
## - Wrist          1      0.00  20.21 -593.27
## - Forearm        1      0.01  20.22 -593.21
## - Ankle          1      0.01  20.22 -593.16
## - Chest          1      0.01  20.22 -593.16
## - Age            1      0.03  20.24 -592.96
## - Knee           1      0.05  20.26 -592.72
## - Abdomen        1      0.07  20.28 -592.50
## - Hip            1      0.07  20.28 -592.41
## - Neck           1      0.11  20.32 -591.94
## <none>                        20.21 -591.31
## - Thigh          1      0.29  20.50 -589.81
## - Biceps         1      0.30  20.51 -589.63
## - Weight         1      0.72  20.93 -584.56
## - Adiposity      1      1.03  21.24 -580.95
## - Height         1      1.18  21.39 -579.22
## - FatFreeWeight  1      7.77  27.98 -512.28
## - Density        1    433.57 453.78  181.44
## 
## Step:  AIC=-593.27
## BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
##     Ankle + Biceps + Forearm
## 
##                 Df Sum of Sq    RSS     AIC
## - Forearm        1      0.01  20.22 -595.20
## - Ankle          1      0.01  20.22 -595.15
## - Chest          1      0.01  20.22 -595.13
## - Age            1      0.04  20.25 -594.80
## - Knee           1      0.05  20.26 -594.70
## - Abdomen        1      0.07  20.28 -594.47
## - Hip            1      0.07  20.29 -594.37
## - Neck           1      0.11  20.32 -593.93
## <none>                        20.21 -593.27
## - Thigh          1      0.28  20.50 -591.80
## - Biceps         1      0.30  20.51 -591.62
## + Wrist          1      0.00  20.21 -591.31
## - Weight         1      0.72  20.94 -586.53
```

```
## - Adiposity          1        1.03   21.24 -582.92
## - Height             1        1.18   21.39 -581.17
## - FatFreeWeight      1        7.93   28.15 -512.83
## - Density            1      434.43  454.65  179.91
##
## Step:  AIC=-595.2
## BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
##      FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
##      Ankle + Biceps
##
##                   Df Sum of Sq     RSS      AIC
## - Ankle            1       0.01   20.23 -597.08
## - Chest            1       0.01   20.23 -597.07
## - Age              1       0.04   20.26 -596.67
## - Knee             1       0.05   20.27 -596.58
## - Abdomen          1       0.06   20.28 -596.44
## - Hip              1       0.07   20.29 -596.33
## - Neck             1       0.12   20.34 -595.70
## <none>                            20.22 -595.20
## - Thigh            1       0.29   20.51 -593.67
## + Forearm          1       0.01   20.21 -593.27
## + Wrist            1       0.00   20.22 -593.21
## - Biceps           1       0.35   20.57 -592.95
## - Weight           1       0.72   20.94 -588.52
## - Adiposity        1       1.05   21.27 -584.58
## - Height           1       1.19   21.41 -582.92
## - FatFreeWeight    1       8.04   28.26 -513.83
## - Density          1      448.55  468.77  185.53
##
## Step:  AIC=-597.08
## BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
##      FatFreeWeight + Neck + Chest + Abdomen + Hip + Thigh + Knee +
##      Biceps
##
##                   Df Sum of Sq     RSS      AIC
## - Chest            1       0.01   20.24 -598.92
## - Age              1       0.04   20.27 -598.54
## - Abdomen          1       0.06   20.28 -598.40
## - Knee             1       0.06   20.29 -598.32
## - Hip              1       0.07   20.30 -598.26
## - Neck             1       0.12   20.35 -597.63
## <none>                            20.23 -597.08
## - Thigh            1       0.30   20.53 -595.45
## + Ankle            1       0.01   20.22 -595.20
## + Forearm          1       0.01   20.22 -595.15
## + Wrist            1       0.00   20.23 -595.08
## - Biceps           1       0.34   20.57 -594.91
## - Weight           1       0.72   20.94 -590.42
## - Adiposity        1       1.09   21.32 -586.02
## - Height           1       1.21   21.44 -584.62
```

```
## - FatFreeWeight  1       8.07  28.30 -515.48
## - Density        1     453.26 473.49  186.03
##
## Step:  AIC=-598.92
## BodyFat_Siri ~ Density + Age + Weight + Height + Adiposity +
##     FatFreeWeight + Neck + Abdomen + Hip + Thigh + Knee + Biceps
##
##                 Df Sum of Sq    RSS     AIC
## - Age            1      0.04  20.29 -600.37
## - Abdomen        1      0.05  20.29 -600.36
## - Knee           1      0.06  20.31 -600.13
## - Hip            1      0.08  20.33 -599.88
## - Neck           1      0.12  20.36 -599.43
## <none>                        20.24 -598.92
## - Thigh          1      0.28  20.53 -597.45
## + Chest          1      0.01  20.23 -597.08
## + Ankle          1      0.01  20.23 -597.07
## + Forearm        1      0.01  20.24 -596.98
## + Wrist          1      0.00  20.24 -596.92
## - Biceps         1      0.34  20.58 -596.81
## - Weight         1      0.72  20.96 -592.24
## - Adiposity      1      1.08  21.33 -587.93
## - Height         1      1.20  21.44 -586.55
## - FatFreeWeight  1      8.51  28.75 -513.50
## - Density        1    467.51 487.75  191.42
##
## Step:  AIC=-600.37
## BodyFat_Siri ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Neck + Abdomen + Hip + Thigh + Knee + Biceps
##
##                 Df Sum of Sq    RSS     AIC
## - Abdomen        1      0.02  20.31 -602.10
## - Knee           1      0.04  20.33 -601.86
## - Hip            1      0.09  20.38 -601.26
## - Neck           1      0.10  20.39 -601.15
## <none>                        20.29 -600.37
## - Thigh          1      0.24  20.53 -599.45
## + Age            1      0.04  20.24 -598.92
## + Chest          1      0.01  20.27 -598.54
## + Ankle          1      0.01  20.27 -598.53
## + Forearm        1      0.01  20.28 -598.49
## - Biceps         1      0.32  20.61 -598.43
## + Wrist          1      0.00  20.28 -598.43
## - Weight         1      0.73  21.02 -593.54
## - Adiposity      1      1.12  21.41 -588.96
## - Height         1      1.26  21.54 -587.39
## - FatFreeWeight  1      8.58  28.86 -514.56
## - Density        1    468.50 488.78  189.94
##
## Step:  AIC=-602.1
```

