Final Project

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Preliminary Data Gathering

1. Below, we gather and process our data

```r
bodyfat.dat = read.table("http://inside.mines.edu/~wnavidi/math424/project/bodyfat.dat",
                         header = TRUE)
bodyfatDF = as.data.frame(bodyfat.dat)

min(bodyfatDF$Bodyfat)
bodyfatDF <- bodyfatDF[-c(which.min(bodyfatDF$Bodyfat)),]
min(bodyfatDF$Bodyfat)
max(bodyfatDF$Bodyfat)

min(bodyfatDF$Age)
max(bodyfatDF$Age)

min(bodyfatDF$Weight)
max(bodyfatDF$Weight)

min(bodyfatDF$Height)
bodyfatDF <- bodyfatDF[-c(which.min(bodyfatDF$Height)),]
min(bodyfatDF$Height)
max(bodyfatDF$Height)

min(bodyfatDF$BMI)
max(bodyfatDF$BMI)

min(bodyfatDF$Abdomen)
max(bodyfatDF$Abdomen)

min(bodyfatDF$Ankle)
max(bodyfatDF$Ankle)

min(bodyfatDF$Biceps)
max(bodyfatDF$Biceps)

min(bodyfatDF$Chest)
max(bodyfatDF$Chest)

min(bodyfatDF$Forearm)
max(bodyfatDF$Forearm)

min(bodyfatDF$Hip)
max(bodyfatDF$Hip)

min(bodyfatDF$Knee)
max(bodyfatDF$Knee)
```

```r
min(bodyfatDF$Neck)
max(bodyfatDF$Neck)

min(bodyfatDF$Thigh)
max(bodyfatDF$Thigh)

min(bodyfatDF$Wrist)
max(bodyfatDF$Wrist)

Bodyfat = bodyfatDF$Bodyfat
Age = bodyfatDF$Age
Weight = bodyfatDF$Weight
Height = bodyfatDF$Height
BMI = bodyfatDF$BMI
Abdomen = bodyfatDF$Abdomen
Ankle = bodyfatDF$Ankle
Biceps = bodyfatDF$Biceps
Chest = bodyfatDF$Chest
Forearm = bodyfatDF$Forearm
Hip = bodyfatDF$Hip
Knee = bodyfatDF$Knee
Neck = bodyfatDF$Neck
Thigh = bodyfatDF$Thigh
Wrist = bodyfatDF$Wrist
```
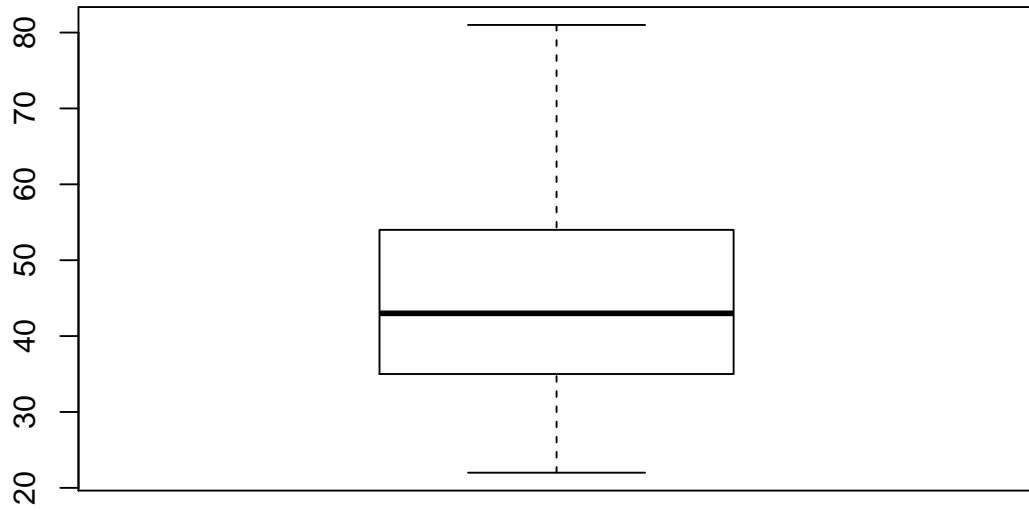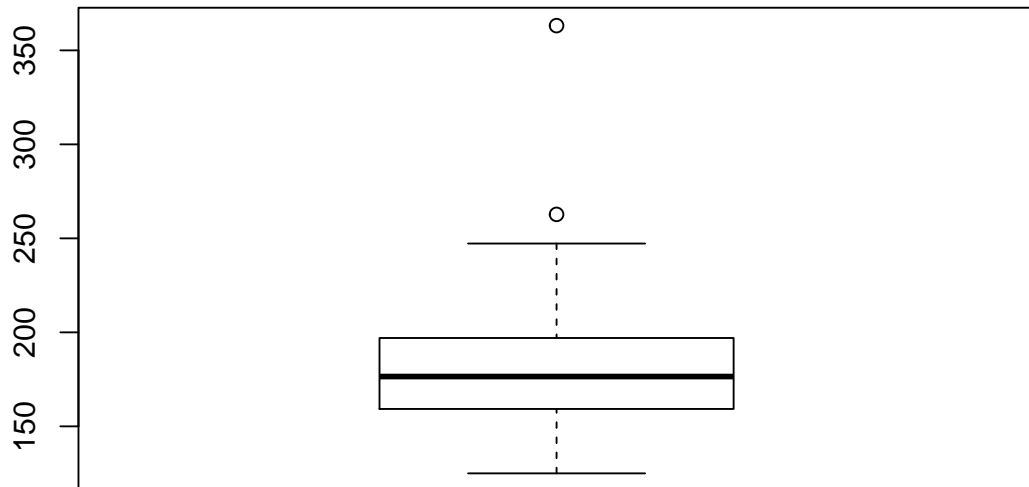
Bodyfa

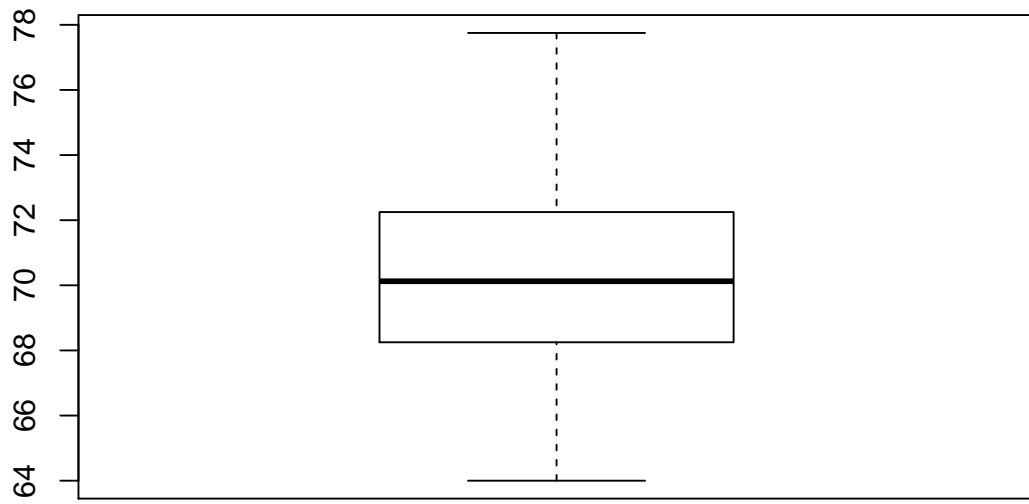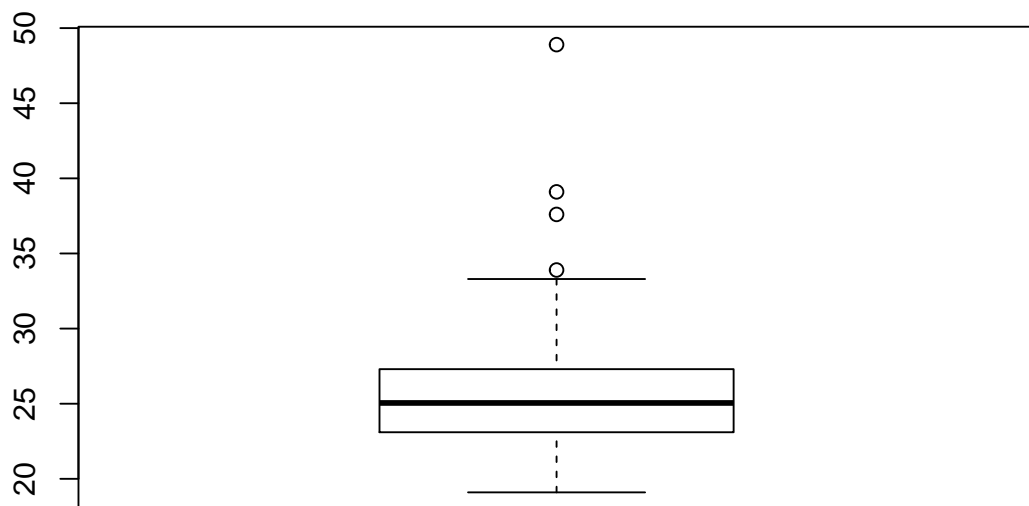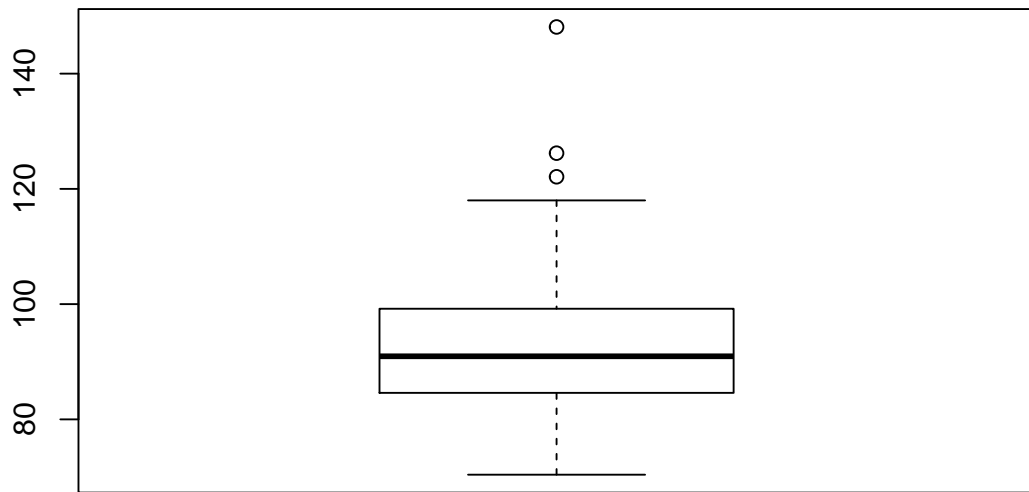2. Boxplots for the data to help identify influential points later on
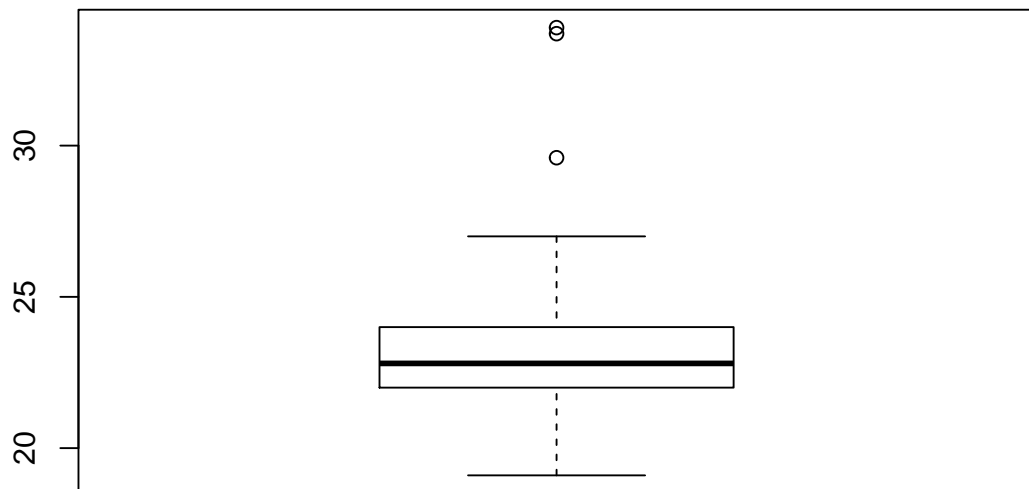
Age

