# DASC-5301-ASSIGNMENT

NIVAS

2024-03-01

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

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

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

```
library(MASS)
```

```
##
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:dplyr':
##
##     select
```

```
library(corrplot)
```

```
## corrplot 0.92 loaded
```

```
library(glmnet)
```

```
## Loading required package: Matrix
```

```
## Loaded glmnet 4.1-8
```

```
csv_file <- read.csv("fat.csv", header=TRUE)
csv_file
```

```
##     brozek siri density age weight height adipos  free neck chest abdom   hip
## 1     12.6 12.3  1.0708  23 154.25  67.75   23.7 134.9 36.2  93.1  85.2  94.5
## 2      6.9  6.1  1.0853  22 173.25  72.25   23.4 161.3 38.5  93.6  83.0  98.7
## 3     24.6 25.3  1.0414  22 154.00  66.25   24.7 116.0 34.0  95.8  87.9  99.2
## 4     10.9 10.4  1.0751  26 184.75  72.25   24.9 164.7 37.4 101.8  86.4 101.2
## 5     27.8 28.7  1.0340  24 184.25  71.25   25.6 133.1 34.4  97.3 100.0 101.9
## 6     20.6 20.9  1.0502  24 210.25  74.75   26.5 167.0 39.0 104.5  94.4 107.8
## 7     19.0 19.2  1.0549  26 181.00  69.75   26.2 146.6 36.4 105.1  90.7 100.3
## 8     12.8 12.4  1.0704  25 176.00  72.50   23.6 153.6 37.8  99.6  88.5  97.1
## 9      5.1  4.1  1.0900  25 191.00  74.00   24.6 181.3 38.1 100.9  82.5  99.9
## 10    12.0 11.7  1.0722  23 198.25  73.50   25.8 174.4 42.1  99.6  88.6 104.1
## 11     7.5  7.1  1.0830  26 186.25  74.50   23.6 172.3 38.5 101.5  83.6  98.2
## 12     8.5  7.8  1.0812  27 216.00  76.00   26.3 197.7 39.4 103.6  90.9 107.7
## 13    20.5 20.8  1.0513  32 180.50  69.50   26.3 143.5 38.4 102.0  91.6 103.9
## 14    20.8 21.2  1.0505  30 205.25  71.25   28.5 162.5 39.4 104.1 101.8 108.6
## 15    21.7 22.1  1.0484  35 187.75  69.50   27.4 147.0 40.5 101.3  96.4 100.1
## 16    20.5 20.9  1.0512  35 162.75  66.00   26.3 129.3 36.4  99.1  92.8  99.2
## 17    28.1 29.0  1.0333  34 195.75  71.00   27.3 140.8 38.9 101.9  96.4 105.2
## 18    22.4 22.9  1.0468  32 209.25  71.00   29.2 162.5 42.1 107.6  97.5 107.0
## 19    16.1 16.0  1.0622  28 183.75  67.75   28.2 154.3 38.0 106.8  89.6 102.4
## 20    16.5 16.5  1.0610  33 211.75  73.50   27.6 176.8 40.0 106.2 100.5 109.0
## 21    19.0 19.1  1.0551  28 179.00  68.00   27.3 145.1 39.1 103.3  95.9 104.9
## 22    15.3 15.2  1.0640  28 200.50  69.75   29.1 169.8 41.3 111.4  98.8 104.8
## 23    15.7 15.6  1.0631  31 140.25  68.25   21.2 118.2 33.9  86.0  76.4  94.6
## 24    17.6 17.7  1.0584  32 148.75  70.00   21.4 122.6 35.5  86.7  80.0  93.4
## 25    14.2 14.0  1.0668  28 151.25  67.75   23.2 129.8 34.5  90.2  76.3  95.8
## 26     4.6  3.7  1.0911  27 159.25  71.50   21.9 151.9 35.7  89.6  79.7  96.5
```

```
## 27     8.5  7.9  1.0811  34 131.50  67.50   20.3 120.3 36.2  88.6  74.6  85.3
## 28    22.4 22.9  1.0468  31 148.00  67.50   22.9 114.9 38.8  97.4  88.7  94.7
## 29     4.7  3.7  1.0910  27 133.25  64.75   22.4 127.0 36.4  93.5  73.9  88.5
## 30     9.4  8.8  1.0790  29 160.75  69.00   23.8 145.7 36.7  97.4  83.5  98.7
## 31    12.3 11.9  1.0716  32 182.00  73.75   23.6 159.7 38.7 100.5  88.7  99.8
## 32     6.5  5.7  1.0862  29 160.25  71.25   22.2 149.8 37.3  93.5  84.5 100.6
## 33    13.4 11.8  1.0719  27 168.00  71.25   23.3 142.5 38.1  93.0  79.1  94.5
## 34    20.9 21.3  1.0502  41 218.50  71.00   30.5 172.7 39.8 111.7 100.5 108.3
## 35    31.1 32.3  1.0263  41 247.25  73.50   32.2 170.4 42.1 117.0 115.6 116.1
## 36    38.2 40.1  1.0101  49 191.75  65.00   32.0 118.4 38.4 118.5 113.1 113.8
## 37    23.6 24.2  1.0438  40 202.25  70.00   29.1 154.5 38.5 106.5 100.9 106.2
## 38    27.5 28.4  1.0346  50 196.75  68.25   29.7 142.6 42.1 105.6  98.8 104.8
## 39    33.8 35.2  1.0202  46 363.15  72.25   48.9 240.5 51.2 136.2 148.1 147.7
## 40    31.3 32.6  1.0258  50 203.00  67.00   31.8 139.4 40.2 114.8 108.1 102.5
## 41    33.1 34.5  1.0217  45 262.75  68.75   39.1 175.8 43.2 128.3 126.2 125.6
## 42    31.7 32.9  1.0250  44 205.00  29.50   29.9 140.1 36.6 106.0 104.3 115.5
## 43    30.4 31.6  1.0279  48 217.00  70.00   31.2 151.1 37.3 113.3 111.2 114.1
## 44    30.8 32.0  1.0269  41 212.00  71.50   29.2 146.7 41.5 106.6 104.3 106.0
## 45     8.4  7.7  1.0814  39 125.25  68.00   19.1 114.7 31.5  85.1  76.0  88.2
## 46    14.1 13.9  1.0670  43 164.25  73.25   21.3 141.1 35.7  96.6  81.5  97.2
## 47    11.2 10.8  1.0742  40 133.50  67.50   20.6 118.5 33.6  88.2  73.7  88.5
## 48     6.4  5.6  1.0665  39 148.50  71.25   20.6 139.0 34.6  89.8  79.5  92.7
## 49    13.4 13.6  1.0678  45 135.75  68.50   20.4 117.6 32.8  92.3  83.4  90.4
## 50     5.0  4.0  1.0903  47 127.50  66.75   20.2 121.2 34.0  83.4  70.4  87.2
## 51    10.7 10.2  1.0756  47 158.25  72.25   21.3 141.4 34.9  90.2  86.7  98.3
## 52     7.4  6.6  1.0840  40 139.25  69.00   20.6 129.0 34.3  89.2  77.9  91.0
## 53     8.7  8.0  1.0807  51 137.25  67.75   21.1 125.3 36.5  89.7  82.0  89.1
## 54     7.1  6.3  1.0848  49 152.75  73.50   19.9 142.0 35.1  93.3  79.6  91.6
## 55     4.9  3.9  1.0906  42 136.25  67.50   21.1 129.6 37.8  87.6  77.6  88.6
## 56    22.2 22.6  1.0473  54 198.00  72.00   26.9 154.1 39.9 107.6 100.0  99.6
## 57    20.1 20.4  1.0524  58 181.50  68.00   27.6 145.1 39.1 100.0  99.8 102.5
## 58    27.1 28.0  1.0356  62 201.25  69.50   29.3 146.7 40.5 111.5 104.2 105.8
## 59    30.4 31.5  1.0280  54 202.50  70.75   28.4 141.0 40.5 115.4 105.3  97.0
## 60    24.0 24.6  1.0430  61 179.75  65.75   29.2 136.7 38.4 104.8  98.3  99.6
## 61    25.4 26.1  1.0396  62 216.00  73.25   28.2 161.2 41.4 112.3 104.8 103.1
## 62    28.8 29.8  1.0317  56 178.75  68.50   26.8 127.4 35.6 102.9  94.7 100.8
## 63    29.6 30.7  1.0298  54 193.25  70.25   27.6 136.1 38.0 107.6 102.4  99.4
## 64    25.1 25.8  1.0403  61 178.00  67.00   27.9 133.3 37.4 105.3  99.7  99.7
## 65    31.0 32.3  1.0264  57 205.50  70.00   29.5 141.7 40.1 105.3 105.5 108.3
## 66    28.9 30.0  1.0313  55 183.50  67.50   28.3 130.4 40.9 103.0 100.3 104.2
## 67    21.1 21.5  1.0499  54 151.50  70.75   21.3 119.6 35.6  90.0  83.9  93.9
## 68    14.0 13.8  1.0673  55 154.75  71.50   21.3 133.1 36.9  95.4  86.6  91.8
## 69     7.1  6.3  1.0847  54 155.25  69.25   22.8 144.2 37.5  89.3  78.4  96.1
## 70    13.2 12.9  1.0693  55 156.75  71.50   21.6 136.1 36.3  94.4  84.6  94.3
## 71    23.7 24.3  1.0439  62 167.50  71.50   23.1 127.8 35.5  97.6  91.5  98.5
## 72     9.4  8.8  1.0788  55 146.75  68.75   21.9 132.9 38.7  88.5  82.8  95.5
## 73     9.1  8.5  1.0796  56 160.75  73.75   20.8 146.1 36.4  93.6  82.9  96.3
## 74    13.7 13.5  1.0680  55 125.00  64.00   21.5 107.9 33.2  87.7  76.0  88.6
## 75    12.0 11.8  1.0720  61 143.00  65.75   23.3 125.9 36.5  93.4  83.3  93.0
## 76    18.3 18.5  1.0666  61 148.25  67.50   22.9 121.1 36.0  91.6  81.8  94.8
## 77     9.2  8.8  1.0790  57 162.50  69.50   23.7 147.5 38.7  91.6  78.8  94.3
## 78    21.7 22.2  1.0483  69 177.75  68.50   26.7 139.1 38.7 102.0  95.0  98.3
## 79    21.1 21.5  1.0498  81 161.25  70.25   23.0 127.2 37.8  96.4  95.4  99.3
## 80    18.6 18.8  1.0560  66 171.25  69.25   25.1 139.5 37.4 102.7  98.6 100.2
## 81    30.2 31.4  1.0283  67 163.75  67.75   25.1 114.3 38.4  97.7  95.8  97.1
## 82    26.0 26.8  1.0382  64 150.25  67.25   23.4 111.2 38.1  97.1  89.0  96.9
## 83    18.2 18.4  1.0568  64 190.25  72.75   25.3 155.6 39.3 103.1  97.8  99.6
## 84    26.2 27.0  1.0377  70 170.75  70.00   24.5 126.0 38.7 101.8  94.9  95.0
## 85    26.1 27.0  1.0378  72 168.00  69.25   24.7 124.1 38.5 101.4  99.8  96.2
## 86    25.8 26.6  1.0386  67 167.00  67.50   26.0 123.9 36.5  98.9  89.7  96.2
## 87    15.0 14.9  1.0648  72 157.75  67.25   24.6 134.1 37.7  97.5  88.1  96.9
## 88    22.6 23.1  1.0462  64 160.00  65.75   26.0 123.8 36.5 104.3  90.9  93.8
## 89     8.8  8.3  1.0800  46 176.75  72.50   23.7 161.1 38.0  97.3  86.0  99.3
## 90    14.3 14.1  1.0666  48 176.00  73.00   23.3 150.9 36.7  96.7  86.5  98.3
## 91    20.2 20.5  1.0520  46 177.00  70.00   25.4 141.3 37.2  99.7  95.6 102.2
## 92    18.1 18.2  1.0573  44 179.75  69.50   26.2 147.3 39.2 101.9  93.2 100.6
## 93     9.2  8.5  1.0795  47 165.25  70.50   23.4 150.1 37.5  97.2  83.1  95.4
## 94    24.2 24.9  1.0424  46 192.50  71.75   26.3 145.9 38.0 106.6  97.5 100.6
## 95     9.6  9.0  1.0785  47 184.25  74.50   23.4 166.6 37.3  99.6  88.8 101.4
## 96    17.3 17.4  1.0991  53 224.50  77.75   26.1 185.7 41.1 113.2  99.2 107.5
## 97    10.1  9.6  1.0770  38 188.75  73.25   24.8 169.6 37.5  99.1  91.6 102.4
## 98    11.1 11.3  1.0730  50 162.50  66.50   25.9 143.5 38.7  99.4  86.7  96.2
## 99    17.7 17.8  1.0582  46 156.50  68.25   23.7 128.8 35.9  95.1  88.2  92.8
## 100   21.7 22.2  1.0484  47 197.00  72.00   26.7 154.2 40.0 107.5  94.0 103.7
## 101   20.8 21.2  1.0506  49 198.50  73.50   25.9 157.2 40.1 106.5  95.0 101.7
## 102   20.1 20.4  1.0524  48 173.75  72.00   23.6 138.9 37.0  99.1  92.0  98.3
## 103   19.8 20.1  1.0530  41 172.75  71.25   24.0 138.6 36.3  96.7  89.2  98.3
## 104   21.9 22.3  1.0480  49 196.75  73.75   25.5 153.7 40.7 103.5  95.5 101.6
## 105   24.7 25.4  1.0412  43 177.00  69.25   26.0 133.2 39.6 104.0  98.6  99.5
```