```
## BodyFat_Siri ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Neck + Hip + Thigh + Knee + Biceps
##
##                  Df Sum of Sq    RSS     AIC
## - Knee            1      0.04  20.35 -603.57
## - Hip             1      0.11  20.42 -602.76
## - Neck            1      0.11  20.42 -602.74
## <none>                         20.31 -602.10
## - Thigh           1      0.29  20.60 -600.55
## - Biceps          1      0.30  20.61 -600.42
## + Abdomen         1      0.02  20.29 -600.37
## + Age             1      0.02  20.29 -600.36
## + Ankle           1      0.01  20.30 -600.18
## + Chest           1      0.01  20.30 -600.17
## + Forearm         1      0.00  20.30 -600.16
## + Wrist           1      0.00  20.30 -600.15
## - Weight          1      0.76  21.06 -595.01
## - Adiposity       1      1.19  21.50 -589.92
## - Height          1      1.26  21.57 -589.14
## - FatFreeWeight   1      8.56  28.86 -516.56
## - Density         1    511.10 531.41  208.76
##
## Step:  AIC=-603.57
## BodyFat_Siri ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Neck + Hip + Thigh + Biceps
##
##                  Df Sum of Sq    RSS     AIC
## - Neck            1      0.10  20.46 -604.29
## - Hip             1      0.12  20.47 -604.11
## <none>                         20.35 -603.57
## - Thigh           1      0.26  20.61 -602.39
## + Knee            1      0.04  20.31 -602.10
## - Biceps          1      0.29  20.65 -601.99
## + Abdomen         1      0.02  20.33 -601.86
## + Ankle           1      0.01  20.34 -601.74
## + Age             1      0.01  20.35 -601.65
## + Chest           1      0.01  20.35 -601.64
## + Forearm         1      0.01  20.35 -601.64
## + Wrist           1      0.00  20.35 -601.57
## - Weight          1      0.77  21.12 -596.29
## - Adiposity       1      1.17  21.52 -591.62
## - Height          1      1.26  21.61 -590.63
## - FatFreeWeight   1      8.54  28.90 -518.29
## - Density         1    523.46 543.81  212.51
##
## Step:  AIC=-604.29
## BodyFat_Siri ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##     Hip + Thigh + Biceps
##
##                  Df Sum of Sq    RSS     AIC
```

```
## - Hip                1       0.08   20.53 -605.35
## <none>                               20.46 -604.29
## + Neck               1       0.10   20.35 -603.57
## - Thigh              1       0.29   20.74 -602.82
## + Knee               1       0.04   20.42 -602.74
## + Abdomen            1       0.04   20.42 -602.73
## + Forearm            1       0.01   20.44 -602.46
## + Ankle              1       0.01   20.45 -602.38
## + Chest              1       0.01   20.45 -602.36
## + Wrist              1       0.01   20.45 -602.36
## + Age                1       0.00   20.46 -602.30
## - Biceps             1       0.34   20.80 -602.15
## - Weight             1       0.87   21.32 -595.97
## - Adiposity          1       1.16   21.62 -592.53
## - Height             1       1.20   21.66 -592.10
## - FatFreeWeight  1       8.45   28.91 -520.16
## - Density            1     531.27 551.73  214.11
##
## Step:  AIC=-605.35
## BodyFat_Siri ~ Density + Weight + Height + Adiposity + FatFreeWeight +
##      Thigh + Biceps
##
##                      Df Sum of Sq    RSS     AIC
## <none>                               20.53 -605.35
## - Thigh              1       0.21   20.74 -604.82
## + Hip                1       0.08   20.46 -604.29
## + Neck               1       0.06   20.47 -604.11
## + Abdomen            1       0.05   20.48 -603.99
## + Knee               1       0.05   20.49 -603.90
## - Biceps             1       0.29   20.83 -603.82
## + Chest              1       0.02   20.52 -603.54
## + Forearm            1       0.01   20.53 -603.41
## + Ankle              1       0.01   20.53 -603.41
## + Wrist              1       0.00   20.53 -603.37
## + Age                1       0.00   20.53 -603.36
## - Weight             1       0.96   21.49 -595.99
## - Height             1       1.31   21.84 -591.99
## - Adiposity          1       1.32   21.85 -591.89
## - FatFreeWeight  1       8.84   29.37 -518.22
## - Density            1     538.11 558.64  215.21

summary(stepwise_model_Siri)

##
## Call:
## lm(formula = BodyFat_Siri ~ Density + Weight + Height + Adiposity +
##      FatFreeWeight + Thigh + Biceps, data = my_data)
##
## Residuals:
##     Min      1Q  Median      3Q      Max
```

```
## -1.7631 -0.0986 -0.0182  0.0625  3.3427
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     4.221e+02  6.805e+00  62.035  < 2e-16 ***
## Density        -3.916e+02  4.927e+00 -79.471  < 2e-16 ***
## Weight          2.550e-02  7.602e-03   3.354 0.000926 ***
## Height          1.524e-01  3.893e-02   3.915 0.000118 ***
## Adiposity       2.040e-01  5.193e-02   3.929 0.000111 ***
## FatFreeWeight  -7.027e-02  6.900e-03 -10.185  < 2e-16 ***
## Thigh          -1.186e-02  7.559e-03  -1.569 0.118023
## Biceps          2.009e-02  1.083e-02   1.856 0.064729 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.2919 on 241 degrees of freedom
## Multiple R-squared:  0.9988, Adjusted R-squared:  0.9988
## F-statistic: 2.912e+04 on 7 and 241 DF,  p-value: < 2.2e-16
```