Weight

Height

BMI

Abdomen

Ankle

Biceps
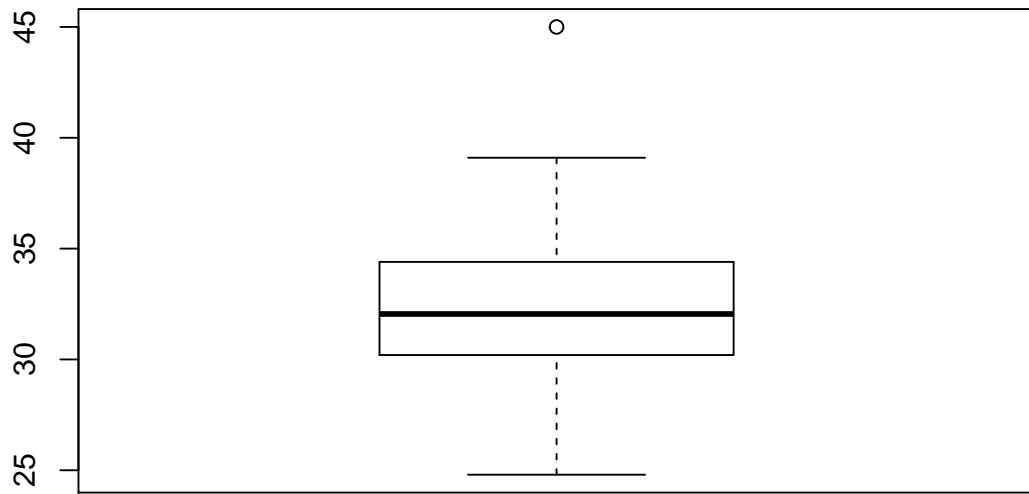
Chest
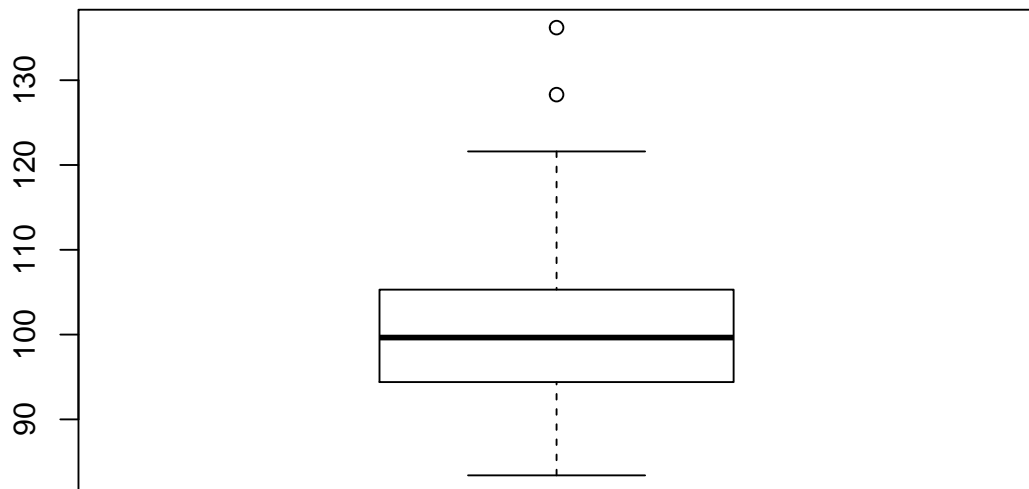
Forearm
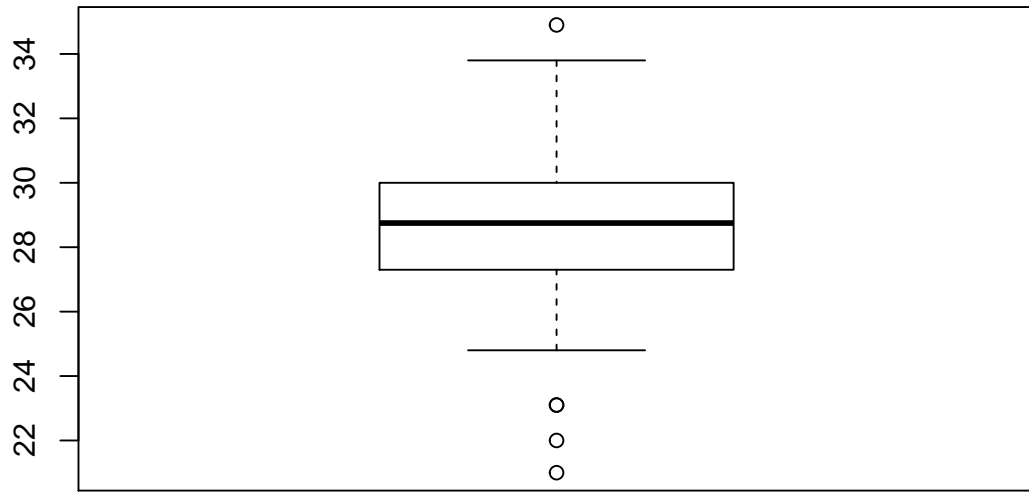
Hip
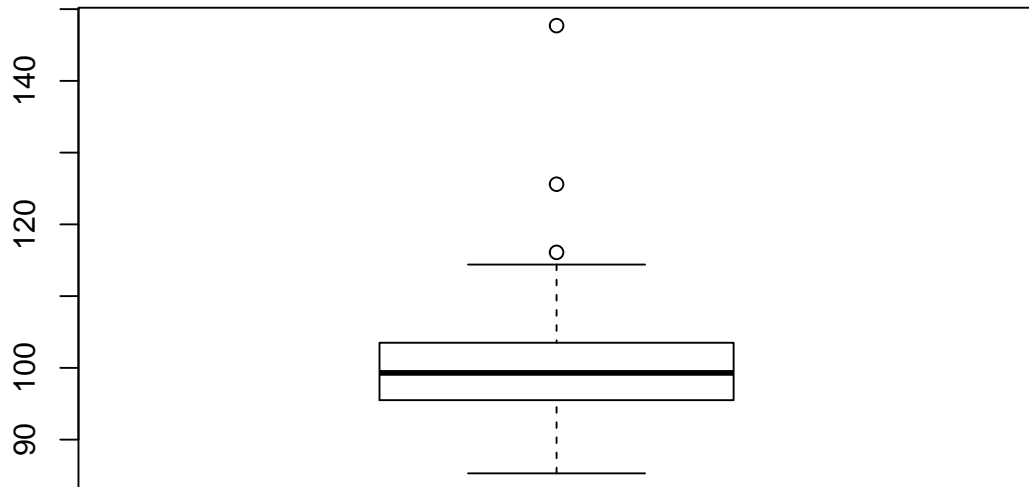
Knee
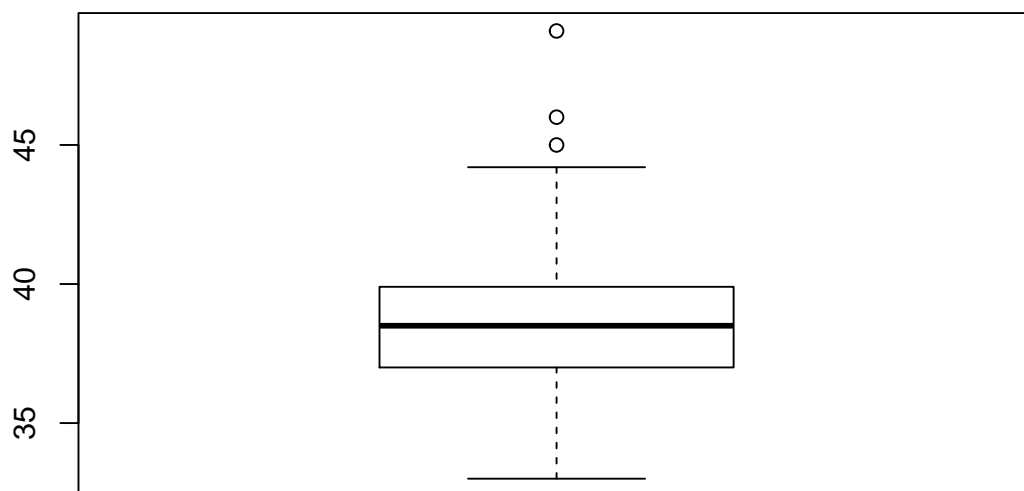
Neck
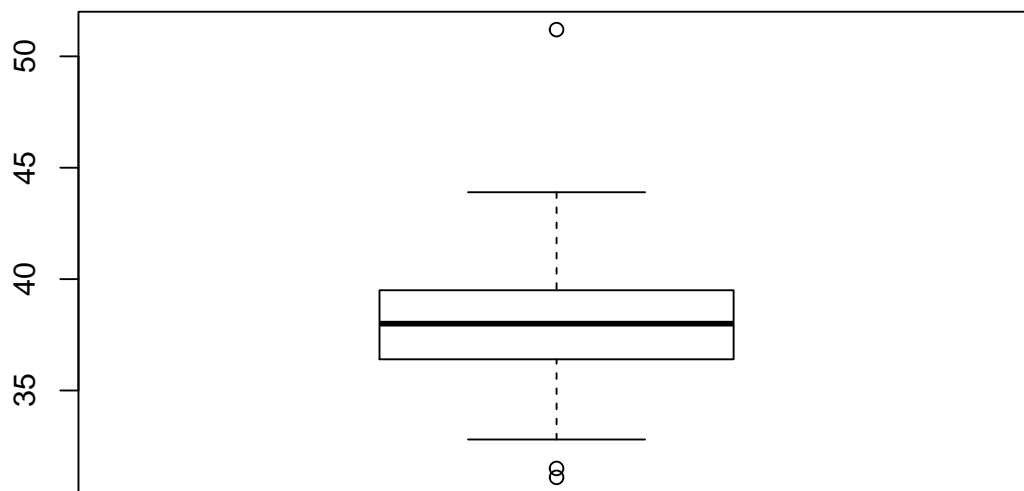
Thigh
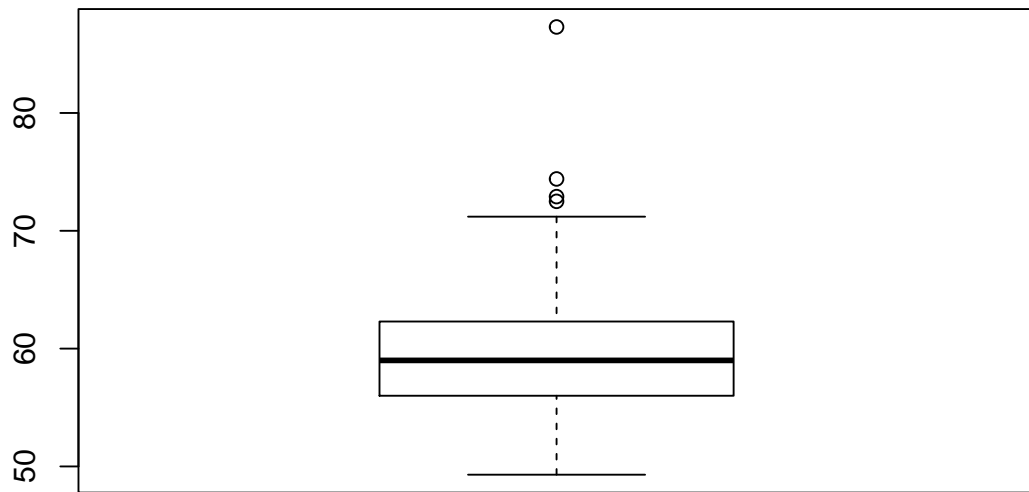
Wrist
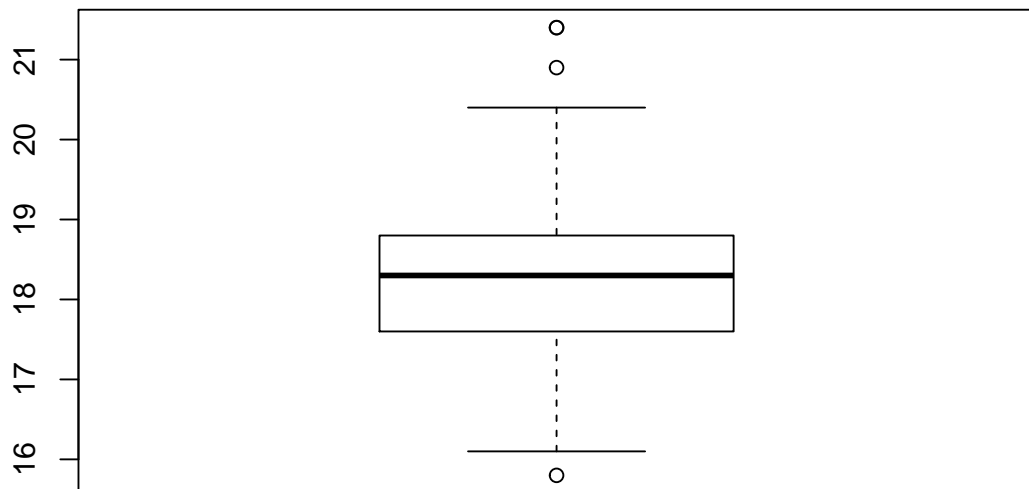
3. Below we fit a simple linear model Figure 1

```
all.lm = lm(Bodyfat ~ Age + Weight + Height + BMI + Neck + Chest + Abdomen + Hip +
            Thigh + Knee + Ankle + Biceps + Forearm + Wrist)
all.sum = summary(all.lm)
all.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Height + BMI + Neck + Chest +
##     Abdomen + Hip + Thigh + Knee + Ankle + Biceps + Forearm +
##     Wrist)
##
## Residuals:
##      Min      1Q   Median      3Q      Max
## -10.1062  -2.6605  -0.2011   2.8920   9.2619
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -44.91075   36.67739  -1.224  0.22200
## Age           0.05740    0.03004   1.911  0.05725 .
## Weight       -0.16239    0.10076  -1.612  0.10838
## Height        0.43668    0.50801   0.860  0.39089
## BMI           0.75340    0.73339   1.027  0.30534
## Neck         -0.42594    0.21857  -1.949  0.05251 .
## Chest        -0.05969    0.09907  -0.603  0.54740
## Abdomen       0.87126    0.08569  10.168  < 2e-16 ***
## Hip          -0.22543    0.13796  -1.634  0.10359
## Thigh         0.21780    0.13660   1.594  0.11220
## Knee         -0.01257    0.22965  -0.055  0.95639
## Ankle         0.12398    0.20837   0.595  0.55243
## Biceps        0.16357    0.16000   1.022  0.30769
## Forearm       0.39166    0.18627   2.103  0.03656 *
## Wrist        -1.49585    0.49586  -3.017  0.00284 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.988 on 235 degrees of freedom
## Multiple R-squared:  0.7432, Adjusted R-squared:  0.7279
## F-statistic: 48.58 on 14 and 235 DF,  p-value: < 2.2e-16
```