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## 106   17.8 18.0  1.0578  43 165.50  68.50   24.8 136.0 31.1  93.1  87.3  96.6
## 107   19.1 19.3  1.0547  43 200.25  73.50   26.0 162.0 38.6 105.2 102.8 103.6
## 108   18.2 18.3  1.0569  52 203.25  74.25   26.0 166.3 42.0 110.0 101.6 100.7
## 109   17.2 17.3  1.0593  43 194.00  75.50   24.0 160.6 38.5 110.1  88.7 102.1
## 110   21.0 21.4  1.0500  40 168.50  69.25   24.7 133.1 34.2  97.8  92.3 100.6
## 111   19.5 19.7  1.0538  43 170.75  68.50   25.6 137.5 37.2  96.3  90.6  99.3
## 112   27.1 28.0  1.0355  43 183.25  70.00   26.3 133.5 37.1 108.0 105.0 103.0
## 113   21.6 22.1  1.0486  47 178.25  70.00   25.6 139.7 40.2  99.7  95.0  98.6
## 114   20.9 21.3  1.0503  42 163.00  70.25   23.3 128.9 35.3  93.5  89.6  99.8
## 115   25.9 26.7  1.0384  48 175.25  71.75   24.0 129.9 38.0 100.7  92.4  97.5
## 116   16.7 16.7  1.0607  40 158.00  69.25   23.4 131.7 36.3  97.0  86.6  92.6
## 117   19.8 20.1  1.0529  48 177.25  72.75   23.6 142.1 36.8  96.0  90.0  99.7
## 118   14.1 13.9  1.0671  51 179.00  72.00   24.3 153.8 41.0  99.2  90.0  96.4
## 119   25.1 25.8  1.0404  40 191.00  74.00   24.6 143.1 38.3  95.4  92.4 104.3
## 120   17.9 18.1  1.0575  44 187.50  72.25   25.3 153.8 38.0 101.8  87.5 101.0
## 121   27.0 27.9  1.0358  52 206.50  74.50   26.2 150.7 40.8 104.3  99.2 104.1
## 122   24.6 25.3  1.0414  44 185.25  71.50   25.5 139.6 39.5  99.2  98.1 101.4
## 123   14.8 14.7  1.0652  40 160.25  68.75   23.9 136.5 36.9  99.3  83.3  97.5
## 124   16.0 16.0  1.0623  47 151.50  66.75   23.9 127.3 36.9  94.0  86.1  95.2
## 125   14.0 13.8  1.0674  50 161.00  66.50   25.6 138.5 37.7  98.9  84.1  94.0
## 126   17.4 17.5  1.0587  46 167.00  67.00   26.2 137.9 36.6 101.0  89.9 100.0
## 127   26.4 27.2  1.0373  42 177.50  68.75   26.4 130.7 38.9  98.7  92.1  98.5
## 128   17.4 17.4  1.0590  43 152.25  67.75   23.4 125.8 37.5  95.9  78.0  93.2
## 129   20.4 20.8  1.0515  40 192.25  73.25   25.2 153.0 39.8 103.9  93.5  99.5
## 130   15.0 14.9  1.0648  42 165.25  69.75   23.9 140.5 38.3  96.2  87.0  97.8
## 131   18.0 18.1  1.0575  49 171.75  71.50   23.7 140.9 35.5  97.8  90.1  95.8
## 132   22.2 22.7  1.0472  40 171.25  70.50   24.3 133.3 36.3  94.6  90.3  99.1
## 133   23.1 23.6  1.0452  47 197.00  73.25   25.8 151.2 37.8 103.6  99.8 103.2
## 134   25.3 26.1  1.0398  50 157.00  66.75   24.8 117.2 37.8 100.4  89.4  92.3
## 135   23.8 24.4  1.0435  41 168.25  69.50   24.5 128.3 36.5  98.4  87.2  98.4
## 136   26.3 27.1  1.0374  44 186.00  69.75   26.8 137.1 37.8 104.6 101.1 102.1
## 137   21.4 21.8  1.0491  39 166.75  70.75   23.5 131.0 37.0  92.9  86.1  95.6
## 138   28.4 29.4  1.0325  43 187.75  74.00   24.1 134.4 37.7  97.8  98.6 100.6
## 139   21.8 22.4  1.0481  40 168.25  71.25   23.3 131.6 34.3  98.3  88.5  98.3
## 140   20.1 20.4  1.0522  49 212.75  75.00   26.6 169.9 40.8 104.7 106.6 107.7
## 141   24.3 24.9  1.0422  40 176.75  71.00   24.6 133.8 37.4  98.6  93.1 101.6
## 142   18.1 18.3  1.0571  40 173.25  69.50   25.3 141.8 36.5  99.5  93.0  99.3
## 143   22.7 23.3  1.0459  52 167.00  67.75   25.6 129.0 37.5 102.7  91.0  98.9
## 144    9.9  9.4  1.0775  23 159.75  72.25   21.6 143.9 35.5  92.1  77.1  93.9
## 145   10.8 10.3  1.0754  23 188.15  77.50   22.1 168.4 38.0  96.6  85.3 102.5
## 146   14.4 14.2  1.0664  24 156.00  70.75   21.9 133.6 35.7  92.7  81.9  95.3
## 147   19.0 19.2  1.0550  24 208.50  72.75   27.7 168.9 39.2 102.0  99.1 110.1
## 148   28.6 29.6  1.0322  25 206.50  69.75   29.8 147.5 40.9 110.9 100.5 106.2
## 149    6.1  5.3  1.0873  25 143.75  72.50   19.3 135.0 35.2  92.3  76.5  92.1
## 150   24.5 25.2  1.0416  26 223.00  70.25   31.8 168.3 40.6 114.1 106.8 113.9
## 151    9.9  9.4  1.0776  26 152.25  69.00   22.5 137.2 35.4  92.9  77.6  93.5
## 152   19.1 19.6  1.0542  26 241.75  74.50   30.7 195.1 41.8 108.3 102.9 114.4
## 153   10.6 10.1  1.0758  27 146.00  72.25   19.7 130.5 34.1  88.5  72.8  91.1
## 154   16.5 16.5  1.0610  27 156.75  67.25   24.4 130.9 37.9  94.0  88.2  95.2
## 155   20.5 21.0  1.0510  27 200.25  73.50   26.1 159.3 38.2 101.1 100.1 105.0
## 156   17.2 17.3  1.0594  28 171.50  75.25   21.6 142.0 35.6  92.1  83.5  98.3
## 157   30.1 31.2  1.0287  28 205.75  69.00   30.4 143.9 38.5 105.6 105.0 106.4
## 158   10.5 10.0  1.0761  28 182.50  72.25   24.6 163.4 37.0  98.5  90.8 102.5
## 159   12.8 12.5  1.0704  30 136.50  68.75   20.3 119.1 35.9  88.7  76.6  89.8
## 160   22.0 22.5  1.0477  31 177.25  71.50   24.4 138.3 36.2 101.1  92.4  99.3
## 161    9.9  9.4  1.0775  31 151.25  72.25   20.4 136.2 35.0  94.0  81.2  91.5
## 162   14.8 14.6  1.0653  33 196.00  73.00   25.9 167.0 38.5 103.8  95.6 105.1
## 163   13.3 13.0  1.0690  33 184.25  68.75   24.4 159.8 40.7  98.9  92.1 103.5
## 164   15.2 15.1  1.0644  34 140.00  70.50   19.8 118.8 36.0  89.2  83.4  89.6
## 165   26.5 27.3  1.0370  34 218.75  72.00   29.7 160.8 39.5 111.4 106.0 108.8
## 166   19.0 19.2  1.0549  35 217.00  73.75   28.1 175.8 40.5 107.5  95.1 104.5
## 167   21.4 21.8  1.0492  35 166.25  68.00   25.3 130.7 38.5  99.1  90.4  95.6
## 168   20.0 20.3  1.0525  35 224.75  72.25   30.3 179.7 43.9 108.2 100.4 106.8
## 169   34.7 34.3  1.0180  35 228.25  69.50   33.3 149.3 40.4 114.9 115.9 111.9
## 170   16.5 16.5  1.0610  35 172.75  69.50   25.2 144.2 37.6  99.1  90.8  98.1
## 171    4.1  3.0  1.0926  35 152.25  67.75   23.4 146.1 37.0  92.2  81.9  92.8
## 172    1.9  0.7  1.0983  35 125.75  65.50   20.6 123.4 34.0  90.8  75.0  89.2
## 173   20.2 20.5  1.0521  35 177.25  71.00   24.8 141.7 38.4 100.5  90.3  98.7
## 174   16.8 16.9  1.0603  36 176.25  71.50   24.3 146.6 38.7  98.2  90.3  99.9
## 175   24.6 25.3  1.0414  36 226.75  71.75   31.0 170.9 41.5 115.3 108.8 114.4
## 176   10.4  9.9  1.0763  37 145.25  69.25   21.3 130.2 36.0  96.8  79.4  89.2
## 177   13.4 13.1  1.0689  37 151.00  67.00   23.7 130.8 35.3  92.6  83.2  96.4
## 178   28.8 29.9  1.0316  37 241.25  71.50   33.2 171.7 42.1 119.2 110.3 113.9
## 179   22.0 22.5  1.0477  38 187.25  69.25   27.5 146.1 38.0 102.7  92.7 101.9
## 180   16.8 16.9  1.0603  39 234.75  74.50   29.8 195.3 42.8 109.5 104.5 109.9
## 181   25.8 26.6  1.0387  39 219.25  74.25   28.0 162.7 40.0 108.5 104.6 109.8
## 182    0.0  0.0  1.1089  40 118.50  68.00   18.1 118.5 33.8  79.3  69.4  85.0
## 183   11.9 11.5  1.0725  40 145.75  67.25   22.7 128.4 35.5  95.5  83.6  91.6
## 184   12.4 12.1  1.0713  40 159.25  69.75   23.0 139.5 35.3  92.3  86.8  96.1
```