```r
# Predicted vs Actual Plots
plot(my_data$BodyFat_Brozek, predict(model_Brozek), col='blue',
main='Predicted vs Actual - Brozek', xlab='Actual Body Fat %',
ylab='Predicted Body Fat %')
abline(0, 1, col='red')
```


Predicted vs Actual - Brozek
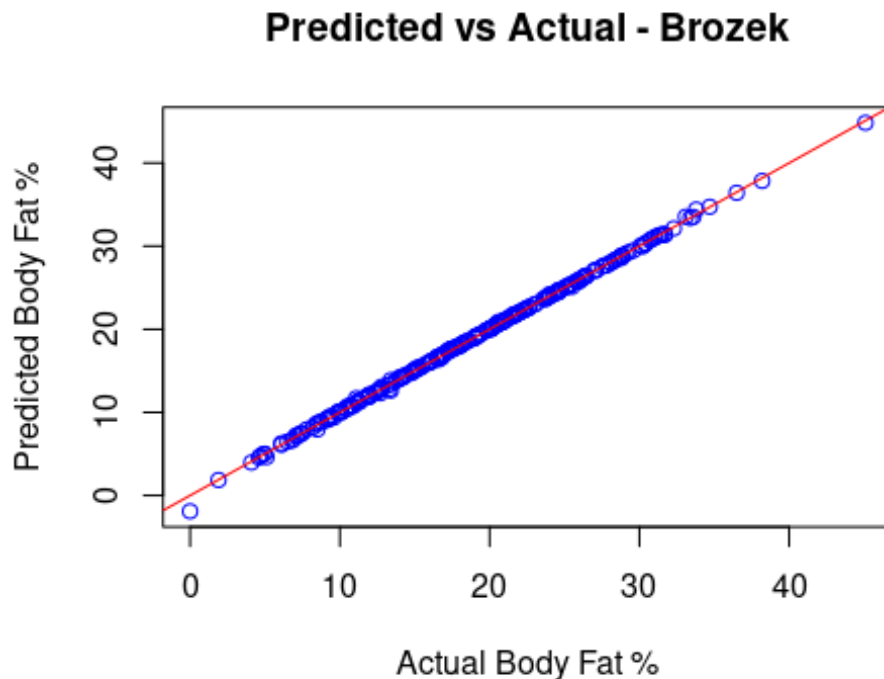
```r
plot(my_data$BodyFat_Siri, predict(model_Siri), col='green', main='Predicted
vs Actual - Siri', xlab='Actual Body Fat %', ylab='Predicted Body Fat %')
abline(0, 1, col='red')
```

Predicted vs Actual - Siri
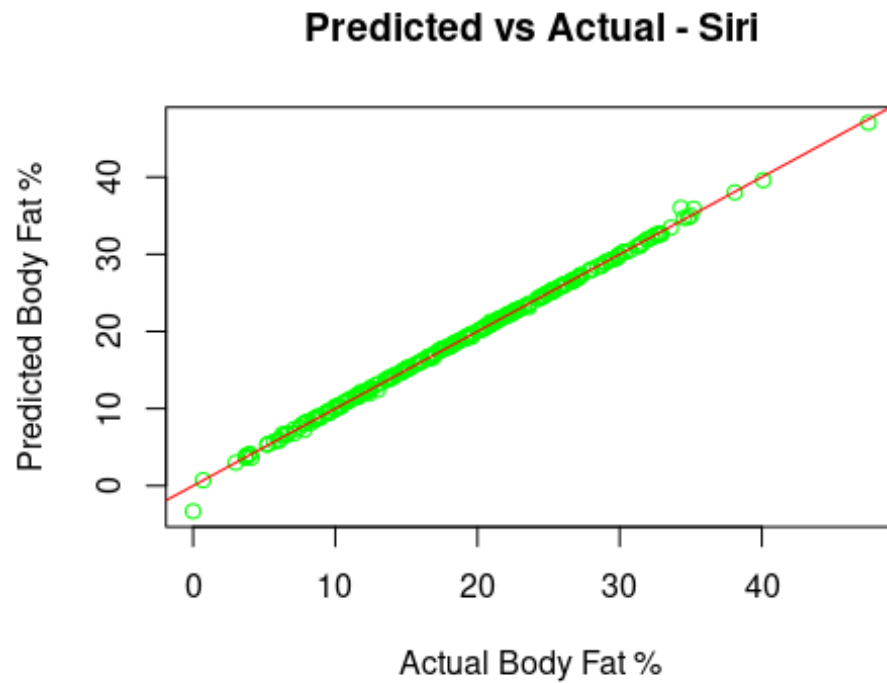

```r
# Residuals vs Fitted Plots
plot(predict(model_Brozek), residuals(model_Brozek), col='blue',
main='Residuals vs Fitted - Brozek', xlab='Fitted Values', ylab='Residuals')
abline(h=0, col='red')
```

Residuals vs Fitted - Brozek
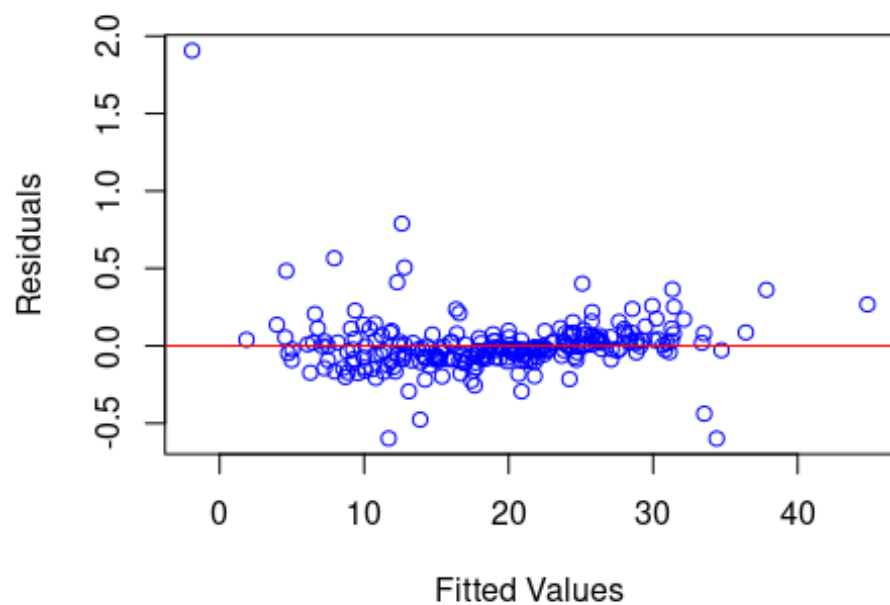