Figure 1

Scater plots for high p-val variables

Bodyfat Vs. Age
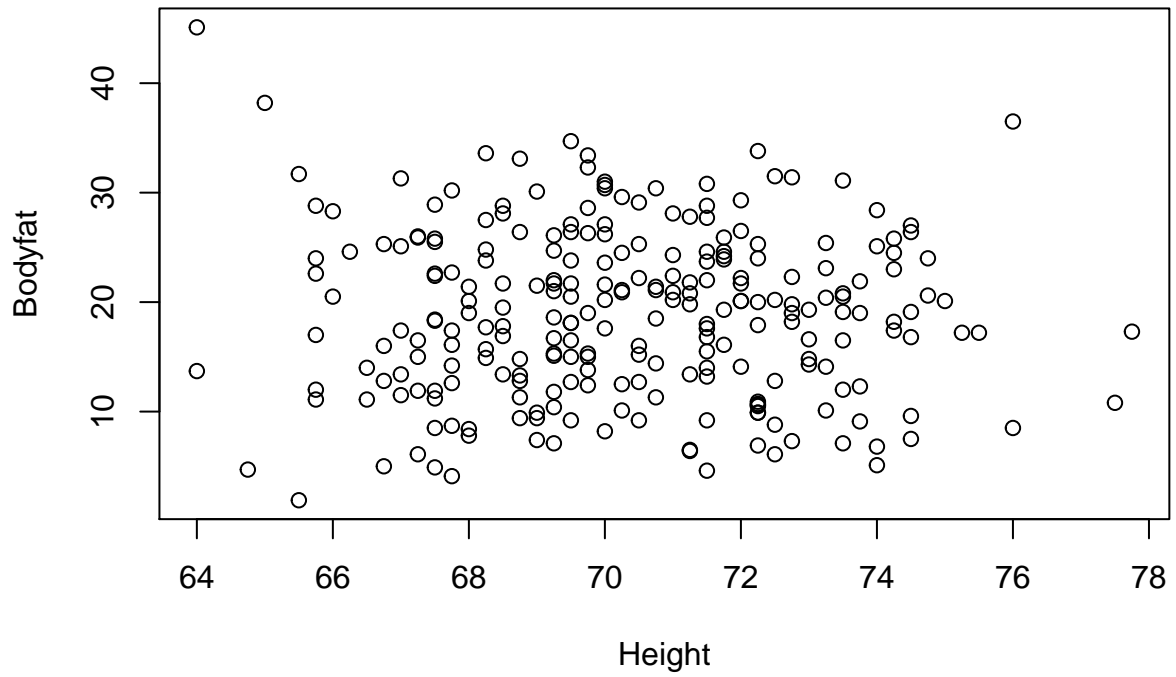
Bodyfat Vs. Height

Bodyfat Vs. BMI
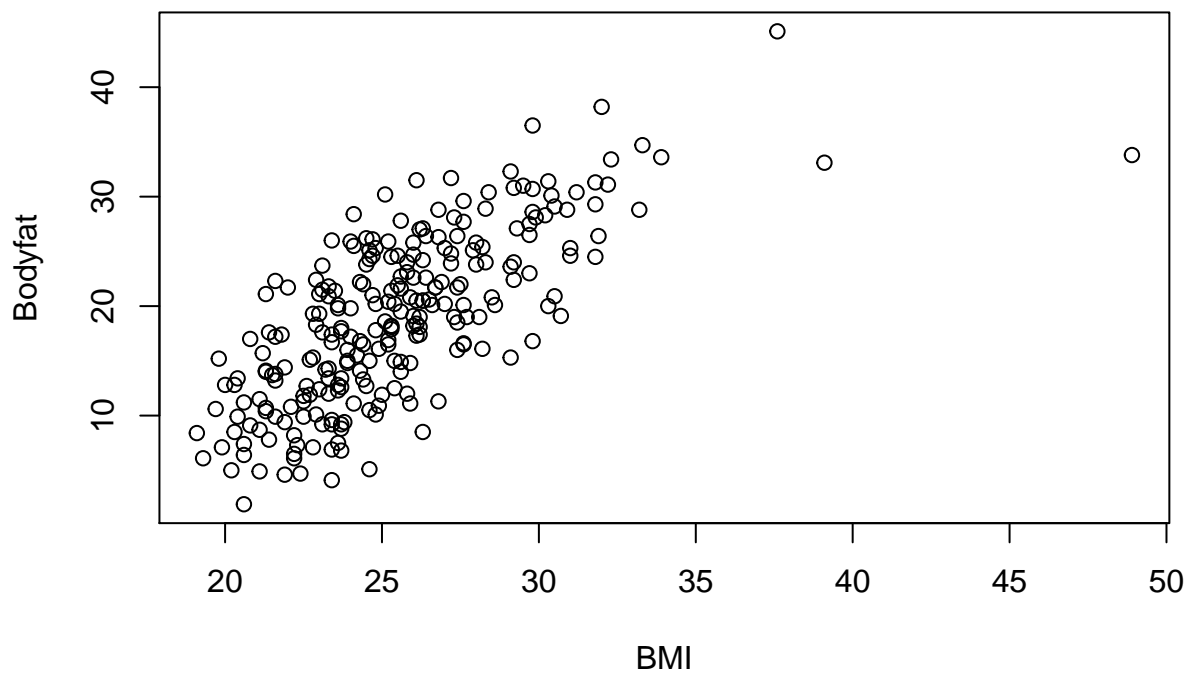
Bodyfat Vs. Chest
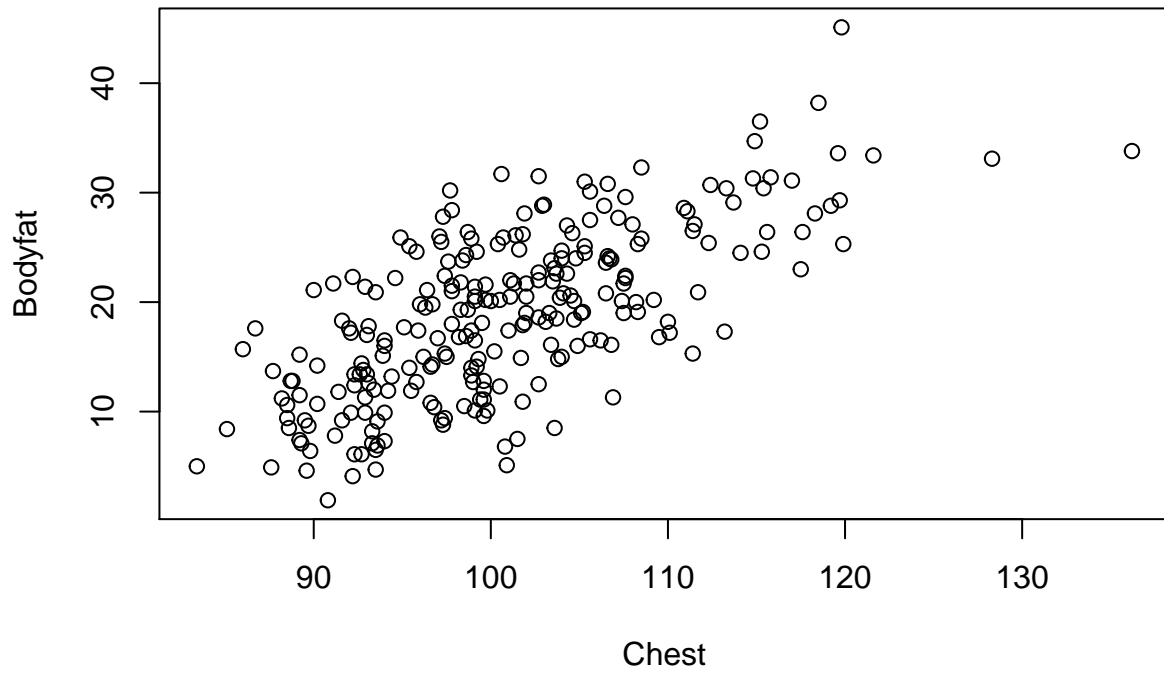
Bodyfat Vs. Knee
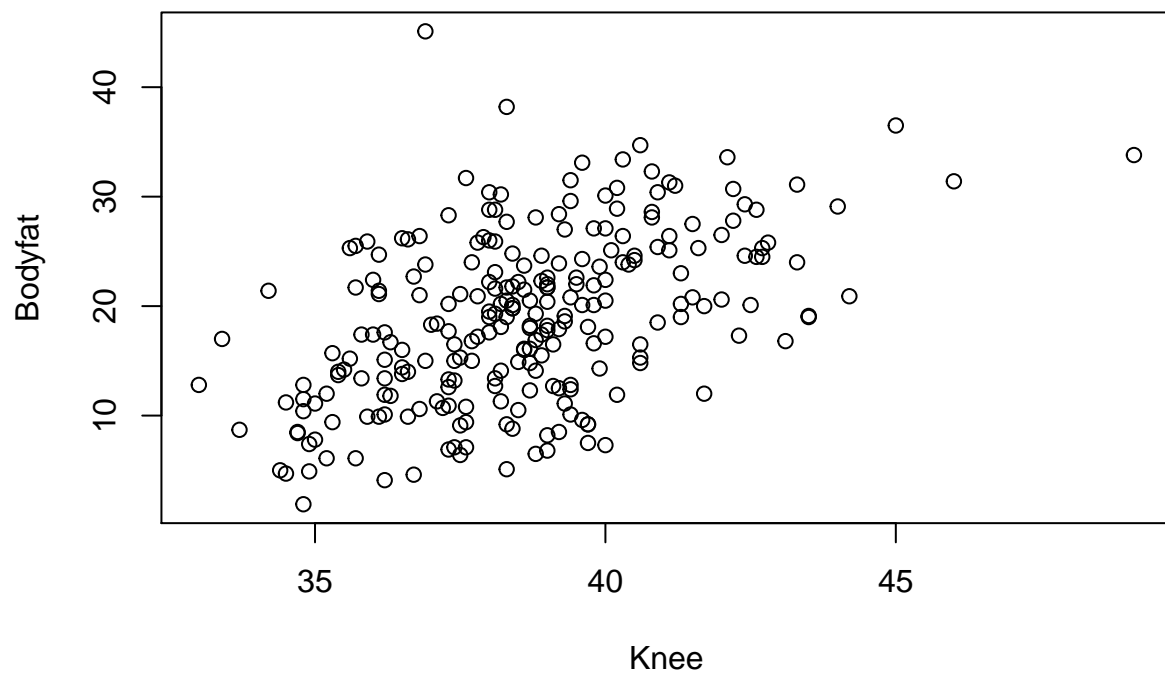
Bodyfat Vs. Ankle
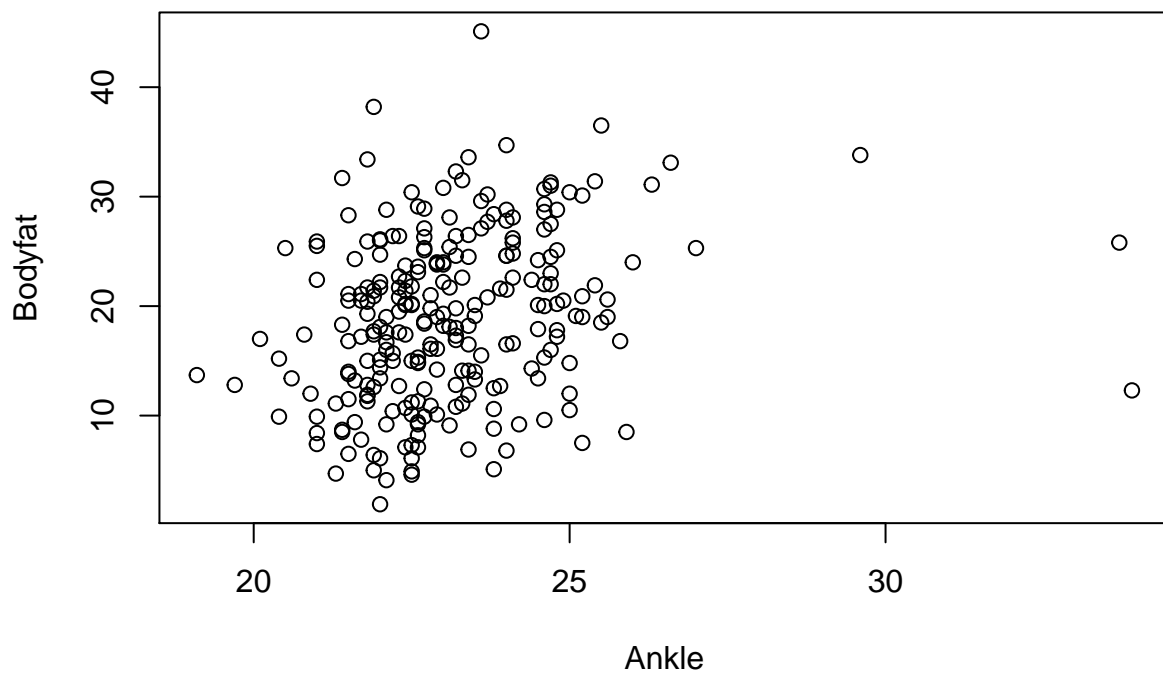
Bodyfat Vs. Biceps
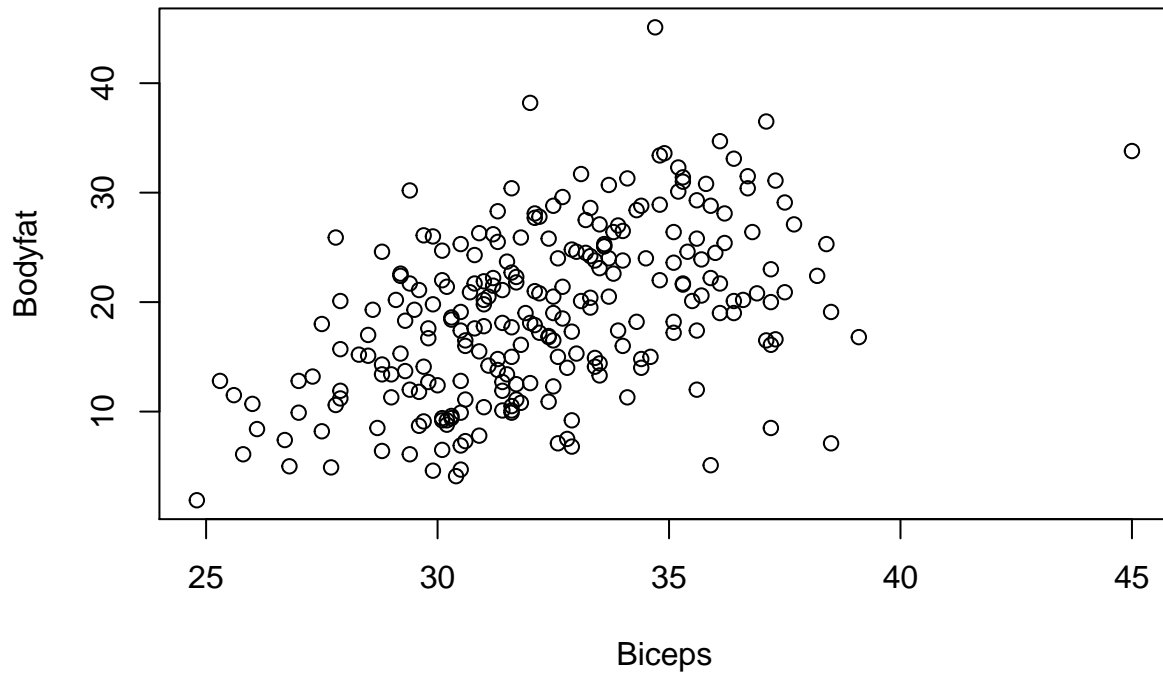
Fit a linear model without height Figure 2
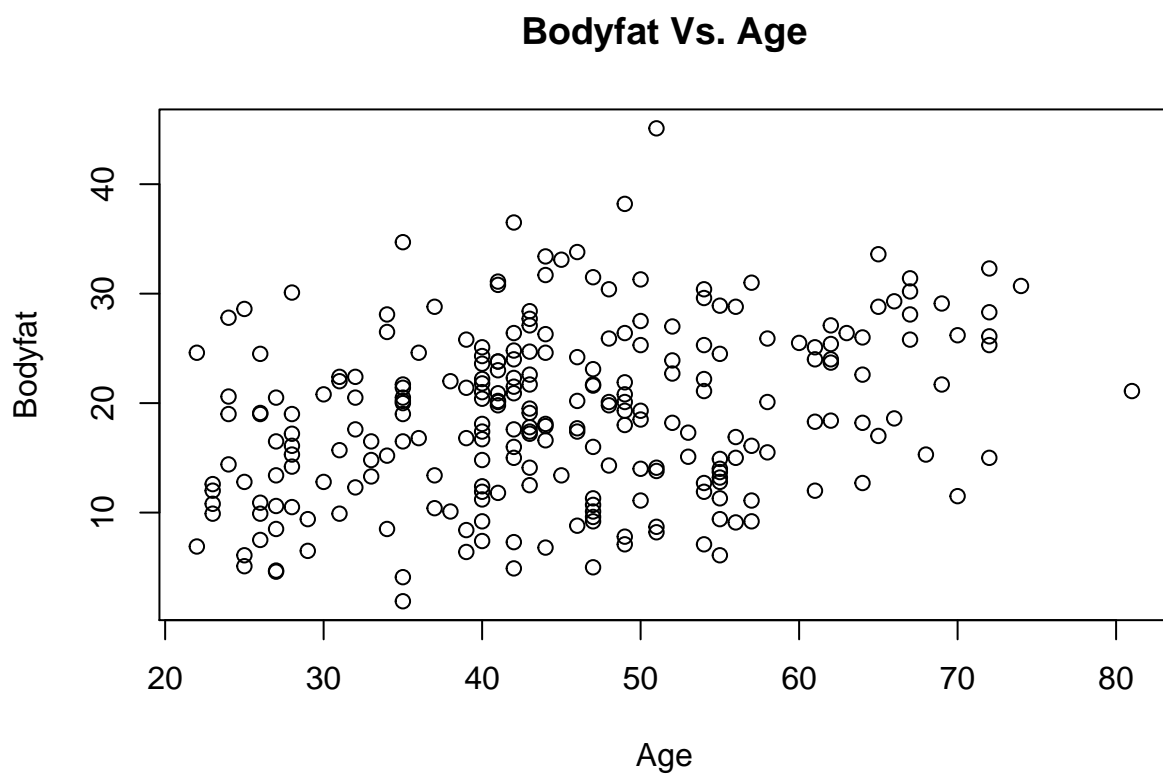
```
new1.lm = lm(Bodyfat ~ Age + Weight + BMI + Neck + Chest + Abdomen + Hip + Thigh
             + Knee + Ankle + Biceps + Forearm + Wrist)
new1.sum = summary(new1.lm)
new1.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + BMI + Neck + Chest + Abdomen +
##     Hip + Thigh + Knee + Ankle + Biceps + Forearm + Wrist)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -10.277  -2.605  -0.163   2.902   9.238
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -15.833985  14.169855  -1.117  0.26494
## Age           0.055256   0.029918   1.847  0.06601 .
## Weight       -0.084941   0.045082  -1.884  0.06077 .
## BMI           0.157594   0.239499   0.658  0.51117
## Neck         -0.436939   0.218070  -2.004  0.04625 *
## Chest        -0.050986   0.098497  -0.518  0.60519
## Abdomen       0.879453   0.085108  10.333  < 2e-16 ***
## Hip          -0.214112   0.137254  -1.560  0.12011
## Thigh         0.205946   0.135832   1.516  0.13081
```

```
## Knee            -0.004585    0.229331   -0.020   0.98407
## Ankle            0.141490    0.207258    0.683   0.49548
## Biceps           0.161964    0.159902    1.013   0.31215
## Forearm          0.410752    0.184836    2.222   0.02722 *
## Wrist           -1.486709    0.495474   -3.001   0.00298 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.986 on 236 degrees of freedom
## Multiple R-squared:  0.7424, Adjusted R-squared:  0.7282
## F-statistic: 52.32 on 13 and 236 DF,  p-value: < 2.2e-16
```