```
## 185   17.4 17.5  1.0587  40 170.50  74.25   21.8 140.8 37.7  98.9  90.4  95.5
## 186    9.2  8.6  1.0794  40 167.50  71.50   23.1 152.1 39.4  89.5  83.7  98.1
## 187   23.0 23.6  1.0453  41 232.75  74.25   29.7 179.2 41.9 117.5 109.3 108.8
## 188   20.1 20.4  1.0524  41 210.50  72.00   28.6 168.3 38.5 107.4  98.9 104.1
## 189   20.2 20.5  1.0520  41 202.25  72.50   27.0 161.4 40.8 109.2  98.0 101.8
## 190   23.8 24.4  1.0434  41 185.00  68.25   28.0 141.0 38.0 103.4 101.2 103.1
## 191   11.8 11.4  1.0728  41 153.00  69.25   22.5 135.0 36.4  91.4  80.6  92.3
## 192   36.5 38.1  1.0140  42 244.25  76.00   29.8 155.2 41.8 115.2 113.7 112.4
## 193   16.0 15.9  1.0624  42 193.50  70.50   27.4 162.6 40.7 104.9  94.1 102.7
## 194   24.0 24.7  1.0429  42 224.75  74.75   28.3 170.8 38.5 106.7 105.7 111.8
## 195   22.3 22.8  1.0470  42 162.75  72.75   21.6 126.5 35.4  92.2  85.6  96.5
## 196   24.8 25.5  1.0411  42 180.00  68.25   27.2 135.4 38.5 101.6  96.6 100.6
## 197   21.5 22.0  1.0488  42 156.25  69.00   23.1 122.6 35.5  97.8  86.0  96.2
## 198   17.6 17.7  1.0583  42 168.00  71.50   23.1 138.4 36.5  92.0  89.7 101.0
## 199    7.3  6.6  1.0841  42 167.25  72.75   22.3 155.1 37.6  94.0  78.0  99.0
## 200   22.6 23.6  1.0462  43 170.75  67.50   26.4 132.1 37.4 103.7  89.7  94.2
## 201   12.5 12.2  1.0709  43 178.25  70.25   25.4 155.9 37.8 102.7  89.2  99.2
## 202   21.7 22.1  1.0484  43 150.00  69.25   22.0 117.5 35.2  91.1  85.7  96.9
## 203   27.7 28.7  1.0340  43 200.50  71.50   27.6 144.9 37.9 107.2 103.1 105.5
## 204    6.8  6.0  1.0854  44 184.00  74.00   23.7 171.4 37.9 100.8  89.1 102.6
## 205   33.4 34.8  1.0209  44 223.00  69.75   32.3 148.5 40.9 121.6 113.9 107.1
## 206   16.6 16.6  1.0610  44 208.75  73.00   27.6 174.2 41.9 105.6  96.3 102.0
## 207   31.7 32.9  1.0250  44 166.00  65.50   27.2 113.5 39.1 100.6  93.9 100.1
## 208   31.5 32.8  1.0254  47 195.00  72.50   26.1 133.6 40.2 102.7 101.3 101.7
## 209   10.1  9.6  1.0771  47 160.50  70.25   22.9 144.3 36.0  99.8  83.9  91.8
## 210   11.3 10.8  1.0742  47 159.75  70.75   22.5 141.8 34.5  92.9  84.4  94.0
## 211    7.8  7.1  1.0829  49 140.50  68.00   21.4 129.5 35.8  91.2  79.4  89.0
## 212   26.4 27.2  1.0373  49 216.25  74.50   27.4 159.3 40.2 115.6 104.0 109.0
## 213   19.3 19.5  1.0543  49 168.25  71.75   23.0 135.9 38.3  98.3  89.7  99.1
## 214   18.5 18.7  1.0561  50 194.75  70.75   27.4 158.7 39.0 103.7  97.6 104.2
## 215   19.3 19.5  1.0543  50 172.75  73.00   22.8 139.4 37.4  98.7  87.6  96.1
## 216   45.1 47.5  0.9950  51 219.00  64.00   37.6 120.2 41.2 119.8 122.1 112.8
## 217   13.8 13.6  1.0678  51 149.25  69.75   21.6 128.7 34.8  92.8  81.1  96.3
## 218    8.2  7.5  1.0819  51 154.50  70.00   22.2 141.9 36.9  93.3  81.5  94.4
## 219   23.9 24.5  1.0433  52 199.25  71.75   27.2 151.7 39.4 106.8 100.0 105.0
## 220   15.1 15.0  1.0646  53 154.50  69.25   22.7 131.2 37.6  93.9  88.7  94.5
## 221   12.7 12.4  1.0706  54 153.25  70.50   24.5 151.3 38.5  99.0  91.8  96.2
## 222   25.3 26.0  1.0399  54 230.00  72.25   31.0 171.9 42.5 119.9 110.4 105.5
## 223   11.9 11.5  1.0726  54 161.75  67.50   25.0 142.6 37.4  94.2  87.6  95.6
## 224    6.1  5.2  1.0874  55 142.25  67.25   22.2 133.6 35.2  92.7  82.8  91.9
## 225   11.3 10.9  1.0740  55 179.75  68.75   26.8 159.5 41.1 106.9  95.3  98.2
## 226   12.8 12.5  1.0703  55 126.50  66.75   20.0 110.3 33.4  88.8  78.2  87.5
## 227   14.9 14.8  1.0650  55 169.50  68.25   25.6 144.2 37.2 101.7  91.1  97.1
## 228   24.5 25.2  1.0418  55 198.50  74.25   25.3 149.9 38.3 105.3  96.7 106.6
## 229   15.0 14.9  1.0647  56 174.50  69.50   25.4 148.3 38.1 104.0  89.4  98.4
## 230   16.9 17.0  1.0601  56 167.75  68.50   25.2 139.4 37.4  98.6  93.0  97.0
## 231   11.1 10.6  1.0745  57 147.75  65.75   24.1 131.4 35.2  99.6  86.4  90.1
## 232   16.1 16.1  1.0620  57 182.25  71.75   24.9 152.9 39.4 103.4  96.7 100.7
## 233   15.5 15.4  1.0636  58 175.50  71.50   24.2 148.4 38.0 100.2  88.1  97.8
## 234   25.9 26.7  1.0384  58 161.75  67.25   25.2 119.9 35.1  94.9  94.9 100.2
## 235   25.5 25.8  1.0403  60 157.75  67.50   24.1 117.5 40.4  97.2  93.3  94.0
## 236   18.4 18.6  1.0563  62 168.75  67.50   26.1 137.6 38.3 104.7  95.6  93.7
## 237   24.0 24.8  1.0424  62 191.50  72.25   25.8 145.2 40.6 104.0  98.2 101.1
## 238   26.4 27.3  1.0372  63 219.15  69.50   31.9 161.2 40.2 117.6 113.8 111.8
## 239   12.7 12.4  1.0705  64 155.25  69.50   22.6 135.5 37.9  95.8  82.8  94.5
## 240   28.8 29.9  1.0316  65 189.75  65.75   30.9 135.1 40.8 106.4 100.5 100.5
## 241   17.0 17.0  1.0599  65 127.50  65.75   20.8 105.9 34.7  93.0  79.7  87.6
## 242   33.6 35.0  1.0207  65 224.50  68.25   33.9 149.2 38.8 119.6 118.0 114.3
## 243   29.3 30.4  1.0304  66 234.25  72.00   31.8 165.6 41.4 119.7 109.0 109.1
## 244   31.4 32.6  1.0256  67 227.75  72.75   30.3 156.3 41.3 115.8 113.4 109.8
## 245   28.1 29.0  1.0334  67 199.50  68.50   29.9 143.6 40.7 118.3 106.1 101.6
## 246   15.3 15.2  1.0641  68 155.50  69.25   22.8 131.8 36.3  97.4  84.3  94.4
## 247   29.1 30.2  1.0308  69 215.50  70.50   30.5 152.7 40.8 113.7 107.6 110.0
## 248   11.5 11.0  1.0736  70 134.25  67.00   21.1 118.9 34.9  89.2  83.6  88.8
## 249   32.3 33.6  1.0236  72 201.00  69.75   29.1 136.1 40.9 108.5 105.0 104.5
## 250   28.3 29.3  1.0328  72 186.75  66.00   30.2 133.9 38.9 111.1 111.5 101.7
## 251   25.3 26.0  1.0399  72 190.75  70.50   27.0 142.6 38.9 108.3 101.3  97.8
## 252   30.7 31.9  1.0271  74 207.50  70.00   29.8 143.7 40.8 112.4 108.5 107.1
##     thigh knee ankle biceps forearm wrist
## 1    59.0 37.3  21.9   32.0    27.4  17.1
## 2    58.7 37.3  23.4   30.5    28.9  18.2
## 3    59.6 38.9  24.0   28.8    25.2  16.6
## 4    60.1 37.3  22.8   32.4    29.4  18.2
## 5    63.2 42.2  24.0   32.2    27.7  17.7
## 6    66.0 42.0  25.6   35.7    30.6  18.8
## 7    58.4 38.3  22.9   31.9    27.8  17.7
## 8    60.0 39.4  23.2   30.5    29.0  18.8
## 9    62.9 38.3  23.8   35.9    31.1  18.2
## 10   63.1 41.7  25.0   35.6    30.0  19.2
```