```
plot(predict(model_Siri), residuals(model_Siri), col='green', main='Residuals
vs Fitted - Siri', xlab='Fitted Values', ylab='Residuals')
abline(h=0, col='red')
```

Residuals vs Fitted - Siri
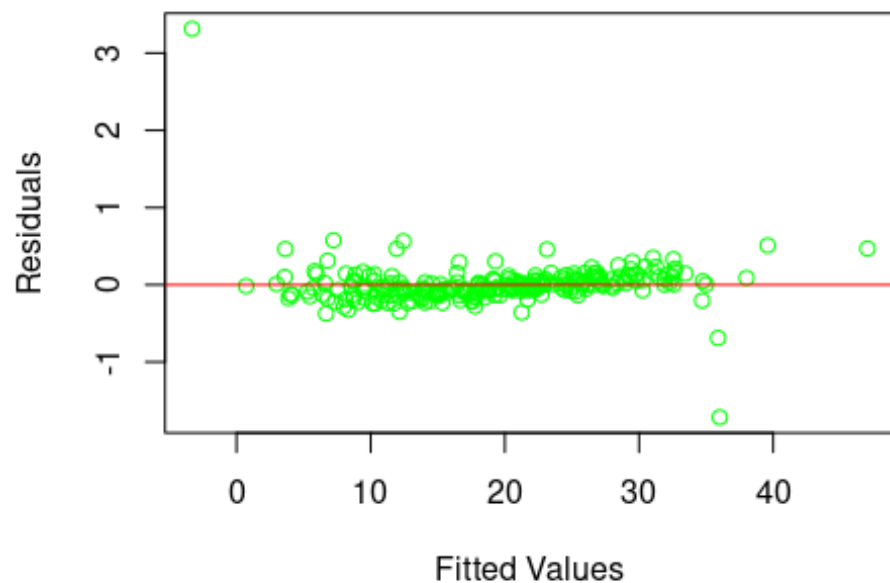
```r
# Boxplots
boxplot(my_data$BodyFat_Brozek, main = "Boxplot of BodyFat_Brozek", ylab =
"Body Fat Percentage")
```

Boxplot of BodyFat_Brozek
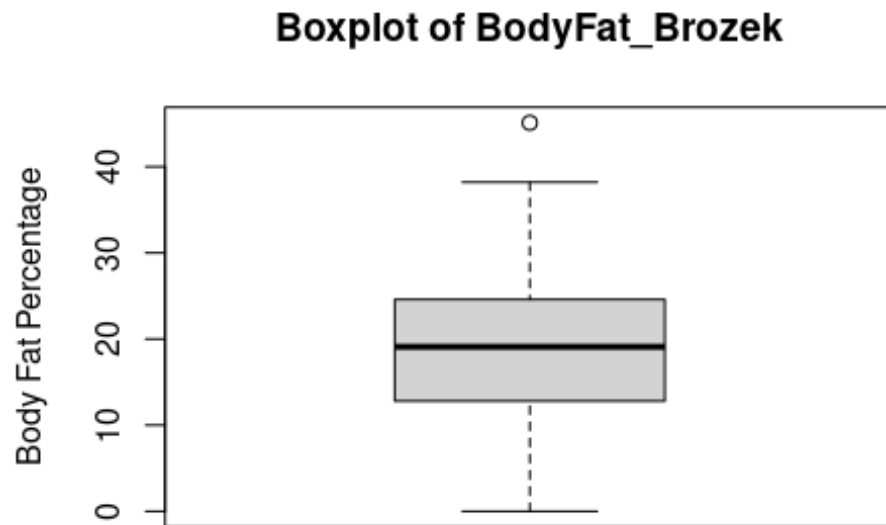

```r
boxplot(my_data$BodyFat_Siri, main = "Boxplot of BodyFat_Siri", ylab = "Body
Fat Percentage")
```

Boxplot of BodyFat_Siri
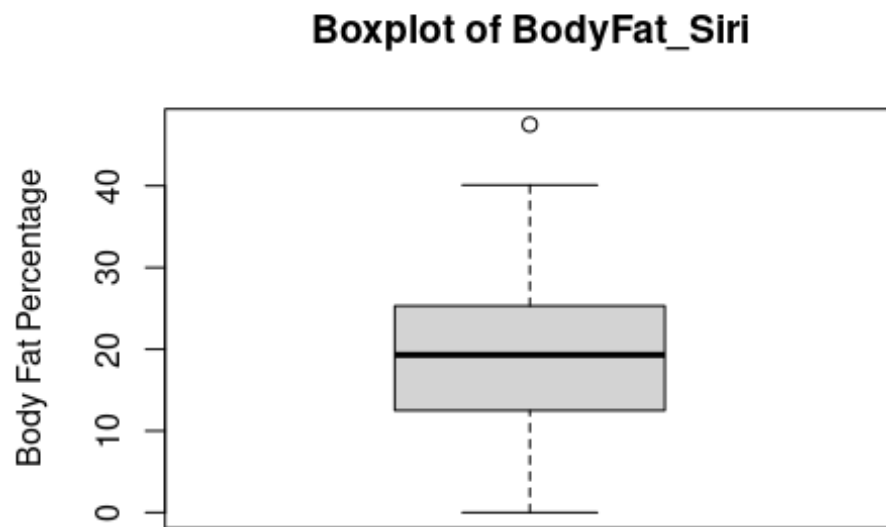

```r
# Splitting by Age
my_data$AgeGroup <- cut(my_data$Age, breaks = c(18, 28, 38, 48, 58, Inf),
labels = c("18-28", "29-38", "39-48", "49-58", "59+"))
age_group_stats <- aggregate(cbind(BodyFat_Brozek, BodyFat_Siri) ~ AgeGroup,
data = my_data, mean)
summary(age_group_stats)

##    AgeGroup BodyFat_Brozek    BodyFat_Siri
##  18-28:1    Min.   :14.80   Min.   :14.64
##  29-38:1    1st Qu.:17.26   1st Qu.:17.27
##  39-48:1    Median :18.75   Median :18.96
##  49-58:1    Mean   :18.85   Mean   :19.04
##  59+  :1    3rd Qu.:19.53   3rd Qu.:19.82
##             Max.   :23.90   Max.   :24.52