New model without ankle

```
new2.lm = lm(Bodyfat ~ Age + Weight + BMI + Neck + Chest + Abdomen + Hip + Thigh
             + Knee + Biceps + Forearm + Wrist)
new2.sum = summary(new2.lm)
new2.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + BMI + Neck + Chest + Abdomen +
##     Hip + Thigh + Knee + Biceps + Forearm + Wrist)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -10.101  -2.633  -0.170   2.827   9.169
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -13.68806   13.80122  -0.992  0.32231
## Age           0.05311    0.02972   1.787  0.07519 .
## Weight       -0.07884    0.04414  -1.786  0.07533 .
## BMI           0.18272    0.23639   0.773  0.44032
## Neck         -0.45501    0.21621  -2.104  0.03639 *
## Chest        -0.05607    0.09810  -0.572  0.56817
## Abdomen       0.87178    0.08427  10.345  < 2e-16 ***
## Hip          -0.22132    0.13669  -1.619  0.10675
## Thigh         0.20243    0.13558   1.493  0.13675
## Knee          0.02524    0.22488   0.112  0.91072
## Biceps        0.15656    0.15953   0.981  0.32738
## Forearm       0.40738    0.18456   2.207  0.02825 *
## Wrist        -1.40727    0.48107  -2.925  0.00378 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.982 on 237 degrees of freedom
## Multiple R-squared:  0.7419, Adjusted R-squared:  0.7288
## F-statistic: 56.77 on 12 and 237 DF,  p-value: < 2.2e-16
```

New linear model dropping Chest, Knee, Biceps

```
new3.lm = lm(Bodyfat ~ Age + Weight + BMI + Neck + Abdomen + Hip + Thigh +
             Forearm + Wrist)
new3.sum = summary(new3.lm)
new3.sum
```

```
## 
## Call:
## lm(formula = Bodyfat ~ Age + Weight + BMI + Neck + Abdomen +
##     Hip + Thigh + Forearm + Wrist)
## 
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10.1188  -2.7265  -0.1013   2.7409   9.3604
## 
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -15.96792   11.40076  -1.401  0.16262
## Age           0.05527    0.02874   1.923  0.05569 .
## Weight       -0.07950    0.03712  -2.142  0.03324 *
## BMI           0.15700    0.20777   0.756  0.45060
## Neck         -0.44224    0.21276  -2.079  0.03872 *
## Abdomen       0.84596    0.07900  10.709  < 2e-16 ***
## Hip          -0.21651    0.13179  -1.643  0.10173
## Thigh         0.25286    0.12188   2.075  0.03908 *
## Forearm       0.45102    0.17408   2.591  0.01016 *
## Wrist        -1.37966    0.47463  -2.907  0.00399 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 3.967 on 240 degrees of freedom
## Multiple R-squared:  0.7405, Adjusted R-squared:  0.7308
## F-statistic: 76.11 on 9 and 240 DF,  p-value: < 2.2e-16
```

Calculate F-statistic for dropping Chest, Knee, Biceps Figure 3

```
anova(new3.lm, new1.lm)
```

```
## Analysis of Variance Table
## 
## Model 1: Bodyfat ~ Age + Weight + BMI + Neck + Abdomen + Hip + Thigh +
##     Forearm + Wrist
## Model 2: Bodyfat ~ Age + Weight + BMI + Neck + Chest + Abdomen + Hip +
##     Thigh + Knee + Ankle + Biceps + Forearm + Wrist
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    240 3777.2
## 2    236 3750.0  4    27.168 0.4274 0.7888
```

BMI vs Weight
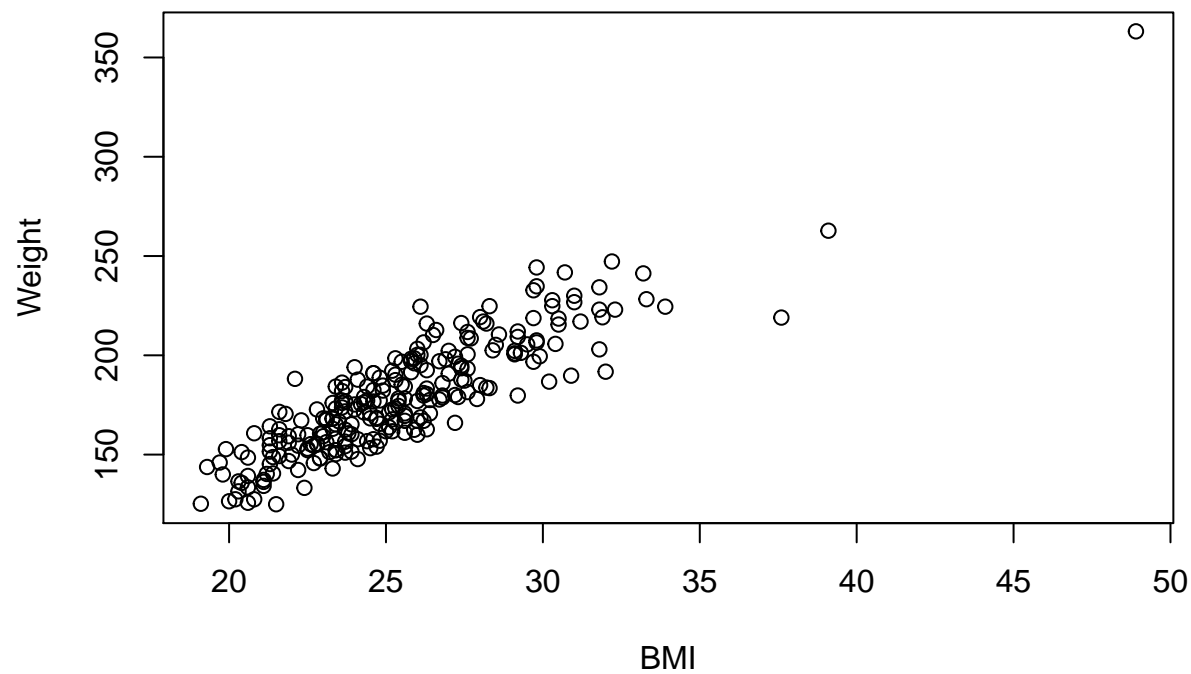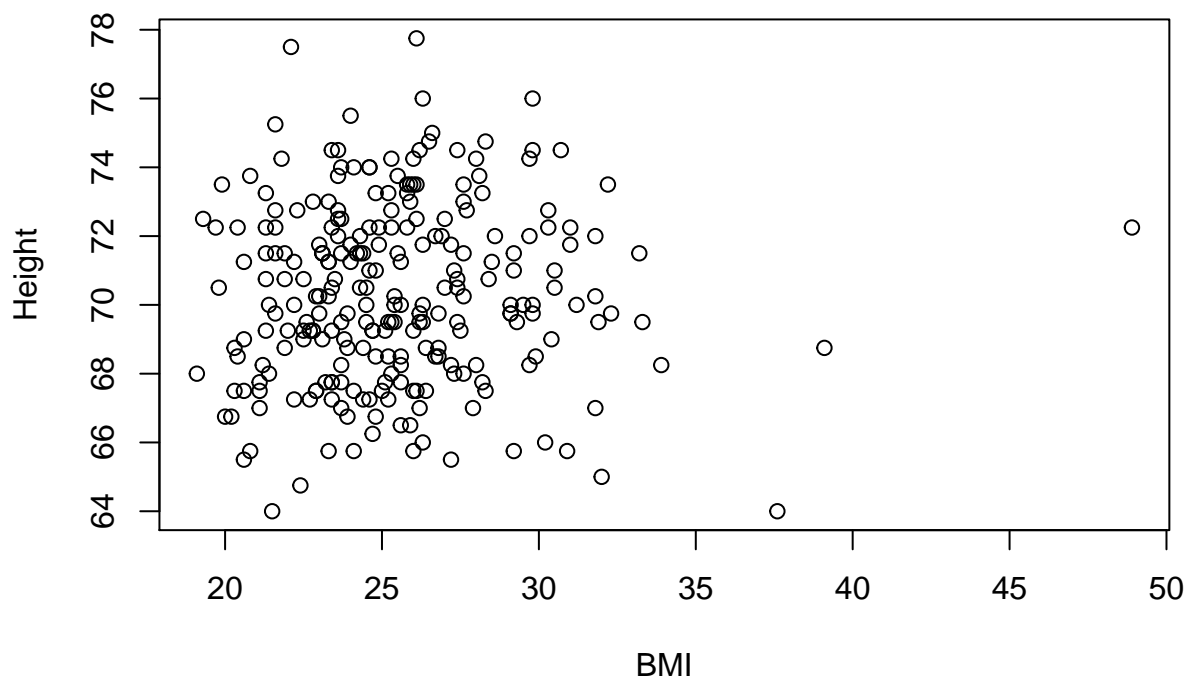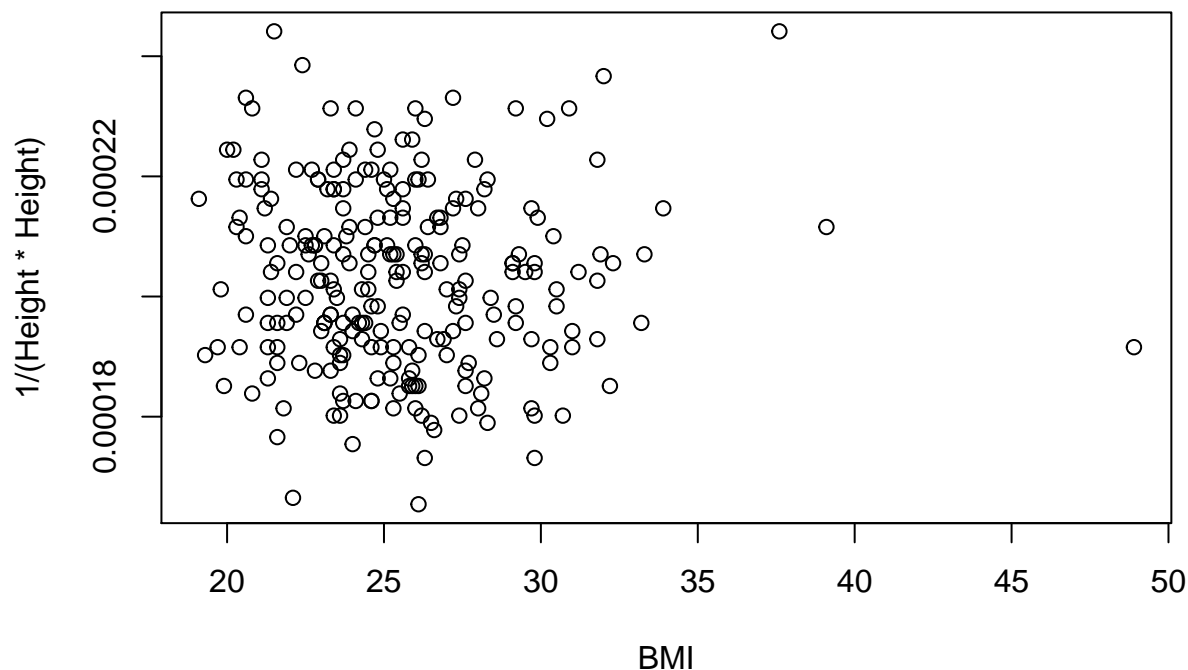
New model dropping BMI Figure 4

```
new4.lm = lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm +
             Wrist)
new4.sum = summary(new4.lm)
new4.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Neck + Abdomen + Hip +
##     Thigh + Forearm + Wrist)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -10.0756  -2.7707  -0.1871   2.7057   9.5237
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -18.46826   10.90031  -1.694  0.09150 .
## Age           0.05577    0.02871   1.943  0.05323 .
## Weight       -0.08081    0.03705  -2.181  0.03014 *
## Neck         -0.41183    0.20874  -1.973  0.04965 *
## Abdomen       0.87775    0.06680  13.140  < 2e-16 ***
## Hip          -0.20063    0.12999  -1.543  0.12404
## Thigh         0.26719    0.12028   2.221  0.02726 *
## Forearm       0.46567    0.17285   2.694  0.00755 **
## Wrist        -1.39341    0.47386  -2.941  0.00359 **
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.964 on 241 degrees of freedom
## Multiple R-squared:  0.7399, Adjusted R-squared:  0.7313
## F-statistic:  85.7 on 8 and 241 DF,  p-value: < 2.2e-16
```