```
## 11   59.7 39.7  25.2   32.8    29.4  18.5
## 12   66.2 39.2  25.9   37.2    30.2  19.0
## 13   63.4 38.3  21.5   32.5    28.6  17.7
## 14   66.0 41.5  23.7   36.9    31.6  18.8
## 15   69.0 39.0  23.1   36.1    30.5  18.2
## 16   63.1 38.7  21.7   31.1    26.4  16.9
## 17   64.8 40.8  23.1   36.2    30.8  17.3
## 18   66.9 40.0  24.4   38.2    31.6  19.3
## 19   64.2 38.7  22.9   37.2    30.5  18.5
## 20   65.8 40.6  24.0   37.1    30.1  18.2
## 21   63.5 38.0  22.1   32.5    30.3  18.4
## 22   63.4 40.6  24.6   33.0    32.8  19.9
## 23   57.4 35.3  22.2   27.9    25.9  16.7
## 24   54.9 36.2  22.1   29.8    26.7  17.1
## 25   58.4 35.5  22.9   31.1    28.0  17.6
## 26   55.0 36.7  22.5   29.9    28.2  17.7
## 27   51.7 34.7  21.4   28.7    27.0  16.5
## 28   57.5 36.0  21.0   29.2    26.6  17.0
## 29   50.1 34.5  21.3   30.5    27.9  17.2
## 30   58.9 35.3  22.6   30.1    26.7  17.6
## 31   57.5 38.7  33.9   32.5    27.7  18.4
## 32   58.5 38.8  21.5   30.1    26.4  17.9
## 33   57.3 36.2  24.5   29.0    30.0  18.8
## 34   67.1 44.2  25.2   37.5    31.5  18.7
## 35   71.2 43.3  26.3   37.3    31.7  19.7
## 36   61.9 38.3  21.9   32.0    29.8  17.0
## 37   63.5 39.9  22.6   35.1    30.6  19.0
## 38   66.0 41.5  24.7   33.2    30.5  19.4
## 39   87.3 49.1  29.6   45.0    29.0  21.4
## 40   61.3 41.1  24.7   34.1    31.0  18.3
## 41   72.5 39.6  26.6   36.4    32.7  21.4
## 42   70.6 42.5  23.7   33.6    28.7  17.4
## 43   67.7 40.9  25.0   36.7    29.8  18.4
## 44   65.0 40.2  23.0   35.8    31.5  18.8
## 45   50.0 34.7  21.0   26.1    23.1  16.1
## 46   58.4 38.2  23.4   29.7    27.4  18.3
## 47   53.3 34.5  22.5   27.9    26.2  17.3
## 48   52.7 37.5  21.9   28.8    26.8  17.9
## 49   52.0 35.8  20.6   28.8    25.5  16.3
## 50   50.6 34.4  21.9   26.8    25.8  16.8
## 51   52.6 37.2  22.4   26.0    25.8  17.3
## 52   51.4 34.9  21.0   26.7    26.1  17.2
## 53   49.3 33.7  21.4   29.6    26.0  16.9
## 54   52.6 37.6  22.6   38.5    27.4  18.5
## 55   51.9 34.9  22.5   27.7    27.5  18.5
## 56   57.2 38.0  22.0   35.9    30.2  18.9
## 57   62.1 39.6  22.5   33.1    28.3  18.5
## 58   61.8 39.8  22.7   37.7    30.9  19.2
## 59   59.1 38.0  22.5   31.6    28.8  18.2
## 60   60.6 37.7  22.9   34.5    29.6  18.5
## 61   61.6 40.9  23.1   36.2    31.8  20.2
## 62   60.9 38.0  22.1   32.5    29.8  18.3
## 63   61.0 39.4  23.6   32.7    29.9  19.1
## 64   60.8 40.1  22.7   33.6    29.0  18.8
## 65   65.0 41.2  24.7   35.3    31.1  18.4
## 66   64.8 40.2  22.7   34.8    30.1  18.7
## 67   55.0 36.1  21.7   29.6    27.4  17.4
## 68   54.3 35.4  21.5   32.8    27.4  18.7
## 69   56.0 37.4  22.4   32.6    28.1  18.1
## 70   51.2 37.4  21.6   27.3    27.1  17.3
## 71   56.6 38.6  22.4   31.5    27.3  18.6
## 72   58.9 37.6  21.6   30.3    27.3  18.3
## 73   52.9 37.5  23.1   29.7    27.3  18.2
## 74   50.9 35.4  19.1   29.3    25.7  16.9
## 75   55.5 35.2  20.9   29.4    27.0  16.8
## 76   54.5 37.0  21.4   29.3    27.0  18.3
## 77   56.7 39.7  24.2   30.2    29.2  18.1
## 78   55.0 38.3  21.8   30.8    25.7  18.8
## 79   53.5 37.5  21.5   31.4    26.8  18.3
## 80   56.5 39.3  22.7   30.3    28.7  19.0
## 81   54.8 38.2  23.7   29.4    27.2  19.0
## 82   54.8 38.0  22.0   29.9    25.2  17.7
## 83   58.9 39.0  23.0   34.3    29.6  19.0
## 84   56.0 36.5  24.1   31.2    27.3  19.2
## 85   56.3 36.6  22.0   29.7    26.3  18.0
## 86   54.7 37.8  33.7   32.4    27.7  18.2
## 87   57.2 37.7  21.8   32.6    28.0  18.8
## 88   57.8 39.5  23.3   29.2    28.4  18.1
## 89   61.0 38.4  23.8   30.2    29.3  18.8
```