barplot(t(as.matrix(age_group_stats[, -1])),
        beside = TRUE,
        names.arg = age_group_stats$AgeGroup,
        col = c("red", "green"),
        legend.text = c("BodyFat_Brozek", "BodyFat_Siri"),
        args.legend = list(x = "topleft", inset = c(0.5, -0.3)))
```
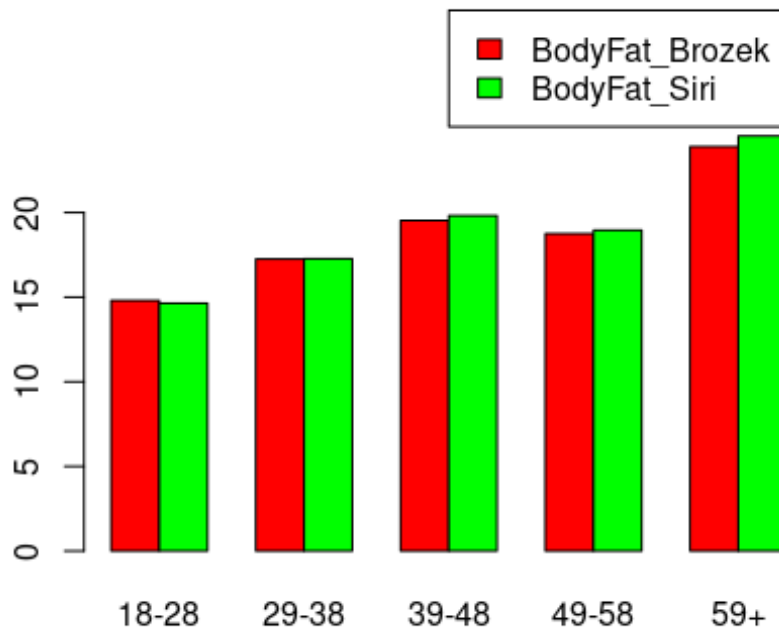
```
hist(my_data$Thigh, main="Histogram of Thigh Measurements", xlab="Thigh
circumference")
```
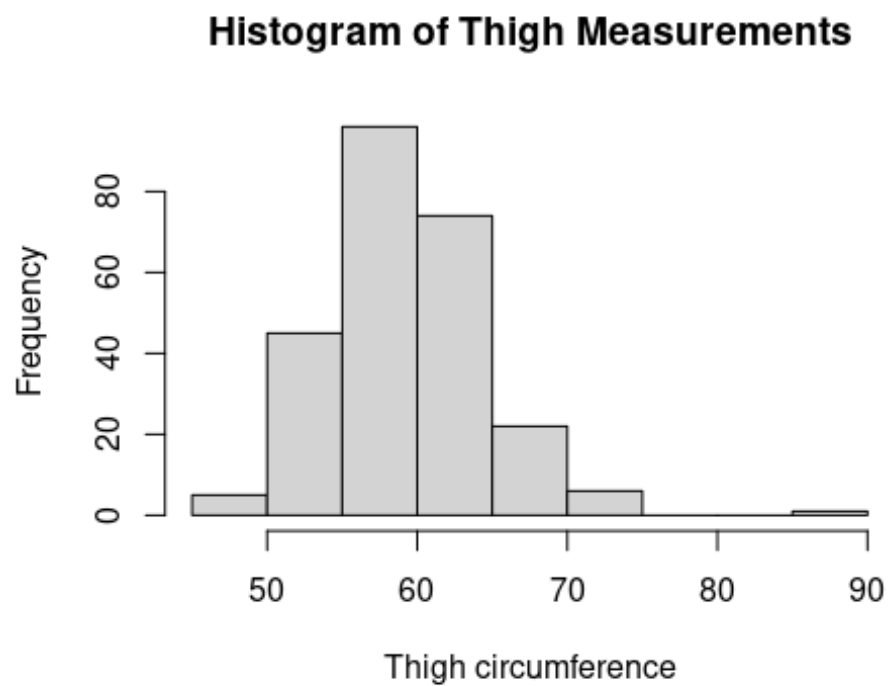
```
hist(my_data$Biceps, main="Histogram of Bicep Measurements", xlab="Bicep
circumference")
```

Histogram of Bicep Measurements

Bicep circumference
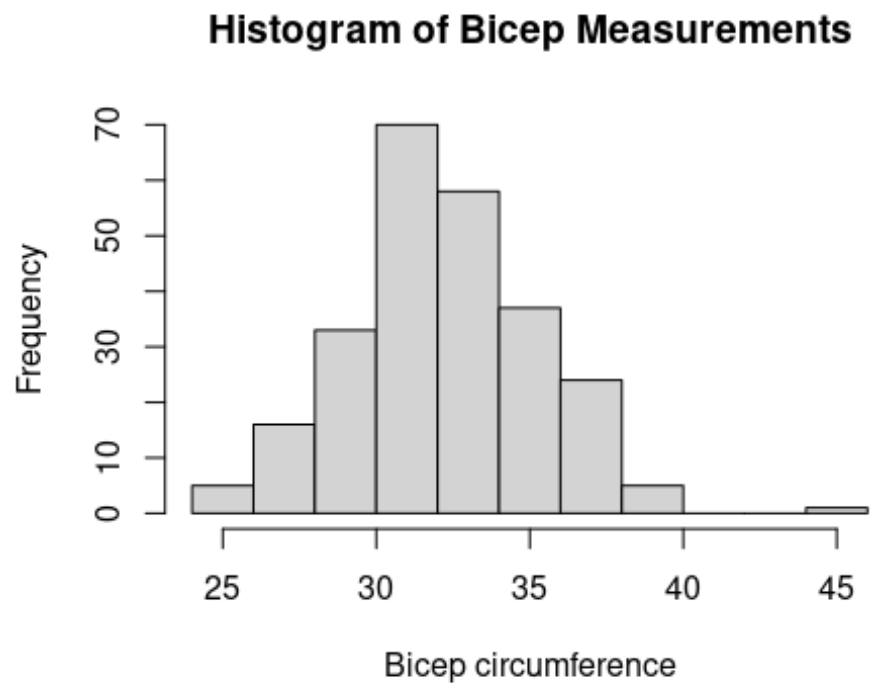
```
hist(my_data$Neck, main="Histogram of Neck Measurements", xlab="Neck
circumference")
```

Histogram of Neck Measurements
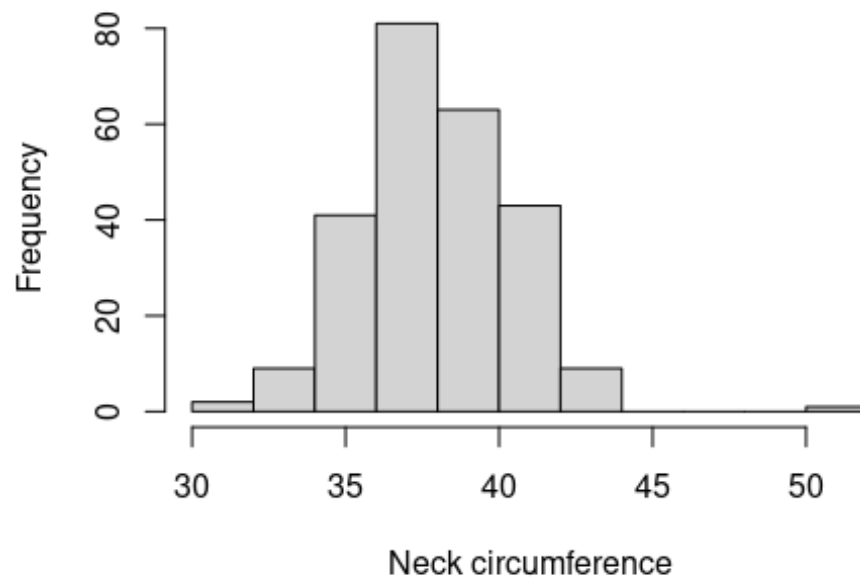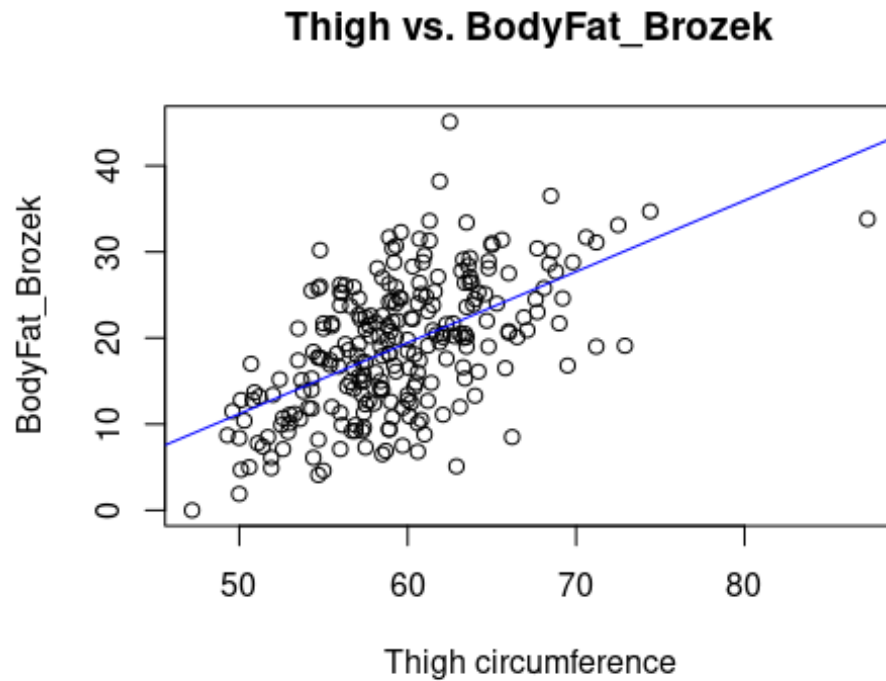