Calculate F-statistic for dropping BMI

```
anova(new4.lm, new3.lm)
```

```
## Analysis of Variance Table
##
## Model 1: Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm +
##     Wrist
## Model 2: Bodyfat ~ Age + Weight + BMI + Neck + Abdomen + Hip + Thigh +
##     Forearm + Wrist
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    241 3786.2
## 2    240 3777.2  1    8.9866 0.571 0.4506
```

Running best subsets on full linear model Figure 5

```
library("leaps")
```

```
## Warning: package 'leaps' was built under R version 3.5.3
```

```
bestall = regsubsets(Bodyfat ~ Age + Weight + Height + BMI + Neck + Chest +
                     Abdomen + Hip + Thigh + Knee + Ankle + Biceps + Forearm +
                     Wrist, data = bodyfatDF[,2:15], nbest = 1, nvmax=15)
bestall.sum = summary(bestall)
bestall.sum$which
```

```
##    (Intercept)  Age Weight Height   BMI  Neck Chest Abdomen   Hip Thigh
## 1         TRUE FALSE  FALSE  FALSE FALSE FALSE FALSE    TRUE FALSE FALSE
## 2         TRUE FALSE   TRUE  FALSE FALSE FALSE FALSE    TRUE FALSE FALSE
## 3         TRUE FALSE   TRUE  FALSE FALSE FALSE FALSE    TRUE FALSE FALSE
## 4         TRUE FALSE   TRUE  FALSE FALSE FALSE FALSE    TRUE FALSE FALSE
## 5         TRUE FALSE   TRUE  FALSE FALSE  TRUE FALSE    TRUE FALSE FALSE
## 6         TRUE FALSE   TRUE  FALSE FALSE  TRUE FALSE    TRUE FALSE FALSE
## 7         TRUE  TRUE   TRUE  FALSE FALSE  TRUE FALSE    TRUE FALSE  TRUE
## 8         TRUE  TRUE   TRUE  FALSE FALSE  TRUE FALSE    TRUE  TRUE  TRUE
## 9         TRUE  TRUE   TRUE  FALSE FALSE  TRUE FALSE    TRUE  TRUE  TRUE
## 10        TRUE  TRUE   TRUE  FALSE FALSE  TRUE FALSE    TRUE  TRUE  TRUE
## 11        TRUE  TRUE   TRUE   TRUE  TRUE  TRUE FALSE    TRUE  TRUE  TRUE
## 12        TRUE  TRUE   TRUE   TRUE  TRUE  TRUE  TRUE    TRUE  TRUE  TRUE
## 13        TRUE  TRUE   TRUE   TRUE  TRUE  TRUE  TRUE    TRUE  TRUE  TRUE
## 14        TRUE  TRUE   TRUE   TRUE  TRUE  TRUE  TRUE    TRUE  TRUE  TRUE
##     Knee Ankle Biceps Forearm Wrist
## 1  FALSE FALSE  FALSE   FALSE FALSE
## 2  FALSE FALSE  FALSE   FALSE FALSE
## 3  FALSE FALSE  FALSE   FALSE  TRUE
## 4  FALSE FALSE  FALSE    TRUE  TRUE
## 5  FALSE FALSE  FALSE    TRUE  TRUE
## 6  FALSE FALSE   TRUE    TRUE  TRUE
## 7  FALSE FALSE  FALSE    TRUE  TRUE
## 8  FALSE FALSE  FALSE    TRUE  TRUE
```

```
## 9  FALSE FALSE    TRUE    TRUE   TRUE
## 10 FALSE  TRUE    TRUE    TRUE   TRUE
## 11 FALSE FALSE    TRUE    TRUE   TRUE
## 12 FALSE FALSE    TRUE    TRUE   TRUE
## 13 FALSE  TRUE    TRUE    TRUE   TRUE
## 14  TRUE  TRUE    TRUE    TRUE   TRUE
```

```r
cbind(bestall.sum$rsq, bestall.sum$adjr2, bestall.sum$cp)
```

```
##             [,1]      [,2]       [,3]
##  [1,] 0.6544848 0.6530916 70.186605
##  [2,] 0.7133475 0.7110264 18.320404
##  [3,] 0.7218054 0.7184128 12.580385
##  [4,] 0.7291333 0.7247110  7.874507
##  [5,] 0.7316391 0.7261399  7.581443
##  [6,] 0.7342576 0.7276961  7.185159
##  [7,] 0.7373402 0.7297426  6.364294
##  [8,] 0.7399110 0.7312774  6.011651
##  [9,] 0.7411428 0.7314357  6.884436
## [10,] 0.7418156 0.7310129  8.268787
## [11,] 0.7423393 0.7304307  9.789467
## [12,] 0.7428117 0.7297895 11.357206
## [13,] 0.7431988 0.7290529 13.002996
## [14,] 0.7432020 0.7279034 15.000000
```

```r
anova(new4.lm, all.lm)
```

```
## Analysis of Variance Table
##
## Model 1: Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm +
##     Wrist
## Model 2: Bodyfat ~ Age + Weight + Height + BMI + Neck + Chest + Abdomen +
##     Hip + Thigh + Knee + Ankle + Biceps + Forearm + Wrist
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    241 3786.2
## 2    235 3738.3  6    47.908 0.5019 0.8066
```

Calculating the linear models for all interactions of Body Measurements

```
NeckAbdomen = Neck*Abdomen
NeckHip = Neck*Hip
NeckThigh = Neck*Thigh
NeckForearm = Neck*Forearm
NeckWrist = Neck*Wrist
AbdomenHip = Abdomen*Hip
AbdomenThigh = Abdomen*Thigh
AbdomenForearm = Abdomen*Forearm
AbdomenWrist = Abdomen*Wrist
HipThigh = Hip*Thigh
HipForearm = Hip*Forearm
HipWrist = Hip*Wrist
ThighForearm = Thigh*Forearm
ThighWrist = Thigh*Wrist
ForearmWrist = Forearm*Wrist
Neck2 = Neck^2
Abdomen2 = Abdomen^2
```

```
Hip2 = Hip^2
Thigh2 = Thigh^2
Forearm2 = Forearm^2
Wrist2 = Wrist^2
logNeck = log(Neck)
logAbdomen = log(Abdomen)
logHip = log(Hip)
logThigh = log(Thigh)
logForearm = log(Forearm)
logWrist = log(Wrist)

interactions.lm = lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh +
                      Forearm + Wrist + NeckAbdomen + NeckHip + NeckThigh +
                      NeckForearm + NeckWrist + AbdomenHip + AbdomenThigh +
                      AbdomenForearm + AbdomenWrist + HipThigh + HipForearm +
                      HipWrist + ThighForearm + ThighWrist + ForearmWrist +
                      Neck2 + Abdomen2 + Hip2 + Thigh2 + Forearm2 + Wrist2 +
                      logNeck + logAbdomen + logHip + logThigh + logForearm +
                      logWrist)

interactions.sum = summary(interactions.lm)
interactions.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Neck + Abdomen + Hip +
##     Thigh + Forearm + Wrist + NeckAbdomen + NeckHip + NeckThigh +
##     NeckForearm + NeckWrist + AbdomenHip + AbdomenThigh + AbdomenForearm +
##     AbdomenWrist + HipThigh + HipForearm + HipWrist + ThighForearm +
##     ThighWrist + ForearmWrist + Neck2 + Abdomen2 + Hip2 + Thigh2 +
##     Forearm2 + Wrist2 + logNeck + logAbdomen + logHip + logThigh +
##     logForearm + logWrist)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.4632 -2.1526 -0.1828  2.1902  8.3718
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -4.690e+03  5.353e+03  -0.876  0.38188
## Age             5.598e-02  2.980e-02   1.879  0.06164 .
## Weight         -7.498e-02  4.047e-02  -1.853  0.06530 .
## Neck           -6.842e+01  9.505e+01  -0.720  0.47243
## Abdomen         3.671e+00  1.026e+01   0.358  0.72070
## Hip             1.278e+01  3.294e+01   0.388  0.69838
## Thigh          -6.217e+01  3.290e+01  -1.890  0.06016 .
## Forearm         5.733e+01  5.642e+01   1.016  0.31071
## Wrist          -2.730e+01  3.995e+02  -0.068  0.94557
## NeckAbdomen     5.458e-02  4.812e-02   1.134  0.25795
## NeckHip         5.876e-05  1.033e-01   0.001  0.99955
## NeckThigh      -1.942e-01  1.026e-01  -1.894  0.05959 .
## NeckForearm     3.208e-01  1.762e-01   1.821  0.07007 .
## NeckWrist      -1.128e+00  4.170e-01  -2.705  0.00737 **
## AbdomenHip      3.215e-02  2.971e-02   1.082  0.28039
```

```
## AbdomenThigh      1.911e-02  2.738e-02   0.698  0.48600
## AbdomenForearm   -1.118e-01  5.360e-02  -2.086  0.03818 *
## AbdomenWrist      2.101e-01  1.066e-01   1.971  0.05004 .
## HipThigh         -3.723e-02  6.089e-02  -0.611  0.54156
## HipForearm        1.605e-01  1.063e-01   1.510  0.13257
## HipWrist         -3.159e-01  2.010e-01  -1.571  0.11760
## ThighForearm      2.595e-02  1.088e-01   0.238  0.81174
## ThighWrist        3.395e-01  2.244e-01   1.513  0.13169
## ForearmWrist     -9.816e-01  3.813e-01  -2.575  0.01071 *
## Neck2             6.807e-01  6.697e-01   1.016  0.31064
## Abdomen2         -3.375e-02  2.725e-02  -1.238  0.21693
## Hip2             -4.349e-02  8.126e-02  -0.535  0.59305
## Thigh2            2.651e-01  1.358e-01   1.952  0.05219 .
## Forearm2         -5.159e-01  5.226e-01  -0.987  0.32464
## Wrist2            2.064e+00  5.366e+00   0.385  0.70083
## logNeck           1.302e+03  1.809e+03   0.720  0.47251
## logAbdomen       -3.360e+02  4.631e+02  -0.726  0.46889
## logHip           -3.780e+02  1.694e+03  -0.223  0.82363
## logThigh          1.974e+03  9.777e+02   2.019  0.04477 *
## logForearm       -8.270e+02  8.144e+02  -1.015  0.31107
## logWrist          2.373e+02  3.695e+03   0.064  0.94885
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.813 on 214 degrees of freedom
## Multiple R-squared:  0.7862,	Adjusted R-squared:  0.7513
## F-statistic: 22.49 on 35 and 214 DF,  p-value: < 2.2e-16
```