```
## 90   60.4 39.9  24.4   28.8    29.6  18.7
## 91   58.3 38.2  22.5   29.1    27.7  17.7
## 92   58.9 39.7  23.1   31.4    28.4  18.8
## 93   56.9 38.3  22.1   30.1    28.2  18.4
## 94   58.9 40.5  24.5   33.3    29.6  19.1
## 95   57.4 39.6  24.6   30.3    27.9  17.8
## 96   61.7 42.3  23.2   32.9    30.8  20.4
## 97   60.6 39.4  22.9   31.6    30.1  18.5
## 98   62.1 39.3  23.3   30.6    27.8  18.2
## 99   54.7 37.3  21.9   31.6    27.5  18.2
## 100  62.7 39.0  22.3   35.3    30.9  18.3
## 101  59.0 39.4  22.3   32.2    31.0  18.6
## 102  59.3 38.4  22.4   27.9    26.2  17.0
## 103  60.0 38.4  23.2   31.0    29.2  18.4
## 104  59.1 39.8  25.4   31.0    30.3  19.7
## 105  59.5 36.1  22.0   30.1    27.2  17.7
## 106  54.7 39.0  24.8   31.0    29.4  18.8
## 107  61.2 39.3  23.5   30.5    28.5  18.1
## 108  55.8 38.7  23.4   35.1    29.6  19.1
## 109  57.5 40.0  24.8   35.1    30.7  19.2
## 110  57.5 36.8  22.8   32.1    26.0  17.3
## 111  61.9 38.0  22.3   33.3    28.2  18.1
## 112  63.7 40.0  23.6   33.5    27.8  17.4
## 113  62.3 38.1  23.9   35.3    31.1  19.8
## 114  61.5 37.8  21.9   30.7    27.6  17.4
## 115  59.3 38.1  21.8   31.8    27.3  17.5
## 116  55.9 36.3  22.1   29.8    26.3  17.3
## 117  58.8 38.4  22.8   29.9    28.0  18.1
## 118  56.8 38.8  23.3   33.4    29.8  19.5
## 119  64.6 41.1  24.8   33.6    29.5  18.5
## 120  58.5 39.2  24.5   32.1    28.6  18.0
## 121  58.5 39.3  24.6   33.9    31.2  19.5
## 122  57.1 40.5  23.2   33.0    29.6  18.4
## 123  60.5 38.7  22.6   34.4    28.0  17.6
## 124  58.1 36.5  22.1   30.6    27.5  17.6
## 125  58.5 36.6  23.5   34.4    29.2  18.0
## 126  60.7 36.0  21.9   35.6    30.2  17.6
## 127  60.7 36.8  22.2   33.8    30.3  17.2
## 128  53.5 35.8  20.8   33.9    28.2  17.4
## 129  61.7 39.0  21.8   33.3    29.6  18.1
## 130  57.4 36.9  22.2   31.6    27.8  17.7
## 131  57.0 38.7  23.2   27.5    26.5  17.6
## 132  60.3 38.5  23.0   31.2    28.4  17.1
## 133  61.2 38.1  22.6   33.5    28.6  17.9
## 134  56.1 35.6  20.5   33.6    29.3  17.3
## 135  56.0 36.9  23.0   34.0    29.8  18.1
## 136  58.9 37.9  22.7   30.9    28.8  17.6
## 137  58.8 36.1  22.4   32.7    28.3  17.1
## 138  63.6 39.2  23.8   34.3    28.4  17.7
## 139  58.1 38.4  22.5   31.7    27.4  17.6
## 140  66.5 42.5  24.5   35.5    29.8  18.7
## 141  59.1 39.6  21.6   30.8    27.9  16.6
## 142  60.4 38.2  22.0   32.0    28.5  17.8
## 143  57.1 36.7  22.3   31.6    27.5  17.9
## 144  56.1 36.1  22.7   30.5    27.2  18.2
## 145  59.1 37.6  23.2   31.8    29.7  18.3
## 146  56.4 36.5  22.0   33.5    28.3  17.3
## 147  71.2 43.5  25.2   36.1    30.3  18.7
## 148  68.4 40.8  24.6   33.3    29.7  18.4
## 149  51.9 35.7  22.0   25.8    25.2  16.9
## 150  67.6 42.7  24.7   36.0    30.4  18.4
## 151  56.9 35.9  20.4   31.6    29.0  17.8
## 152  72.9 43.5  25.1   38.5    33.8  19.6
## 153  53.6 36.8  23.8   27.8    26.3  17.4
## 154  56.8 37.4  22.8   30.6    28.3  17.9
## 155  62.1 40.0  24.9   33.7    29.2  19.4
## 156  57.3 37.8  21.7   32.2    27.7  17.7
## 157  68.6 40.0  25.2   35.2    30.7  19.1
## 158  60.8 38.5  25.0   31.6    28.0  18.6
## 159  50.1 34.8  21.8   27.0    34.9  16.9
## 160  59.4 39.0  24.6   30.1    28.2  18.2
## 161  52.5 36.6  21.0   27.0    26.3  16.5
## 162  61.4 40.6  25.0   31.3    29.2  19.1
## 163  64.0 37.3  23.5   33.5    30.6  19.7
## 164  52.4 35.6  20.4   28.3    26.2  16.5
## 165  63.8 42.0  23.4   34.0    31.2  18.5
## 166  64.8 41.3  25.6   36.4    33.7  19.4
## 167  55.5 34.2  21.9   30.2    28.7  17.7
## 168  63.3 41.7  24.6   37.2    33.1  19.8
```

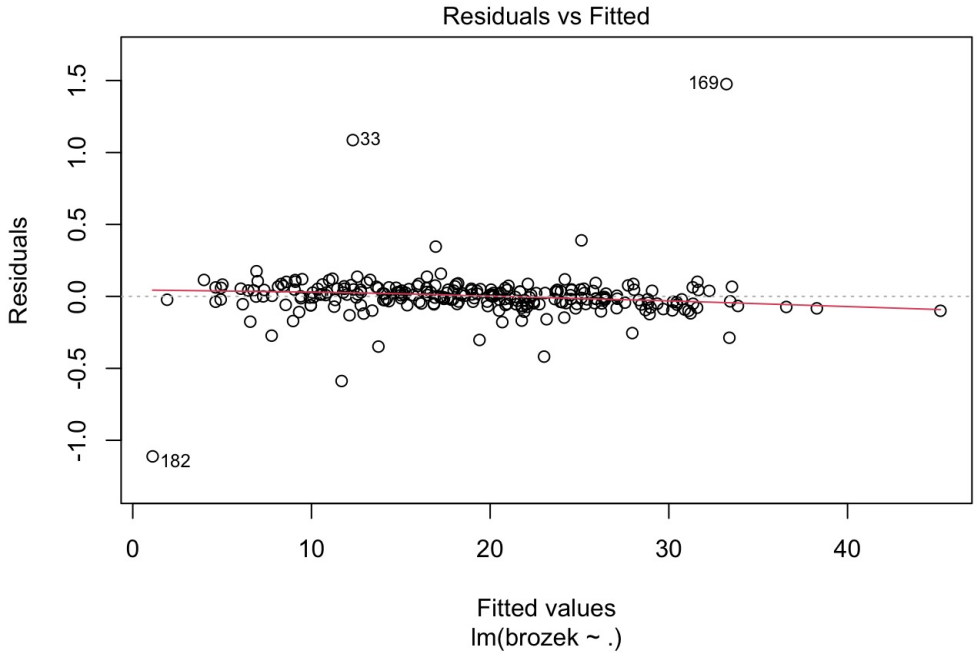
```
## 169  74.4 40.6  24.0   36.1    31.8  18.8
## 170  60.1 39.1  23.4   32.5    29.8  17.4
## 171  54.7 36.2  22.1   30.4    27.4  17.7
## 172  50.0 34.8  22.0   24.8    25.9  16.9
## 173  57.8 37.3  22.4   31.0    28.7  17.7
## 174  59.2 37.7  21.5   32.4    28.4  17.8
## 175  69.2 42.4  24.0   35.4    21.0  20.1
## 176  50.3 34.8  22.2   31.0    26.9  16.9
## 177  60.0 38.1  22.0   31.5    26.6  16.7
## 178  69.8 42.6  24.8   34.4    29.5  18.4
## 179  64.7 39.5  24.7   34.8    30.3  18.1
## 180  69.5 43.1  25.8   39.1    32.5  19.9
## 181  68.1 42.8  24.1   35.6    29.0  19.0
## 182  47.2 33.5  20.2   27.7    24.6  16.5
## 183  54.1 36.2  21.8   31.4    28.3  17.2
## 184  58.0 39.4  22.7   30.0    26.4  17.4
## 185  55.4 38.9  22.4   30.5    28.9  17.7
## 186  57.3 39.7  22.6   32.9    29.3  18.2
## 187  67.7 41.3  24.7   37.2    31.8  20.0
## 188  63.5 39.8  23.5   36.4    30.4  19.1
## 189  62.8 41.3  24.8   36.6    32.4  18.8
## 190  61.5 40.4  22.9   33.4    29.2  18.5
## 191  54.3 36.3  21.8   29.6    27.3  17.9
## 192  68.5 45.0  25.5   37.1    31.2  19.9
## 193  60.6 38.6  24.7   34.0    30.1  18.7
## 194  65.3 43.3  26.0   33.7    29.9  18.5
## 195  60.2 38.9  22.4   31.7    27.1  17.1
## 196  61.1 38.4  24.1   32.9    29.8  18.8
## 197  57.7 38.6  24.0   31.2    27.3  17.4
## 198  62.3 38.0  22.3   30.8    27.8  16.9
## 199  57.5 40.0  22.5   30.6    30.0  18.5
## 200  58.5 39.0  24.1   33.8    28.8  18.8
## 201  60.2 39.2  23.8   31.7    28.4  18.6
## 202  55.5 35.7  22.0   29.4    26.6  17.4
## 203  68.8 38.3  23.7   32.1    28.9  18.7
## 204  60.6 39.0  24.0   32.9    29.2  18.4
## 205  63.5 40.3  21.8   34.8    30.7  17.4
## 206  63.3 39.8  24.1   37.3    23.1  19.4
## 207  58.9 37.6  21.4   33.1    29.5  17.3
## 208  60.7 39.4  23.3   36.7    31.6  18.4
## 209  53.0 36.2  22.5   31.4    27.5  17.7
## 210  56.0 38.2  22.6   29.0    26.2  17.6
## 211  51.1 35.0  21.7   30.9    28.8  17.4
## 212  63.7 40.3  23.2   36.8    31.0  18.9
## 213  56.3 38.8  23.0   29.5    27.9  18.6
## 214  60.0 40.9  25.5   32.7    30.0  19.0
## 215  57.1 38.1  21.8   28.6    26.7  18.0
## 216  62.5 36.9  23.6   34.7    29.1  18.4
## 217  53.8 36.5  21.5   31.3    26.3  17.8
## 218  54.7 39.0  22.6   27.5    25.9  18.6
## 219  63.9 39.2  22.9   35.7    30.4  19.2
## 220  53.7 36.2  22.0   28.5    25.7  17.1
## 221  57.7 38.1  23.9   31.4    29.9  18.9
## 222  64.2 42.7  27.0   38.4    32.0  19.6
## 223  59.7 40.2  23.4   27.9    27.0  17.8
## 224  54.4 35.2  22.5   29.4    26.8  17.0
## 225  57.4 37.1  21.8   34.1    31.1  19.2
## 226  50.8 33.0  19.7   25.3    22.0  15.8
## 227  56.6 38.5  22.6   33.4    29.3  18.8
## 228  64.0 42.6  23.4   33.2    30.0  18.4
## 229  58.4 37.4  22.5   34.6    30.1  18.8
## 230  55.4 38.8  23.2   32.4    29.7  19.0
## 231  53.0 35.0  21.3   31.7    27.3  16.9
## 232  59.3 38.6  22.8   31.8    29.1  19.0
## 233  57.1 38.9  23.6   30.9    29.6  18.0
## 234  56.8 35.9  21.0   27.8    26.1  17.6
## 235  54.3 35.7  21.0   31.3    28.7  18.3
## 236  54.4 37.1  22.7   30.3    26.3  18.3
## 237  59.3 40.3  23.0   32.6    28.5  19.0
## 238  63.4 41.1  22.3   35.1    29.6  18.5
## 239  61.2 39.1  22.3   29.8    28.9  18.3
## 240  59.2 38.1  24.0   35.9    30.5  19.1
## 241  50.7 33.4  20.1   28.5    24.8  16.5
## 242  61.3 42.1  23.4   34.9    30.1  19.4
## 243  63.7 42.4  24.6   35.6    30.7  19.5
## 244  65.6 46.0  25.4   35.3    29.8  19.5
## 245  58.2 38.8  24.1   32.1    29.3  18.5
## 246  54.3 37.5  22.6   29.2    27.3  18.5
## 247  63.3 44.0  22.6   37.5    32.6  18.8
```

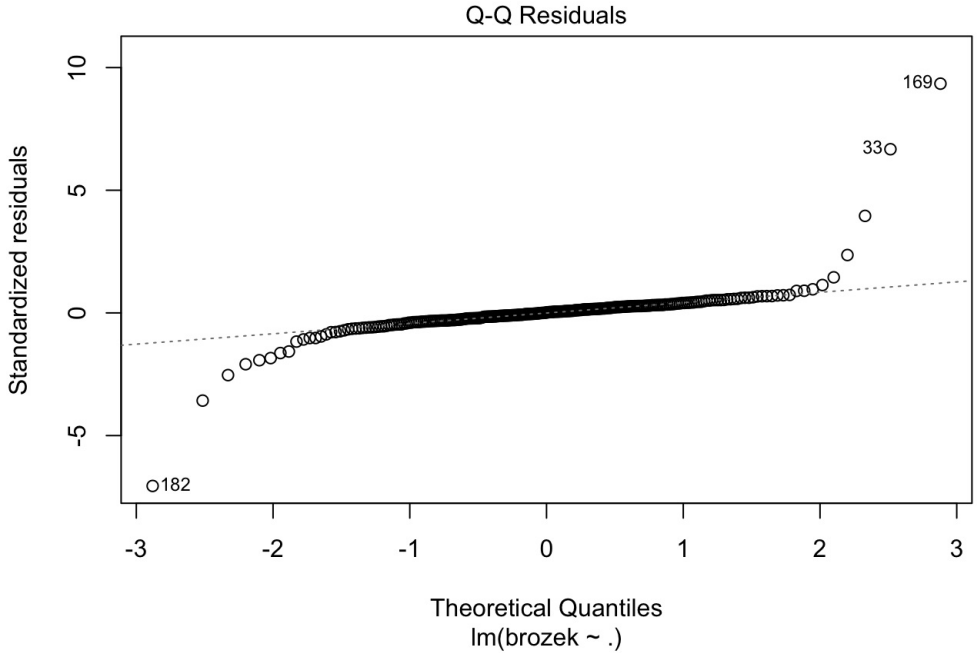
```
## 248  49.6 34.8  21.5   25.6    25.7  18.5
## 249  59.6 40.8  23.2   35.2    28.6  20.1
## 250  60.3 37.3  21.5   31.3    27.2  18.0
## 251  56.0 41.6  22.7   30.5    29.4  19.8
## 252  59.3 42.2  24.6   33.7    30.0  20.9
```

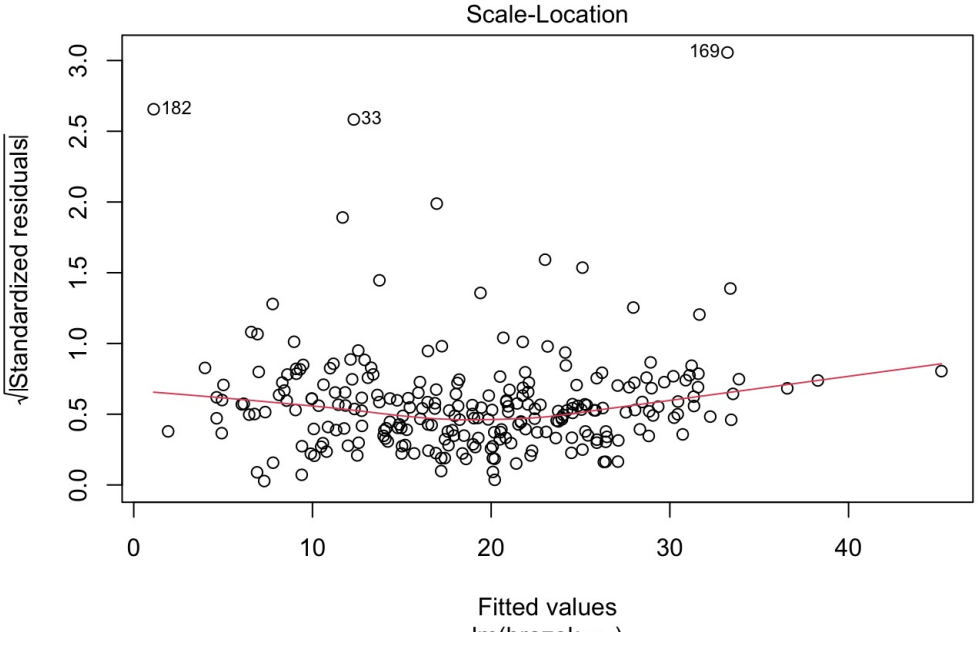
```
lm_model1 <- lm(formula = brozek~. , data = csv_file)
summary(lm_model1)
```