```r
hist(my_data$Forearm, main="Histogram of Forearm Measurements", xlab="Forearm
circumference")
```
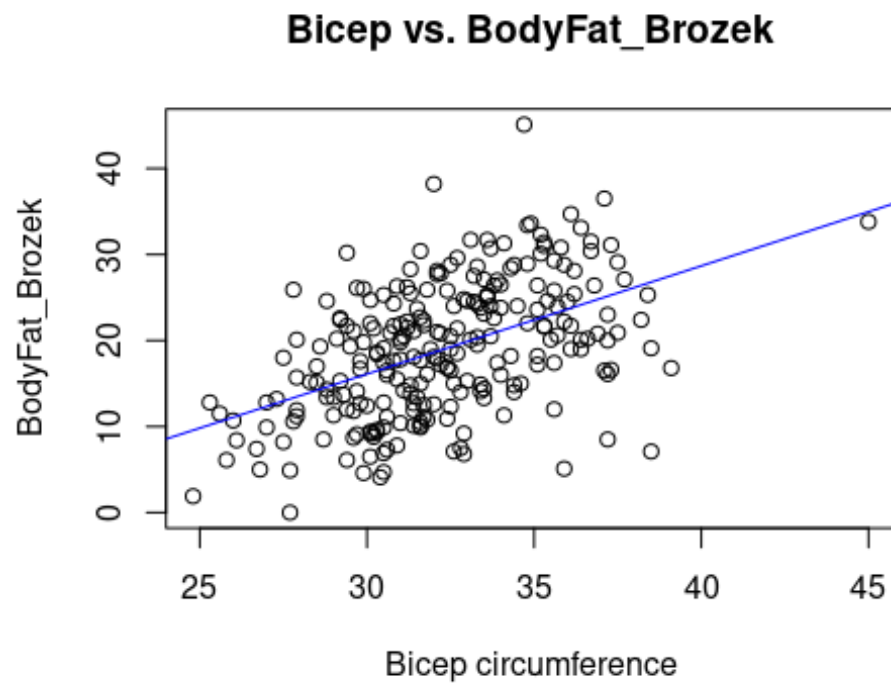
Histogram of Forearm Measurements
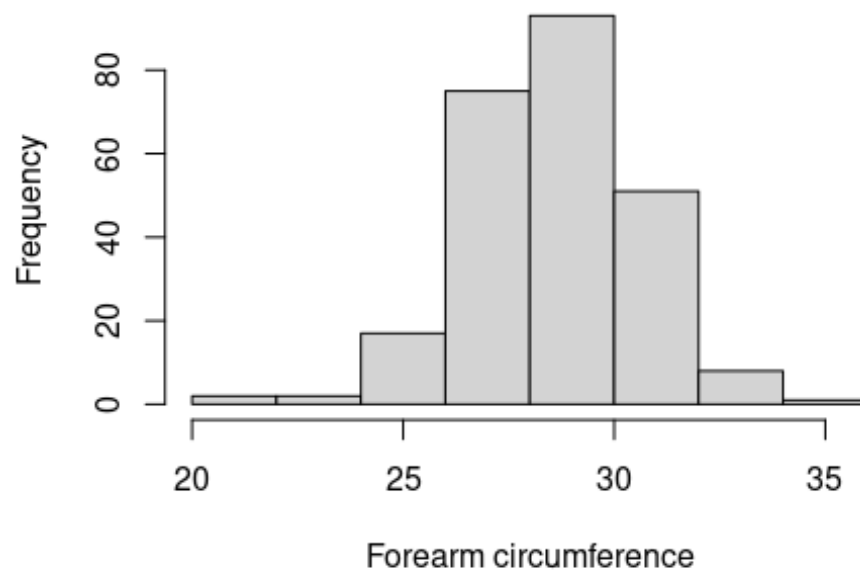
```r
# Plot Thigh vs. Brozek
plot(my_data$Thigh, my_data$BodyFat_Brozek,
     main="Thigh vs. BodyFat_Brozek",
     xlab="Thigh circumference", ylab="BodyFat_Brozek")
abline(lm(BodyFat_Brozek ~ Thigh, data=my_data), col='blue')
```


Thigh vs. BodyFat_Brozek

```r
# Plot Bicep vs. Brozek
plot(my_data$Biceps, my_data$BodyFat_Brozek,
     main="Bicep vs. BodyFat_Brozek",
     xlab="Bicep circumference", ylab="BodyFat_Brozek")
abline(lm(BodyFat_Brozek ~ Biceps, data=my_data), col='blue')
```

Bicep vs. BodyFat_Brozek