Best Subsets on the interactions

```
interactDF = as.data.frame(cbind(Age, Weight, Neck, Abdomen, Hip, Thigh, Forearm,
                                 Wrist, NeckAbdomen, NeckHip, NeckThigh, NeckForearm,
                                 NeckWrist, AbdomenHip, AbdomenThigh, AbdomenForearm,
                                 AbdomenWrist, HipThigh, HipForearm, HipWrist,
                                 ThighForearm, ThighWrist, ForearmWrist, Neck2,
                                 Abdomen2, Hip2, Thigh2, Forearm2, Wrist2, logNeck,
                                 logAbdomen, logHip, logThigh, logForearm, logWrist))


interactbest = regsubsets(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh +
                             Forearm + Wrist + NeckAbdomen + NeckHip + NeckThigh +
                             NeckForearm + NeckWrist + AbdomenHip + AbdomenThigh +
                             AbdomenForearm + AbdomenWrist + HipThigh + HipForearm +
                             HipWrist + ThighForearm + ThighWrist + ForearmWrist +
                             Neck2 + Abdomen2 + Hip2 + Thigh2 + Forearm2 + Wrist2 +
                             logNeck + logAbdomen + logHip + logThigh + logForearm +
                             logWrist, data = interactDF, nbest = 1, nvmax=35)
interactbest.sum = summary(interactbest)
interactbest.sum$which
```

```
##   (Intercept)   Age Weight  Neck Abdomen   Hip Thigh Forearm Wrist
## 1        TRUE FALSE  FALSE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 2        TRUE FALSE  FALSE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 3        TRUE FALSE  FALSE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 4        TRUE FALSE   TRUE FALSE   FALSE FALSE FALSE   FALSE FALSE
```

```
## 5          TRUE TRUE FALSE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 6          TRUE TRUE  TRUE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 7          TRUE TRUE  TRUE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 8          TRUE TRUE  TRUE FALSE   FALSE FALSE  TRUE   FALSE FALSE
## 9          TRUE TRUE  TRUE FALSE   FALSE FALSE  TRUE   FALSE FALSE
## 10         TRUE TRUE  TRUE FALSE   FALSE FALSE  TRUE   FALSE FALSE
## 11         TRUE TRUE  TRUE FALSE   FALSE FALSE FALSE    TRUE FALSE
## 12         TRUE TRUE  TRUE  TRUE   FALSE FALSE FALSE    TRUE FALSE
## 13         TRUE TRUE  TRUE FALSE   FALSE FALSE FALSE    TRUE  TRUE
## 14         TRUE TRUE  TRUE FALSE   FALSE FALSE FALSE   FALSE FALSE
## 15         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 16         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 17         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 18         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 19         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 20         TRUE TRUE FALSE FALSE   FALSE  TRUE  TRUE   FALSE FALSE
## 21         TRUE TRUE  TRUE FALSE   FALSE  TRUE  TRUE   FALSE FALSE
## 22         TRUE TRUE  TRUE FALSE   FALSE  TRUE  TRUE   FALSE FALSE
## 23         TRUE TRUE  TRUE FALSE    TRUE  TRUE  TRUE   FALSE FALSE
## 24         TRUE TRUE  TRUE FALSE    TRUE FALSE  TRUE   FALSE FALSE
## 25         TRUE TRUE  TRUE FALSE   FALSE  TRUE  TRUE    TRUE FALSE
## 26         TRUE TRUE  TRUE FALSE   FALSE FALSE  TRUE    TRUE FALSE
## 27         TRUE TRUE  TRUE FALSE   FALSE  TRUE  TRUE    TRUE FALSE
## 28         TRUE TRUE  TRUE FALSE    TRUE  TRUE  TRUE    TRUE FALSE
## 29         TRUE TRUE  TRUE  TRUE   FALSE  TRUE  TRUE    TRUE FALSE
## 30         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE FALSE
## 31         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE FALSE
## 32         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE FALSE
## 33         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE  TRUE
## 34         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE  TRUE
## 35         TRUE TRUE  TRUE  TRUE    TRUE  TRUE  TRUE    TRUE  TRUE
##    NeckAbdomen NeckHip NeckThigh NeckForearm NeckWrist AbdomenHip
## 1        FALSE   FALSE     FALSE       FALSE     FALSE      FALSE
## 2        FALSE   FALSE     FALSE       FALSE     FALSE      FALSE
## 3        FALSE   FALSE     FALSE       FALSE     FALSE      FALSE
## 4        FALSE   FALSE     FALSE       FALSE     FALSE      FALSE
## 5         TRUE   FALSE      TRUE       FALSE     FALSE      FALSE
## 6        FALSE   FALSE     FALSE       FALSE     FALSE      FALSE
## 7        FALSE    TRUE     FALSE       FALSE     FALSE      FALSE
## 8         TRUE   FALSE      TRUE       FALSE     FALSE      FALSE
## 9        FALSE   FALSE      TRUE       FALSE      TRUE      FALSE
## 10       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 11       FALSE   FALSE      TRUE       FALSE     FALSE      FALSE
## 12       FALSE   FALSE      TRUE       FALSE     FALSE       TRUE
## 13        TRUE   FALSE      TRUE       FALSE      TRUE      FALSE
## 14        TRUE   FALSE      TRUE       FALSE      TRUE      FALSE
## 15       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 16       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 17       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 18       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 19       FALSE   FALSE      TRUE        TRUE      TRUE      FALSE
## 20       FALSE   FALSE      TRUE        TRUE      TRUE       TRUE
## 21       FALSE   FALSE      TRUE        TRUE      TRUE       TRUE
## 22        TRUE   FALSE      TRUE        TRUE      TRUE       TRUE
```

```
## 23          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 24          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 25          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 26          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 27          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 28          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 29          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 30          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 31          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 32          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 33          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 34          TRUE   FALSE      TRUE         TRUE         TRUE         TRUE
## 35          TRUE    TRUE      TRUE         TRUE         TRUE         TRUE
##      AbdomenThigh AbdomenForearm AbdomenWrist HipThigh HipForearm HipWrist
## 1          FALSE          FALSE        FALSE    FALSE      FALSE    FALSE
## 2          FALSE          FALSE        FALSE    FALSE      FALSE     TRUE
## 3          FALSE          FALSE         TRUE    FALSE      FALSE     TRUE
## 4          FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 5          FALSE          FALSE        FALSE    FALSE      FALSE     TRUE
## 6          FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 7          FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 8          FALSE          FALSE        FALSE    FALSE      FALSE    FALSE
## 9          FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 10         FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 11         FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 12         FALSE          FALSE         TRUE    FALSE      FALSE    FALSE
## 13         FALSE          FALSE        FALSE    FALSE      FALSE    FALSE
## 14          TRUE          FALSE        FALSE    FALSE      FALSE    FALSE
## 15         FALSE          FALSE         TRUE    FALSE      FALSE     TRUE
## 16         FALSE          FALSE         TRUE    FALSE      FALSE     TRUE
## 17         FALSE          FALSE         TRUE    FALSE      FALSE     TRUE
## 18         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 19          TRUE           TRUE         TRUE    FALSE       TRUE     TRUE
## 20         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 21         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 22         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 23         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 24          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 25         FALSE           TRUE         TRUE    FALSE       TRUE     TRUE
## 26          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 27          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 28          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 29          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 30          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 31          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 32          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 33          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 34          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
## 35          TRUE           TRUE         TRUE     TRUE       TRUE     TRUE
##      ThighForearm ThighWrist ForearmWrist Neck2 Abdomen2  Hip2 Thigh2
## 1          FALSE      FALSE        FALSE FALSE    FALSE FALSE  FALSE
## 2          FALSE      FALSE        FALSE FALSE    FALSE FALSE  FALSE
## 3          FALSE      FALSE        FALSE FALSE    FALSE FALSE  FALSE
## 4          FALSE       TRUE        FALSE FALSE    FALSE FALSE  FALSE
```

```
## 5        FALSE       FALSE        FALSE FALSE      FALSE FALSE   FALSE
## 6        FALSE        TRUE        FALSE FALSE      FALSE FALSE   FALSE
## 7        FALSE        TRUE        FALSE FALSE      FALSE FALSE   FALSE
## 8        FALSE       FALSE         TRUE FALSE       TRUE FALSE   FALSE
## 9        FALSE       FALSE        FALSE  TRUE      FALSE FALSE   FALSE
## 10       FALSE       FALSE         TRUE  TRUE      FALSE FALSE   FALSE
## 11        TRUE       FALSE         TRUE  TRUE      FALSE FALSE   FALSE
## 12        TRUE       FALSE         TRUE  TRUE      FALSE FALSE   FALSE
## 13        TRUE       FALSE         TRUE  TRUE       TRUE FALSE   FALSE
## 14        TRUE       FALSE         TRUE  TRUE       TRUE FALSE   FALSE
## 15       FALSE       FALSE         TRUE  TRUE      FALSE FALSE    TRUE
## 16       FALSE       FALSE         TRUE  TRUE      FALSE FALSE    TRUE
## 17        TRUE       FALSE         TRUE  TRUE      FALSE FALSE    TRUE
## 18       FALSE        TRUE         TRUE  TRUE      FALSE FALSE    TRUE
## 19       FALSE        TRUE         TRUE  TRUE      FALSE FALSE    TRUE
## 20       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 21       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 22       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 23       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 24       FALSE        TRUE         TRUE  TRUE       TRUE FALSE    TRUE
## 25       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 26       FALSE        TRUE         TRUE  TRUE       TRUE FALSE    TRUE
## 27       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 28       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 29       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 30       FALSE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 31        TRUE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 32        TRUE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 33        TRUE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 34        TRUE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
## 35        TRUE        TRUE         TRUE  TRUE       TRUE  TRUE    TRUE
##     Forearm2 Wrist2 logNeck logAbdomen logHip logThigh logForearm logWrist
## 1     FALSE  FALSE   FALSE       TRUE  FALSE    FALSE      FALSE    FALSE
## 2     FALSE  FALSE   FALSE       TRUE  FALSE    FALSE      FALSE    FALSE
## 3     FALSE  FALSE   FALSE      FALSE   TRUE    FALSE      FALSE    FALSE
## 4     FALSE  FALSE   FALSE      FALSE  FALSE     TRUE      FALSE    FALSE
## 5     FALSE  FALSE   FALSE      FALSE  FALSE     TRUE      FALSE    FALSE
## 6      TRUE  FALSE   FALSE      FALSE  FALSE     TRUE      FALSE    FALSE
## 7      TRUE  FALSE   FALSE      FALSE  FALSE     TRUE      FALSE    FALSE
## 8      TRUE  FALSE   FALSE      FALSE  FALSE    FALSE      FALSE    FALSE
## 9      TRUE   TRUE   FALSE      FALSE  FALSE    FALSE      FALSE    FALSE
## 10    FALSE   TRUE   FALSE      FALSE  FALSE    FALSE      FALSE    FALSE
## 11    FALSE   TRUE    TRUE      FALSE  FALSE     TRUE      FALSE    FALSE
## 12    FALSE   TRUE   FALSE      FALSE  FALSE     TRUE      FALSE    FALSE
## 13    FALSE  FALSE   FALSE      FALSE  FALSE     TRUE      FALSE     TRUE
## 14     TRUE   TRUE   FALSE       TRUE  FALSE     TRUE      FALSE    FALSE
## 15    FALSE   TRUE   FALSE      FALSE   TRUE     TRUE      FALSE    FALSE
## 16     TRUE   TRUE   FALSE      FALSE   TRUE     TRUE      FALSE    FALSE
## 17     TRUE   TRUE   FALSE      FALSE   TRUE     TRUE      FALSE    FALSE
## 18    FALSE   TRUE   FALSE      FALSE   TRUE     TRUE      FALSE    FALSE
## 19    FALSE   TRUE   FALSE      FALSE   TRUE     TRUE      FALSE    FALSE
## 20    FALSE   TRUE   FALSE       TRUE  FALSE     TRUE      FALSE    FALSE
## 21    FALSE   TRUE   FALSE       TRUE  FALSE     TRUE      FALSE    FALSE
## 22    FALSE   TRUE   FALSE       TRUE  FALSE     TRUE      FALSE    FALSE
```

```
## 23    FALSE    TRUE    FALSE    TRUE   FALSE    TRUE    FALSE    FALSE
## 24    FALSE    TRUE    FALSE    TRUE    TRUE    TRUE    FALSE    FALSE
## 25     TRUE    TRUE    FALSE    TRUE   FALSE    TRUE     TRUE    FALSE
## 26     TRUE    TRUE    FALSE    TRUE    TRUE    TRUE     TRUE    FALSE
## 27     TRUE    TRUE    FALSE    TRUE   FALSE    TRUE     TRUE    FALSE
## 28     TRUE    TRUE    FALSE    TRUE   FALSE    TRUE     TRUE    FALSE
## 29     TRUE    TRUE     TRUE    TRUE   FALSE    TRUE     TRUE    FALSE
## 30     TRUE    TRUE     TRUE    TRUE   FALSE    TRUE     TRUE    FALSE
## 31     TRUE    TRUE     TRUE    TRUE   FALSE    TRUE     TRUE    FALSE
## 32     TRUE    TRUE     TRUE    TRUE    TRUE    TRUE     TRUE    FALSE
## 33     TRUE    TRUE     TRUE    TRUE    TRUE    TRUE     TRUE    FALSE
## 34     TRUE    TRUE     TRUE    TRUE    TRUE    TRUE     TRUE     TRUE
## 35     TRUE    TRUE     TRUE    TRUE    TRUE    TRUE     TRUE     TRUE
```

```r
cbind(bestall.sum$rsq, bestall.sum$adjr2, bestall.sum$cp)
```

```
##           [,1]      [,2]       [,3]
##  [1,] 0.6544848 0.6530916 70.186605
##  [2,] 0.7133475 0.7110264 18.320404
##  [3,] 0.7218054 0.7184128 12.580385
##  [4,] 0.7291333 0.7247110  7.874507
##  [5,] 0.7316391 0.7261399  7.581443
##  [6,] 0.7342576 0.7276961  7.185159
##  [7,] 0.7373402 0.7297426  6.364294
##  [8,] 0.7399110 0.7312774  6.011651
##  [9,] 0.7411428 0.7314357  6.884436
## [10,] 0.7418156 0.7310129  8.268787
## [11,] 0.7423393 0.7304307  9.789467
## [12,] 0.7428117 0.7297895 11.357206
## [13,] 0.7431988 0.7290529 13.002996
## [14,] 0.7432020 0.7279034 15.000000
```

```r
maxradj = which.max(bestall.sum$adjr2)
mincp = which.min(bestall.sum$cp)
maxradj
```

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

```r
mincp
```

```
## [1] 8
```

Fit linear model for the best subsets

```r
subsets.lm = lm(Bodyfat ~ Age + Weight + Thigh + Neck + Abdomen + Forearm +
                  Wrist + NeckAbdomen + NeckThigh + ForearmWrist + Abdomen2 +
                  Forearm2)
subsets.sum = summary(subsets.lm)
subsets.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Thigh + Neck + Abdomen +
##     Forearm + Wrist + NeckAbdomen + NeckThigh + ForearmWrist +
##     Abdomen2 + Forearm2)
##
## Residuals:
##     Min     1Q Median     3Q    Max
```

```
## -9.941 -2.477 -0.218  2.562  9.314
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -1.394e+02  5.642e+01  -2.472 0.014155 *
## Age           5.739e-02  2.801e-02   2.049 0.041563 *
## Weight       -9.440e-02  3.231e-02  -2.922 0.003819 **
## Thigh         4.906e+00  1.317e+00   3.724 0.000245 ***
## Neck         -1.993e-01  1.360e+00  -0.147 0.883580
## Abdomen      -7.867e-01  6.513e-01  -1.208 0.228292
## Forearm       8.256e-01  2.644e+00   0.312 0.755145
## Wrist         2.732e+00  3.069e+00   0.890 0.374257
## NeckAbdomen   7.670e-02  2.329e-02   3.293 0.001144 **
## NeckThigh    -1.226e-01  3.388e-02  -3.617 0.000364 ***
## ForearmWrist -1.495e-01  1.064e-01  -1.405 0.161376
## Abdomen2     -6.997e-03  3.041e-03  -2.301 0.022272 *
## Forearm2      4.079e-02  3.891e-02   1.048 0.295580
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.839 on 237 degrees of freedom
## Multiple R-squared:   0.76,  Adjusted R-squared:  0.7479
## F-statistic: 62.55 on 12 and 237 DF,  p-value: < 2.2e-16
```