```
##
## Call:
## lm(formula = brozek ~ ., data = csv_file)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.11191 -0.04847  0.00277  0.04625  1.47542
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.1524013  4.1718589   2.913  0.00393 **
## siri         0.8884085  0.0111341  79.792  < 2e-16 ***
## density     -9.8456305  3.7471770  -2.627  0.00917 **
## age         -0.0005268  0.0012935  -0.407  0.68421
## weight       0.0084855  0.0036200   2.344  0.01991 *
## height      -0.0005459  0.0044439  -0.123  0.90234
## adipos      -0.0153248  0.0124778  -1.228  0.22062
## free        -0.0097388  0.0044270  -2.200  0.02880 *
## neck         0.0005002  0.0094279   0.053  0.95773
## chest        0.0021454  0.0043013   0.499  0.61840
## abdom        0.0014464  0.0044217   0.327  0.74388
## hip         -0.0044514  0.0058941  -0.755  0.45087
## thigh        0.0156926  0.0059507   2.637  0.00892 **
## knee        -0.0252126  0.0098531  -2.559  0.01113 *
## ankle        0.0027790  0.0089580   0.310  0.75667
## biceps      -0.0147134  0.0069201  -2.126  0.03454 *
## forearm      0.0149983  0.0080832   1.855  0.06478 .
## wrist        0.0326518  0.0218000   1.498  0.13554
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1706 on 234 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 3.046e+04 on 17 and 234 DF,  p-value: < 2.2e-16
```