```r
# Plot Neck vs. Brozek
plot(my_data$Neck, my_data$BodyFat_Brozek,
     main="Neck vs. BodyFat_Brozek",
     xlab="Neck circumference", ylab="BodyFat_Brozek")
abline(lm(BodyFat_Brozek ~ Neck, data=my_data), col='blue')
```
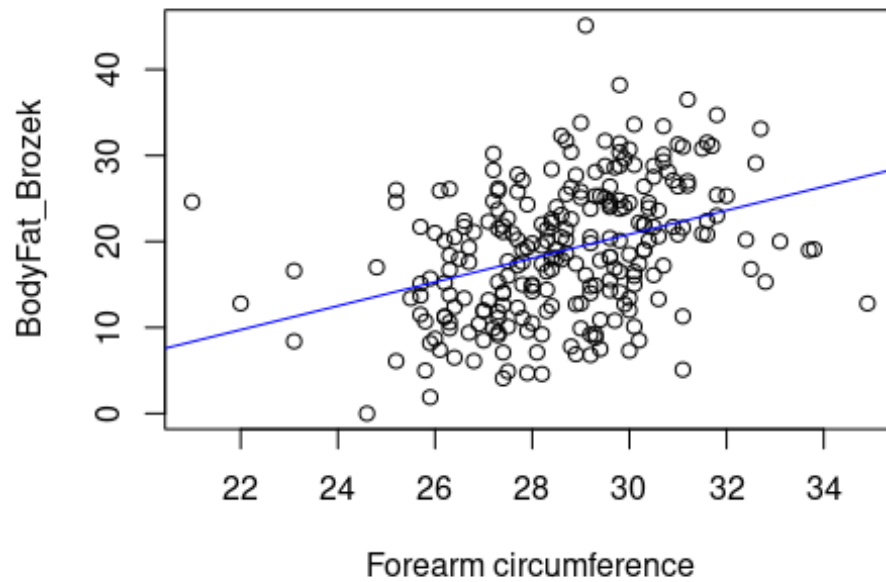
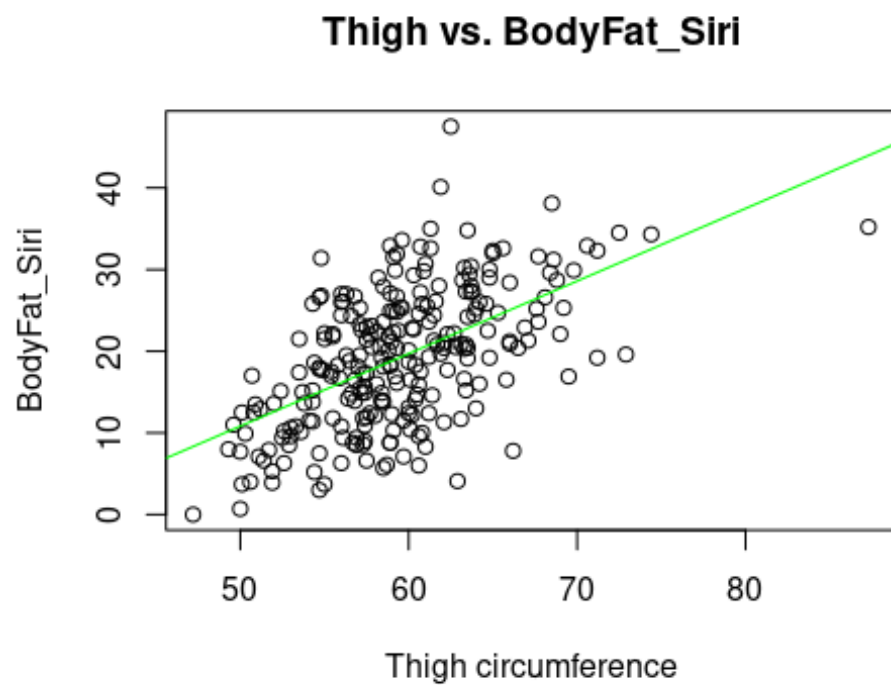# Neck vs. BodyFat_Brozek
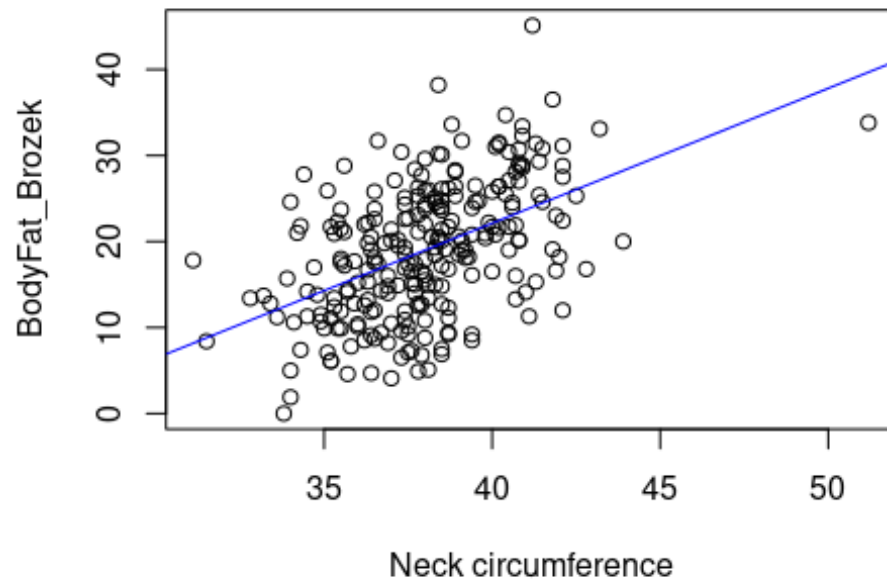