Stepwise Regression on all regressions

```
model0 = lm(Bodyfat ~ 1, data = interactDF)
model1 = lm(Bodyfat ~ ., data = interactDF)
step(model0, scope = list(lower=model0, upper=model1), direction="both")
```

```
## Start:  AIC=1018.1
## Bodyfat ~ 1
##
##                  Df Sum of Sq     RSS     AIC
## + logAbdomen      1    9711.7  4845.6  745.09
## + Abdomen         1    9527.6  5029.8  754.42
## + Abdomen2        1    9109.4  5447.9  774.38
## + AbdomenHip      1    7913.8  6643.6  823.99
## + AbdomenForearm  1    7706.2  6851.1  831.68
## + NeckAbdomen     1    7683.5  6873.9  832.51
## + AbdomenThigh    1    7582.7  6974.6  836.14
## + AbdomenWrist    1    7558.3  6999.0  837.02
## + logHip          1    5662.9  8894.5  896.93
## + Hip             1    5467.3  9090.0  902.37
## + Weight          1    5307.3  9250.0  906.73
## + Hip2            1    5164.5  9392.9  910.56
## + NeckHip         1    4915.2  9642.1  917.11
## + HipThigh        1    4837.7  9719.6  919.11
## + NeckThigh       1    4455.8 10101.6  928.75
## + logThigh        1    4443.6 10113.7  929.05
## + HipForearm      1    4372.9 10184.4  930.79
## + Thigh           1    4322.2 10235.2  932.03
## + HipWrist        1    4308.0 10249.4  932.38
## + Thigh2          1    4141.3 10416.0  936.41
## + ThighWrist      1    3947.7 10609.6  941.01
```

```
## + ThighForearm   1    3852.3 10705.0  943.25
## + Neck           1    3497.8 11059.5  951.40
## + logNeck        1    3487.8 11069.6  951.62
## + Neck2          1    3469.3 11088.1  952.04
## + NeckForearm    1    3113.0 11444.3  959.95
## + NeckWrist      1    2986.0 11571.4  962.71
## + ForearmWrist   1    2201.4 12356.0  979.11
## + Forearm2       1    1820.7 12736.6  986.69
## + Forearm        1    1809.1 12748.3  986.92
## + logForearm     1    1769.6 12787.7  987.69
## + Wrist2         1    1745.7 12811.7  988.16
## + Wrist          1    1724.8 12832.5  988.57
## + logWrist       1    1700.8 12856.5  989.04
## + Age            1    1232.9 13324.4  997.97
## <none>                       14557.3 1018.10
##
## Step:  AIC=745.09
## Bodyfat ~ logAbdomen
##
##                  Df Sum of Sq     RSS    AIC
## + HipWrist        1     862.9  3982.8  698.07
## + Weight          1     777.2  4068.4  703.39
## + NeckWrist       1     772.5  4073.1  703.68
## + NeckHip         1     734.7  4110.9  705.99
## + AbdomenWrist    1     649.3  4196.4  711.13
## + Wrist2          1     644.7  4201.0  711.40
## + Wrist           1     639.9  4205.7  711.68
## + logWrist        1     632.5  4213.1  712.12
## + ThighWrist      1     596.1  4249.5  714.28
## + Neck2           1     538.1  4307.6  717.67
## + Neck            1     514.1  4331.5  719.05
## + NeckThigh       1     495.8  4349.8  720.11
## + NeckAbdomen     1     490.4  4355.3  720.42
## + logNeck         1     485.5  4360.2  720.70
## + Hip2            1     444.3  4401.4  723.05
## + Hip             1     429.5  4416.1  723.89
## + logHip          1     395.0  4450.7  725.84
## + HipThigh        1     346.1  4499.5  728.57
## + ForearmWrist    1     338.1  4507.5  729.01
## + AbdomenHip      1     329.6  4516.0  729.48
## + NeckForearm     1     292.3  4553.3  731.54
## + HipForearm      1     276.7  4568.9  732.39
## + AbdomenThigh    1     232.2  4613.5  734.82
## + Thigh2          1     218.1  4627.6  735.58
## + ThighForearm    1     193.0  4652.6  736.93
## + Thigh           1     183.8  4661.8  737.42
## + logThigh        1     150.2  4695.4  739.22
## + Age             1     146.1  4699.6  739.44
## + AbdomenForearm  1      91.3  4754.3  742.34
## + Forearm2        1      83.3  4762.4  742.76
## + Forearm         1      77.5  4768.1  743.06
## + logForearm      1      70.4  4775.2  743.43
## + Abdomen2        1      42.7  4803.0  744.88
## <none>                        4845.6  745.09
```

```
## + Abdomen          1       32.0  4813.7  745.44
## - logAbdomen       1     9711.7 14557.3 1018.10
##
## Step:  AIC=698.07
## Bodyfat ~ logAbdomen + HipWrist
##
##                    Df Sum of Sq     RSS     AIC
## + logNeck          1       73.3  3909.4 695.42
## + Neck             1       72.8  3910.0 695.46
## + Neck2            1       71.0  3911.7 695.57
## + NeckWrist        1       68.3  3914.4 695.74
## + Weight           1       55.3  3927.5 696.57
## + NeckAbdomen      1       35.8  3947.0 697.81
## + NeckHip          1       33.4  3949.4 697.96
## <none>                          3982.8 698.07
## + Age              1       22.7  3960.1 698.64
## + logHip           1       19.3  3963.5 698.85
## + logThigh         1       15.4  3967.4 699.10
## + Hip              1       14.3  3968.4 699.17
## + Abdomen          1       12.7  3970.1 699.27
## + HipForearm       1       11.6  3971.2 699.34
## + AbdomenHip       1       11.1  3971.6 699.37
## + Thigh            1       11.0  3971.8 699.38
## + ThighForearm     1       10.7  3972.1 699.40
## + logWrist         1       10.7  3972.1 699.40
## + AbdomenThigh     1       10.3  3972.5 699.42
## + AbdomenForearm   1       10.1  3972.7 699.44
## + Wrist            1       10.0  3972.8 699.44
## + Abdomen2         1        9.7  3973.1 699.46
## + HipThigh         1        9.1  3973.6 699.49
## + Wrist2           1        9.0  3973.8 699.50
## + Hip2             1        8.5  3974.2 699.53
## + NeckThigh        1        8.3  3974.5 699.55
## + Thigh2           1        7.0  3975.8 699.63
## + NeckForearm      1        5.8  3977.0 699.70
## + logForearm       1        5.3  3977.5 699.74
## + Forearm          1        5.1  3977.7 699.75
## + Forearm2         1        4.9  3977.9 699.76
## + ThighWrist       1        2.0  3980.8 699.94
## + AbdomenWrist     1        0.8  3982.0 700.02
## + ForearmWrist     1        0.3  3982.4 700.05
## - HipWrist         1      862.9  4845.6 745.09
## - logAbdomen       1     6266.6 10249.4 932.38
##
## Step:  AIC=695.42
## Bodyfat ~ logAbdomen + HipWrist + logNeck
##
##                    Df Sum of Sq     RSS     AIC
## + AbdomenForearm   1       32.2  3877.2 695.35
## + Weight           1       31.2  3878.2 695.42
## <none>                          3909.4 695.42
## + ThighForearm     1       28.8  3880.6 695.57
## + Forearm          1       26.7  3882.8 695.71
## + Forearm2         1       26.5  3883.0 695.72
```

```
## + HipForearm      1     26.4  3883.0 695.73
## + logForearm      1     26.4  3883.0 695.73
## + Age             1     25.7  3883.7 695.77
## + NeckForearm     1     25.0  3884.4 695.82
## + logThigh        1     18.3  3891.1 696.25
## + ForearmWrist    1     14.7  3894.8 696.48
## + Thigh           1     12.8  3896.7 696.60
## + ThighWrist      1      8.6  3900.8 696.87
## + AbdomenThigh    1      8.5  3900.9 696.88
## + Thigh2          1      7.8  3901.6 696.92
## + NeckThigh       1      7.1  3902.4 696.97
## + logHip          1      6.6  3902.9 697.00
## + Abdomen         1      6.3  3903.1 697.02
## + HipThigh        1      5.6  3903.8 697.06
## + Abdomen2        1      4.3  3905.2 697.15
## + Hip             1      3.2  3906.2 697.22
## + NeckWrist       1      2.4  3907.1 697.27
## + AbdomenHip      1      2.2  3907.3 697.28
## + NeckAbdomen     1      1.8  3907.7 697.31
## + logWrist        1      1.4  3908.1 697.33
## + Wrist           1      1.2  3908.3 697.35
## + Wrist2          1      0.9  3908.5 697.36
## + Hip2            1      0.8  3908.6 697.37
## + NeckHip         1      0.5  3909.0 697.39
## + AbdomenWrist    1      0.2  3909.3 697.41
## + Neck2           1      0.1  3909.4 697.42
## + Neck            1      0.0  3909.4 697.42
## - logNeck         1     73.3  3982.8 698.07
## - HipWrist        1    450.7  4360.2 720.70
## - logAbdomen      1   6230.2 10139.7 931.69
##
## Step:  AIC=695.35
## Bodyfat ~ logAbdomen + HipWrist + logNeck + AbdomenForearm
##
##                   Df Sum of Sq    RSS    AIC
## + Weight           1     49.73 3827.5 694.12
## + Age              1     39.11 3838.1 694.82
## <none>                         3877.2 695.35
## - AbdomenForearm   1     32.24 3909.4 695.42
## + logThigh         1     12.33 3864.9 696.56
## + Thigh            1      8.19 3869.0 696.82
## + NeckForearm      1      6.68 3870.5 696.92
## + Abdomen          1      6.56 3870.6 696.93
## + AbdomenThigh     1      6.06 3871.1 696.96
## + Abdomen2         1      5.07 3872.1 697.03
## + logHip           1      4.90 3872.3 697.04
## + Thigh2           1      4.77 3872.4 697.04
## + NeckThigh        1      4.70 3872.5 697.05
## + ThighWrist       1      4.59 3872.6 697.06
## + ForearmWrist     1      4.50 3872.7 697.06
## + HipThigh         1      3.83 3873.4 697.11
## + NeckAbdomen      1      3.21 3874.0 697.14
## + AbdomenHip       1      2.80 3874.4 697.17
## + Hip              1      2.66 3874.5 697.18
```

```
## + ThighForearm   1      2.52 3874.7 697.19
## + NeckWrist       1      1.65 3875.6 697.25
## + logWrist        1      1.63 3875.6 697.25
## + Wrist           1      1.29 3875.9 697.27
## + Forearm2        1      1.10 3876.1 697.28
## + Hip2            1      0.97 3876.2 697.29
## + Forearm         1      0.97 3876.2 697.29
## + Wrist2          1      0.92 3876.3 697.29
## + NeckHip         1      0.91 3876.3 697.29
## + logForearm      1      0.84 3876.4 697.30
## + AbdomenWrist    1      0.37 3876.8 697.33
## + Neck            1      0.31 3876.9 697.33
## + Neck2           1      0.21 3877.0 697.34
## + HipForearm      1      0.03 3877.2 697.35
## - logNeck         1     95.51 3972.7 699.44
## - HipWrist        1    482.88 4360.1 722.70
## - logAbdomen      1   2470.38 6347.6 816.59
##
## Step:  AIC=694.12
## Bodyfat ~ logAbdomen + HipWrist + logNeck + AbdomenForearm +
##     Weight
##
##                  Df Sum of Sq    RSS    AIC
## + logThigh        1     44.88 3782.6 693.18
## + Thigh           1     38.78 3788.7 693.58
## + HipThigh        1     38.37 3789.1 693.61
## + AbdomenThigh    1     37.86 3789.6 693.64
## + logHip          1     36.45 3791.0 693.73
## + NeckThigh       1     35.15 3792.3 693.82
## + Hip             1     32.38 3795.1 694.00
## + Thigh2          1     32.11 3795.4 694.02
## + ForearmWrist    1     31.70 3795.8 694.05
## <none>                        3827.5 694.12
## + logWrist        1     27.70 3799.8 694.31
## + Wrist           1     26.98 3800.5 694.36
## + Wrist2          1     25.64 3801.8 694.44
## + NeckHip         1     25.10 3802.4 694.48
## + NeckWrist       1     24.28 3803.2 694.53
## + Hip2            1     24.17 3803.3 694.54
## + AbdomenHip      1     21.84 3805.6 694.69
## + ThighForearm    1     19.07 3808.4 694.88
## + ThighWrist      1     14.66 3812.8 695.17
## + Abdomen         1     13.06 3814.4 695.27
## - Weight          1     49.73 3877.2 695.35
## + Age             1     11.17 3816.3 695.39
## + Abdomen2        1     11.11 3816.4 695.40
## - AbdomenForearm  1     50.74 3878.2 695.42
## + NeckAbdomen     1     10.60 3816.9 695.43
## + NeckForearm     1      8.72 3818.7 695.55
## + HipForearm      1      7.81 3819.7 695.61
## + AbdomenWrist    1      5.53 3821.9 695.76
## + Neck            1      4.63 3822.8 695.82
## + Neck2           1      4.32 3823.2 695.84
## + logForearm      1      3.39 3824.1 695.90
```

```
## + Forearm           1        3.21 3824.3 695.92
## + Forearm2          1        2.87 3824.6 695.94
## - logNeck           1       70.69 3898.2 696.70
## - HipWrist          1      116.25 3943.7 699.60
## - logAbdomen        1     2514.48 6342.0 818.37
##
## Step:  AIC=693.18
## Bodyfat ~ logAbdomen + HipWrist + logNeck + AbdomenForearm +
##     Weight + logThigh
##
##                   Df Sum of Sq    RSS    AIC
## + ThighForearm     1      102.70 3679.9 688.29
## + Age              1       55.20 3727.4 691.50
## <none>                           3782.6 693.18
## + Abdomen          1       27.64 3755.0 693.34
## + NeckAbdomen      1       24.43 3758.2 693.56
## + Abdomen2         1       24.32 3758.3 693.56
## + ThighWrist       1       22.65 3759.9 693.67
## + ForearmWrist     1       20.20 3762.4 693.84
## + NeckForearm      1       17.64 3765.0 694.01
## + AbdomenHip       1       16.27 3766.3 694.10
## - logThigh         1       44.88 3827.5 694.12
## - AbdomenForearm   1       45.27 3827.9 694.15
## + Neck             1       12.84 3769.8 694.33
## + Neck2            1       12.14 3770.5 694.37
## + Forearm          1       10.96 3771.6 694.45
## + logForearm       1       10.96 3771.6 694.45
## + NeckHip          1       10.93 3771.7 694.45
## + Forearm2         1        9.77 3772.8 694.53
## + logWrist         1        9.41 3773.2 694.55
## + logHip           1        8.79 3773.8 694.59
## + Hip              1        8.41 3774.2 694.62
## + Wrist            1        8.10 3774.5 694.64
## + Thigh            1        7.80 3774.8 694.66
## + Hip2             1        7.05 3775.5 694.71
## + Wrist2           1        6.55 3776.0 694.74
## + Thigh2           1        5.62 3777.0 694.80
## + NeckWrist        1        4.05 3778.5 694.91
## + AbdomenWrist     1        2.78 3779.8 694.99
## + AbdomenThigh     1        2.60 3780.0 695.00
## + HipForearm       1        1.09 3781.5 695.10
## + HipThigh         1        0.62 3782.0 695.14
## + NeckThigh        1        0.16 3782.4 695.17
## - logNeck          1       62.75 3845.3 695.29
## - Weight           1       82.28 3864.9 696.56
## - HipWrist         1      126.71 3909.3 699.41
## - logAbdomen       1     2529.11 6311.7 819.17
##
## Step:  AIC=688.29
## Bodyfat ~ logAbdomen + HipWrist + logNeck + AbdomenForearm +
##     Weight + logThigh + ThighForearm
##
##                   Df Sum of Sq    RSS    AIC
## + Age              1      54.424 3625.5 686.57
```

```
## - logAbdomen      1       5.288 3685.2 686.65
## <none>                          3679.9 688.29
## + Forearm2         1      22.672 3657.2 688.75
## - logNeck          1      37.460 3717.4 688.83
## + NeckForearm      1      19.315 3660.6 688.98
## + Forearm          1      17.435 3662.5 689.11
## + logForearm       1      10.043 3669.9 689.61
## + Thigh            1       9.713 3670.2 689.63
## + Thigh2           1       8.137 3671.8 689.74
## + AbdomenThigh     1       6.830 3673.1 689.83
## + ThighWrist       1       5.768 3674.1 689.90
## + Abdomen2         1       4.723 3675.2 689.97
## + NeckThigh        1       4.544 3675.4 689.99
## + Abdomen          1       4.454 3675.4 689.99
## + HipForearm       1       3.956 3675.9 690.03
## + logHip           1       3.205 3676.7 690.08
## + HipThigh         1       2.701 3677.2 690.11
## + AbdomenHip       1       1.678 3678.2 690.18
## + ForearmWrist     1       1.090 3678.8 690.22
## + Neck             1       0.842 3679.1 690.24
## + AbdomenWrist     1       0.692 3679.2 690.25
## + Neck2            1       0.596 3679.3 690.25
## + Hip              1       0.504 3679.4 690.26
## + NeckAbdomen      1       0.459 3679.4 690.26
## + Hip2             1       0.110 3679.8 690.29
## + Wrist2           1       0.042 3679.9 690.29
## + NeckWrist        1       0.020 3679.9 690.29
## + Wrist            1       0.018 3679.9 690.29
## + logWrist         1       0.006 3679.9 690.29
## + NeckHip          1       0.000 3679.9 690.29
## - Weight           1     100.747 3780.6 693.05
## - ThighForearm     1     102.695 3782.6 693.18
## - AbdomenForearm   1     126.316 3806.2 694.73
## - logThigh         1     128.511 3808.4 694.88
## - HipWrist         1     149.058 3829.0 696.22
##
## Step:  AIC=686.57
## Bodyfat ~ logAbdomen + HipWrist + logNeck + AbdomenForearm +
##     Weight + logThigh + ThighForearm + Age
##
##                   Df Sum of Sq    RSS    AIC
## - logAbdomen       1     1.688 3627.2 684.69
## <none>                         3625.5 686.57
## + Forearm2         1    26.271 3599.2 686.75
## + NeckForearm      1    19.994 3605.5 687.19
## + Forearm          1    18.378 3607.1 687.30
## + ThighWrist       1    16.482 3609.0 687.43
## + HipForearm       1    14.328 3611.1 687.58
## + logHip           1    13.850 3611.6 687.61
## + logForearm       1     9.296 3616.2 687.93
## - Weight           1    49.567 3675.0 687.96
## + Thigh            1     7.747 3617.7 688.03
## + AbdomenWrist     1     6.905 3618.6 688.09
## + Hip              1     6.789 3618.7 688.10
```

```
## + Thigh2           1      6.599 3618.9 688.11
## + AbdomenThigh     1      5.465 3620.0 688.19
## - logNeck          1     53.212 3678.7 688.21
## + NeckThigh        1      4.164 3621.3 688.28
## + Abdomen2         1      4.101 3621.4 688.29
## - Age              1     54.424 3679.9 688.29
## + NeckWrist        1      3.933 3621.5 688.30
## + Abdomen          1      3.711 3621.8 688.31
## + logWrist         1      3.031 3622.4 688.36
## + Wrist            1      2.793 3622.7 688.38
## + Wrist2           1      2.460 3623.0 688.40
## + NeckHip          1      1.802 3623.7 688.45
## + Hip2             1      1.727 3623.7 688.45
## + Neck             1      0.930 3624.5 688.51
## + Neck2            1      0.630 3624.8 688.53
## + NeckAbdomen      1      0.511 3625.0 688.53
## + HipThigh         1      0.156 3625.3 688.56
## + ForearmWrist     1      0.076 3625.4 688.56
## + AbdomenHip       1      0.039 3625.4 688.57
## - ThighForearm     1    101.920 3727.4 691.50
## - AbdomenForearm   1    127.822 3753.3 693.23
## - logThigh         1    145.987 3771.5 694.44
## - HipWrist         1    189.443 3814.9 697.30
##
## Step:  AIC=684.69
## Bodyfat ~ HipWrist + logNeck + AbdomenForearm + Weight + logThigh +
##     ThighForearm + Age
##
##                 Df Sum of Sq    RSS    AIC
## <none>                       3627.2 684.69
## + Forearm2        1      26.6 3600.6 684.85
## + Forearm         1      18.3 3608.8 685.42
## + NeckForearm     1      16.5 3610.6 685.54
## + ThighWrist      1      14.9 3612.2 685.66
## + logHip          1      13.8 3613.3 685.73
## + HipForearm      1      12.4 3614.7 685.83
## + logForearm      1       9.0 3618.1 686.06
## - Weight          1      49.7 3676.8 686.09
## + Thigh           1       8.0 3619.1 686.13
## + Thigh2          1       6.9 3620.2 686.21
## - logNeck         1      51.7 3678.9 686.23
## + AbdomenThigh    1       6.0 3621.1 686.27
## + Hip             1       6.0 3621.2 686.27
## + AbdomenWrist    1       5.3 3621.8 686.32
## + Abdomen2        1       5.2 3622.0 686.33
## + NeckThigh       1       5.0 3622.2 686.34
## + NeckWrist       1       3.5 3623.6 686.44
## + logWrist        1       2.0 3625.2 686.55
## + Wrist           1       1.9 3625.3 686.56
## + Wrist2          1       1.7 3625.4 686.57
## + logAbdomen      1       1.7 3625.5 686.57
## + Abdomen         1       1.5 3625.7 686.58
## + Hip2            1       1.0 3626.1 686.61
## + NeckHip         1       0.9 3626.2 686.62
```

```
## + NeckAbdomen      1       0.8 3626.3 686.63
## - Age              1      58.0 3685.2 686.65
## + HipThigh         1       0.4 3626.8 686.66
## + Neck             1       0.3 3626.8 686.66
## + AbdomenHip        1       0.2 3627.0 686.67
## + Neck2            1       0.2 3627.0 686.67
## + ForearmWrist     1       0.0 3627.1 686.69
## - HipWrist         1     197.3 3824.5 695.93
## - ThighForearm     1    1689.2 5316.3 778.27
## - logThigh         1    1721.3 5348.4 779.77
## - AbdomenForearm   1    3240.8 6868.0 842.29
##
## Call:
## lm(formula = Bodyfat ~ HipWrist + logNeck + AbdomenForearm +
##     Weight + logThigh + ThighForearm + Age, data = interactDF)
##
## Coefficients:
##     (Intercept)           HipWrist            logNeck  AbdomenForearm
##      -281.09537           -0.01355          -13.51502         0.03003
##          Weight           logThigh       ThighForearm             Age
##        -0.06359           91.93300          -0.04226         0.05280
```