```
par(mfrow = c(1,1))
plot(lm_model1)
```


Residuals vs Fitted
Residuals
Fitted values
lm(brozek ~ .)
169
33
182

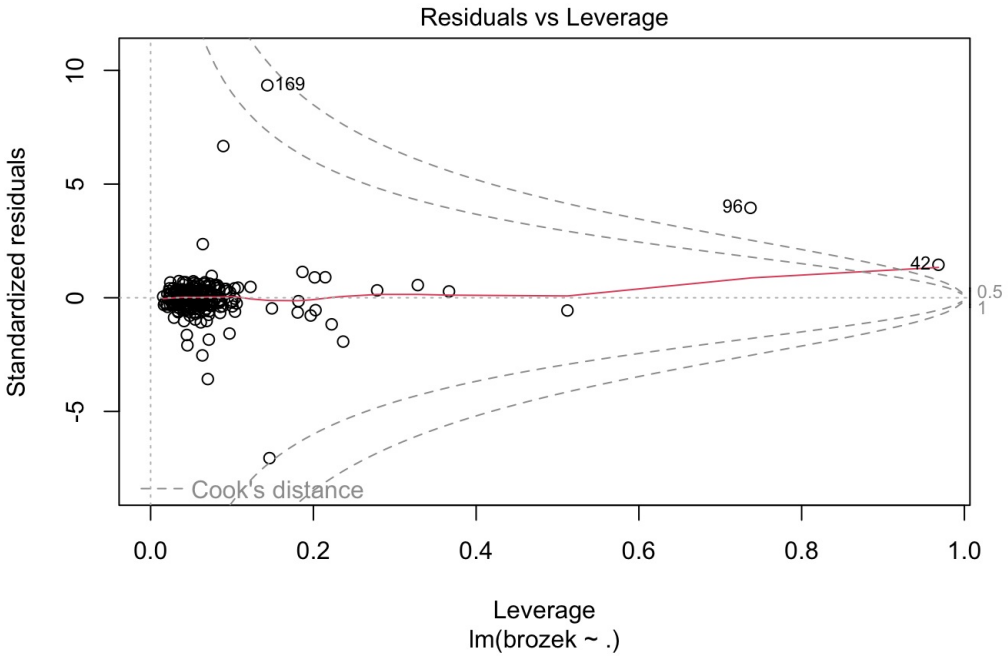

Q-Q Residuals
Standardized residuals
Theoretical Quantiles
lm(brozek ~ .)
169
33
182


Scale-Location
√|Standardized residuals|
Fitted values
169
33
182

lm(brozek ~ .)

```
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced

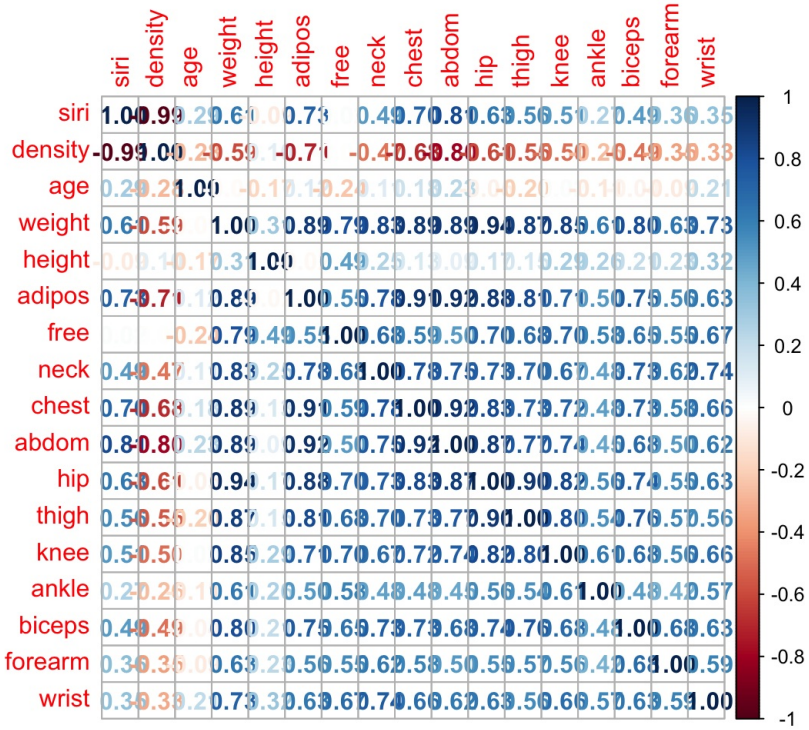
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced
```




```
#Filter using correlation method:
correlations <- cor(csv_file[,-1])
correlations
```