```r
# Plot Forearm vs. Brozek
plot(my_data$Forearm, my_data$BodyFat_Brozek,
     main="Forearm vs. BodyFat_Brozek",
     xlab="Forearm circumference", ylab="BodyFat_Brozek")
abline(lm(BodyFat_Brozek ~ Forearm, data=my_data), col='blue')
```
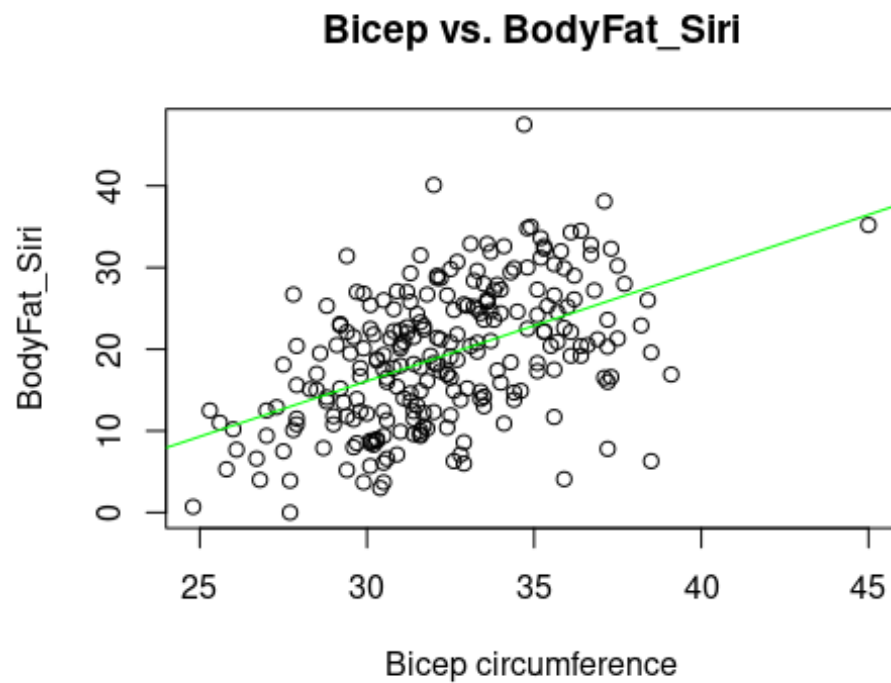
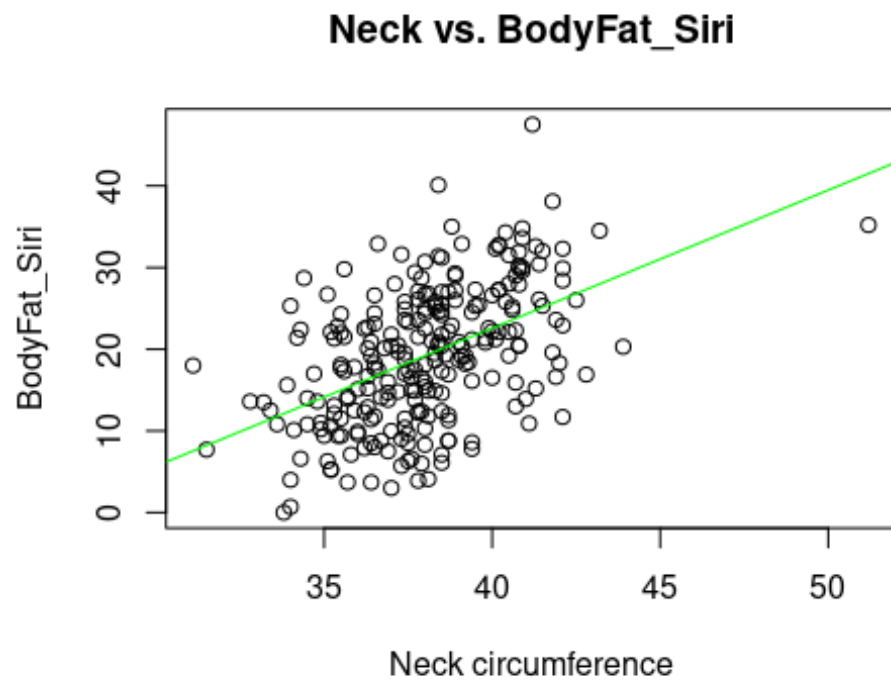# Forearm vs. BodyFat_Brozek


```r
# Plot Thigh vs. Siri
plot(my_data$Thigh, my_data$BodyFat_Siri,
     main="Thigh vs. BodyFat_Siri",
     xlab="Thigh circumference", ylab="BodyFat_Siri")
abline(lm(BodyFat_Siri ~ Thigh, data=my_data), col='green')
```

Thigh vs. BodyFat_Siri


```r
# Plot Bicep vs. Siri
plot(my_data$Biceps, my_data$BodyFat_Siri,
     main="Bicep vs. BodyFat_Siri",
     xlab="Bicep circumference", ylab="BodyFat_Siri")
abline(lm(BodyFat_Siri ~ Biceps, data=my_data), col='green')
```

Bicep vs. BodyFat_Siri


```r
# Plot Neck vs. Siri
plot(my_data$Neck, my_data$BodyFat_Siri,
     main="Neck vs. BodyFat_Siri",
     xlab="Neck circumference", ylab="BodyFat_Siri")
abline(lm(BodyFat_Siri ~ Neck, data=my_data), col='green')
```

Neck vs. BodyFat_Siri


```r
# Plot Forearm vs. Siri
plot(my_data$Forearm, my_data$BodyFat_Siri,
     main="Forearm vs. BodyFat_Siri",
     xlab="Forearm circumference", ylab="BodyFat_Siri")
abline(lm(BodyFat_Siri ~ Forearm, data=my_data), col='green')
```

Forearm vs. BodyFat_Siri
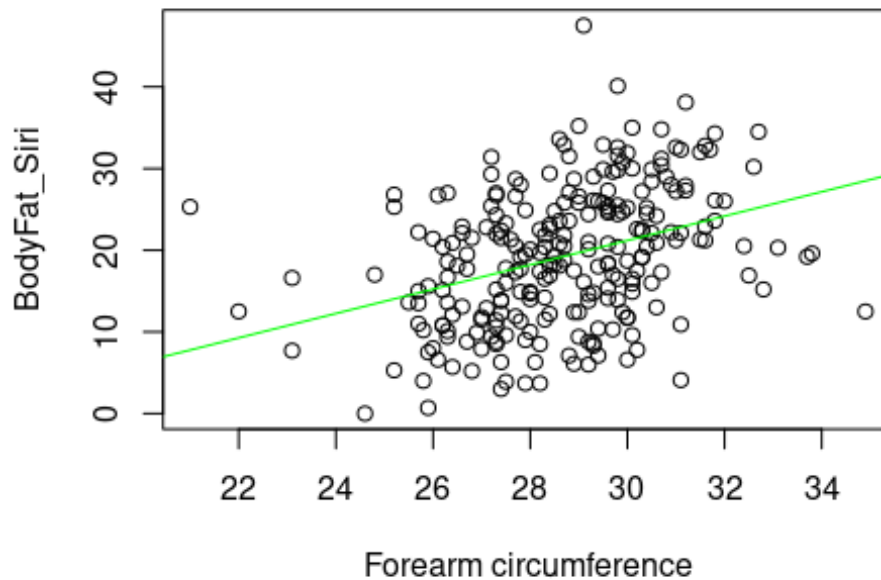

```r
# Correlation with Brozek
cor(my_data$Thigh, my_data$BodyFat_Brozek)

## [1] 0.5590634

cor(my_data$Biceps, my_data$BodyFat_Brozek)

## [1] 0.4903285

cor(my_data$Neck, my_data$BodyFat_Brozek)

## [1] 0.4900519

cor(my_data$Forearm, my_data$BodyFat_Brozek)

## [1] 0.3617737

# Correlation with Siri
cor(my_data$Thigh, my_data$BodyFat_Siri)

## [1] 0.5573777

cor(my_data$Biceps, my_data$BodyFat_Siri)

## [1] 0.4905839

cor(my_data$Neck, my_data$BodyFat_Siri)

## [1] 0.4891409
```

```
cor(my_data$Forearm, my_data$BodyFat_Siri)
```

```
## [1] 0.3598655
```