We fit the linear model suggested by stepwise regression

```
stepwise.lm = lm(Bodyfat ~ logAbdomen + HipWrist + Neck + ThighForearm +
                 Age + Abdomen + Hip + Wrist + Thigh + Forearm)
stepwise.sum = summary(stepwise.lm)
stepwise.sum
```

```
##
## Call:
## lm(formula = Bodyfat ~ logAbdomen + HipWrist + Neck + ThighForearm +
##     Age + Abdomen + Hip + Wrist + Thigh + Forearm)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3850 -2.6137 -0.2316  2.4801 10.0554
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -177.09958  104.26367  -1.699   0.0907 .
## logAbdomen     11.21323   40.00751   0.280   0.7795
## HipWrist       -0.04770    0.03721  -1.282   0.2011
## Neck           -0.50179    0.20074  -2.500   0.0131 *
## ThighForearm   -0.02869    0.02134  -1.345   0.1800
## Age             0.07002    0.02772   2.526   0.0122 *
## Abdomen         0.68729    0.43263   1.589   0.1135
## Hip             0.60381    0.69585   0.868   0.3864
## Wrist           2.95815    3.79348   0.780   0.4363
## Thigh           1.04333    0.63549   1.642   0.1020
## Forearm         2.00697    1.31443   1.527   0.1281
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.939 on 239 degrees of freedom
```

```
## Multiple R-squared:  0.7453, Adjusted R-squared:  0.7346
## F-statistic: 69.94 on 10 and 239 DF,  p-value: < 2.2e-16
```

Compare the linear models

```
##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Neck + Abdomen + Hip +
##     Thigh + Forearm + Wrist)
##
## Residuals:
##      Min      1Q   Median       3Q      Max
## -10.0756  -2.7707  -0.1871   2.7057   9.5237
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -18.46826   10.90031  -1.694  0.09150 .
## Age           0.05577    0.02871   1.943  0.05323 .
## Weight       -0.08081    0.03705  -2.181  0.03014 *
## Neck         -0.41183    0.20874  -1.973  0.04965 *
## Abdomen       0.87775    0.06680  13.140  < 2e-16 ***
## Hip          -0.20063    0.12999  -1.543  0.12404
## Thigh         0.26719    0.12028   2.221  0.02726 *
## Forearm       0.46567    0.17285   2.694  0.00755 **
## Wrist        -1.39341    0.47386  -2.941  0.00359 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.964 on 241 degrees of freedom
## Multiple R-squared:  0.7399, Adjusted R-squared:  0.7313
## F-statistic:  85.7 on 8 and 241 DF,  p-value: < 2.2e-16

##
## Call:
## lm(formula = Bodyfat ~ Age + Weight + Thigh + Neck + Abdomen +
##     Forearm + Wrist + NeckAbdomen + NeckThigh + ForearmWrist +
##     Abdomen2 + Forearm2)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -9.941 -2.477 -0.218  2.562  9.314
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -1.394e+02  5.642e+01  -2.472 0.014155 *
## Age           5.739e-02  2.801e-02   2.049 0.041563 *
## Weight       -9.440e-02  3.231e-02  -2.922 0.003819 **
## Thigh         4.906e+00  1.317e+00   3.724 0.000245 ***
## Neck         -1.993e-01  1.360e+00  -0.147 0.883580
## Abdomen      -7.867e-01  6.513e-01  -1.208 0.228292
## Forearm       8.256e-01  2.644e+00   0.312 0.755145
## Wrist         2.732e+00  3.069e+00   0.890 0.374257
## NeckAbdomen   7.670e-02  2.329e-02   3.293 0.001144 **
## NeckThigh    -1.226e-01  3.388e-02  -3.617 0.000364 ***
## ForearmWrist -1.495e-01  1.064e-01  -1.405 0.161376
```

```
## Abdomen2      -6.997e-03  3.041e-03  -2.301 0.022272 *
## Forearm2       4.079e-02  3.891e-02   1.048 0.295580
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.839 on 237 degrees of freedom
## Multiple R-squared:   0.76,  Adjusted R-squared:  0.7479
## F-statistic: 62.55 on 12 and 237 DF,  p-value: < 2.2e-16

##
## Call:
## lm(formula = Bodyfat ~ logAbdomen + HipWrist + Neck + ThighForearm +
##     Age + Abdomen + Hip + Wrist + Thigh + Forearm)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3850 -2.6137 -0.2316  2.4801 10.0554
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -177.09958  104.26367  -1.699   0.0907 .
## logAbdomen     11.21323   40.00751   0.280   0.7795
## HipWrist       -0.04770    0.03721  -1.282   0.2011
## Neck           -0.50179    0.20074  -2.500   0.0131 *
## ThighForearm   -0.02869    0.02134  -1.345   0.1800
## Age             0.07002    0.02772   2.526   0.0122 *
## Abdomen         0.68729    0.43263   1.589   0.1135
## Hip             0.60381    0.69585   0.868   0.3864
## Wrist           2.95815    3.79348   0.780   0.4363
## Thigh           1.04333    0.63549   1.642   0.1020
## Forearm         2.00697    1.31443   1.527   0.1281
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.939 on 239 degrees of freedom
## Multiple R-squared:  0.7453, Adjusted R-squared:  0.7346
## F-statistic: 69.94 on 10 and 239 DF,  p-value: < 2.2e-16
```

Test our model with training and testing data

```
newDF_x = as.data.frame(cbind(Age, Weight, Neck, Abdomen, Hip, Thigh,
                              Forearm, Wrist))
train = sample(1:252, 200)
test = (-train)
trainX = newDF_x[train,]
trainY = Bodyfat[train]
testX = newDF_x[test,]
testY = Bodyfat[test]


train.lm = lm(trainY ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm +
                Wrist, data=trainX)
train.sum = summary(train.lm)
train.sum
```

```
##
## Call:
```

```
## lm(formula = trainY ~ Age + Weight + Neck + Abdomen + Hip + Thigh +
##     Forearm + Wrist, data = trainX)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.9422 -2.4405 -0.2162  2.6157  9.5012
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -24.18805   12.42468  -1.947  0.05304 .
## Age           0.05639    0.03206   1.759  0.08019 .
## Weight       -0.09957    0.04148  -2.400  0.01736 *
## Neck         -0.48107    0.23536  -2.044  0.04235 *
## Abdomen       0.93177    0.07273  12.812  < 2e-16 ***
## Hip          -0.21642    0.14641  -1.478  0.14101
## Thigh         0.26689    0.13915   1.918  0.05662 .
## Forearm       0.58891    0.20394   2.888  0.00433 **
## Wrist        -1.13745    0.51778  -2.197  0.02925 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.977 on 189 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.7561, Adjusted R-squared:  0.7457
## F-statistic: 73.22 on 8 and 189 DF,  p-value: < 2.2e-16
```

```r
test.lm = lm(testY ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm +
                Wrist, data=testX)
test.sum = summary(test.lm)
test.sum
```

```
##
## Call:
## lm(formula = testY ~ Age + Weight + Neck + Abdomen + Hip + Thigh +
##     Forearm + Wrist, data = testX)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -6.0321 -2.8234 -0.9722  3.1964  6.6939
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.76132   23.96083   0.240  0.81113
## Age          0.11200    0.06844   1.636  0.10907
## Weight       0.05767    0.08951   0.644  0.52282
## Neck         0.04457    0.54019   0.083  0.93462
## Abdomen      0.47112    0.18312   2.573  0.01362 *
## Hip          0.03470    0.30756   0.113  0.91070
## Thigh        0.27033    0.25939   1.042  0.30315
## Forearm      0.14047    0.36121   0.389  0.69928
## Wrist       -3.92204    1.33401  -2.940  0.00526 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.891 on 43 degrees of freedom
```

```
## Multiple R-squared:  0.7087, Adjusted R-squared:  0.6546
## F-statistic: 13.08 on 8 and 43 DF,  p-value: 2.463e-09
```

Plotting Residuals for the model

```
plot(new4.lm)
```

Residuals vs Fitted

Fitted values
lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm + Wrist)

Normal Q–Q

lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm + Wrist)

Scale–Location

lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm + Wrist)

Residuals vs Leverage

lm(Bodyfat ~ Age + Weight + Neck + Abdomen + Hip + Thigh + Forearm + Wrist)