```
##                siri     density         age      weight      height      adipos
## siri     1.00000000 -0.98778240  0.29145844  0.61241400 -0.08949538  0.72748388
## density -0.98778240  1.00000000 -0.27763721 -0.59406188  0.09788114 -0.71473204
## age      0.29145844 -0.27763721  1.00000000 -0.01274609 -0.17164514  0.11885126
## weight   0.61241400 -0.59406188 -0.01274609  1.00000000  0.30827854  0.88735216
## height  -0.08949538  0.09788114 -0.17164514  0.30827854  1.00000000 -0.02489094
## adipos   0.72748388 -0.71473204  0.11885126  0.88735216 -0.02489094  1.00000000
## free     0.01937491 -0.00574871 -0.23790534  0.79219519  0.48779841  0.54719009
## neck     0.49059185 -0.47296636  0.11350519  0.83071622  0.25370988  0.77785691
## chest    0.70262034 -0.68259865  0.17644968  0.89419052  0.13489181  0.91179865
## abdom    0.81343228 -0.79895463  0.23040942  0.88799494  0.08781291  0.92388010
## hip      0.62520092 -0.60933143 -0.05033212  0.94088412  0.17039426  0.88326922
## thigh    0.55960753 -0.55309098 -0.20009576  0.86869354  0.14843561  0.81270609
## knee     0.50866524 -0.49504035  0.01751569  0.85316739  0.28605321  0.71365983
## ankle    0.26596977 -0.26489003 -0.10505810  0.61368542  0.26474369  0.50031664
## biceps   0.49327113 -0.48710872 -0.04116212  0.80041593  0.20781557  0.74638418
## forearm  0.36138690 -0.35164842 -0.08505555  0.63030143  0.22864922  0.55859425
## wrist    0.34657486 -0.32571598  0.21353062  0.72977489  0.32206533  0.62590659
##                free       neck      chest       abdom         hip      thigh
## siri     0.01937491  0.4905919  0.7026203  0.81343228  0.62520092  0.5596075
## density -0.00574871 -0.4729664 -0.6825987 -0.79895463 -0.60933143 -0.5530910
## age     -0.23790534  0.1135052  0.1764497  0.23040942 -0.05033212 -0.2000958
## weight   0.79219519  0.8307162  0.8941905  0.88799494  0.94088412  0.8686935
## height   0.48779841  0.2537099  0.1348918  0.08781291  0.17039426  0.1484356
## adipos   0.54719009  0.7778569  0.9117986  0.92388010  0.88326922  0.8127061
## free     1.00000000  0.6791180  0.5929571  0.49565221  0.70348104  0.6766805
## neck     0.67911804  1.0000000  0.7848350  0.75407737  0.73495788  0.6956973
## chest    0.59295714  0.7848350  1.0000000  0.91582767  0.82941992  0.7298586
## abdom    0.49565221  0.7540774  0.9158277  1.00000000  0.87406618  0.7666239
## hip      0.70348104  0.7349579  0.8294199  0.87406618  1.00000000  0.8964098
## thigh    0.67668053  0.6956973  0.7298586  0.76662393  0.89640979  1.0000000
## knee     0.70362435  0.6724050  0.7194964  0.73717888  0.82347262  0.7991703
## ankle    0.58294600  0.4778924  0.4829879  0.45322269  0.55838682  0.5397971
## biceps   0.64929534  0.7311459  0.7279075  0.68498272  0.73927252  0.7614774
## forearm  0.55027717  0.6236603  0.5801727  0.50331609  0.54501412  0.5668422
## wrist    0.67335898  0.7448264  0.6601623  0.61983243  0.63008954  0.5586848
##                knee      ankle      biceps     forearm      wrist
## siri     0.50866524  0.2659698  0.49327113  0.36138690  0.3465749
## density -0.49504035 -0.2648900 -0.48710872 -0.35164842 -0.3257160
## age      0.01751569 -0.1050581 -0.04116212 -0.08505555  0.2135306
## weight   0.85316739  0.6136854  0.80041593  0.63030143  0.7297749
## height   0.28605321  0.2647437  0.20781557  0.22864922  0.3220653
## adipos   0.71365983  0.5003166  0.74638418  0.55859425  0.6259066
## free     0.70362435  0.5829460  0.64929534  0.55027717  0.6733590
## neck     0.67240498  0.4778924  0.73114592  0.62366027  0.7448264
## chest    0.71949640  0.4829879  0.72790748  0.58017273  0.6601623
## abdom    0.73717888  0.4532227  0.68498272  0.50331609  0.6198324
## hip      0.82347262  0.5583868  0.73927252  0.54501412  0.6300895
## thigh    0.79917030  0.5397971  0.76147745  0.56684218  0.5586848
## knee     1.00000000  0.6116082  0.67870883  0.55589819  0.6645073
## ankle    0.61160820  1.0000000  0.48485454  0.41904999  0.5661946
## biceps   0.67870883  0.4848545  1.00000000  0.67825513  0.6321264
## forearm  0.55589819  0.4190500  0.67825513  1.00000000  0.5855883
## wrist    0.66450729  0.5661946  0.63212642  0.58558825  1.0000000
```

```
corrplot(correlations, method = 'number')
```




```
variable_name <- names(which(abs(correlations[, 1]) > 0.5))
variable_name
```

```
## [1] "siri"    "density" "weight"  "adipos"  "chest"   "abdom"   "hip"
## [8] "thigh"   "knee"
```

```
concat_var_names <- paste(variable_name, collapse = "+ ")
print(concat_var_names)
```

```
## [1] "siri+ density+ weight+ adipos+ chest+ abdom+ hip+ thigh+ knee"
```

```
formula <- reformulate(concat_var_names, response = "brozek")
formula
```

```
## brozek ~ siri + density + weight + adipos + chest + abdom + hip +
##     thigh + knee
```

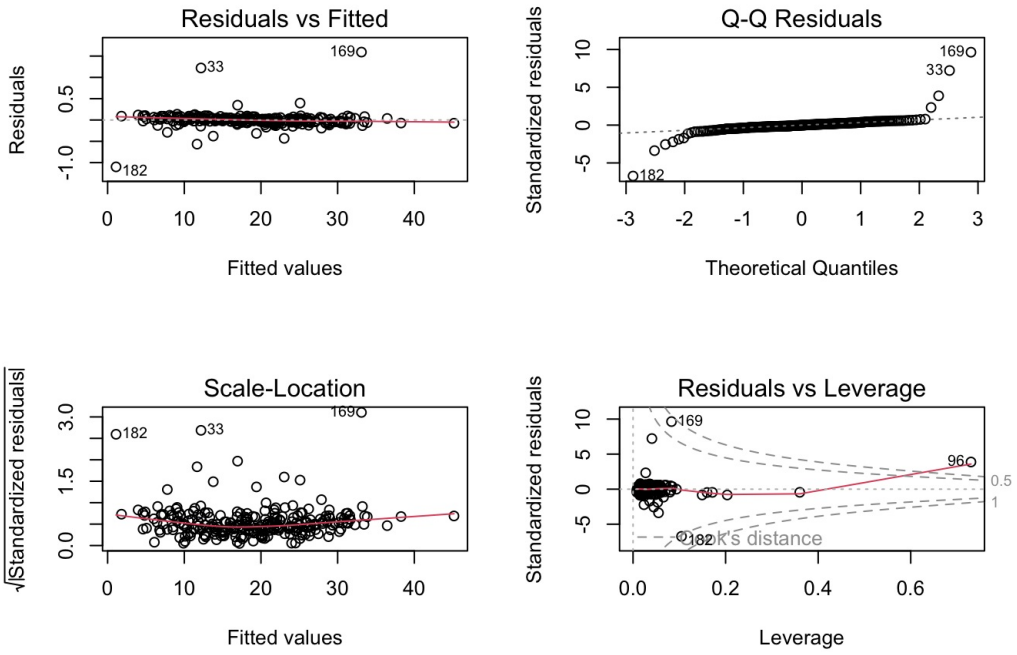
```
lm_filter_model <- lm(formula, data = csv_file)
summary(lm_filter_model)
```

```
##
## Call:
## lm(formula = formula, data = csv_file)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.09987 -0.03998 -0.00079  0.03880  1.59318
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 11.626306   4.121816   2.821  0.00519 **
## siri         0.904779   0.008716 103.812  < 2e-16 ***
## density     -9.020618   3.740332  -2.412  0.01662 *
## weight       0.001973   0.001600   1.233  0.21880
## adipos      -0.006343   0.009961  -0.637  0.52488
## chest       -0.000166   0.004190  -0.040  0.96843
## abdom        0.001062   0.004016   0.265  0.79160
## hip         -0.004815   0.005569  -0.865  0.38809
## thigh        0.010538   0.005213   2.022  0.04433 *
## knee        -0.023617   0.009198  -2.568  0.01084 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1726 on 242 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 5.622e+04 on 9 and 242 DF,  p-value: < 2.2e-16
```

```
anova_result <- anova(lm_filter_model,lm_model1)
print(anova_result)
```

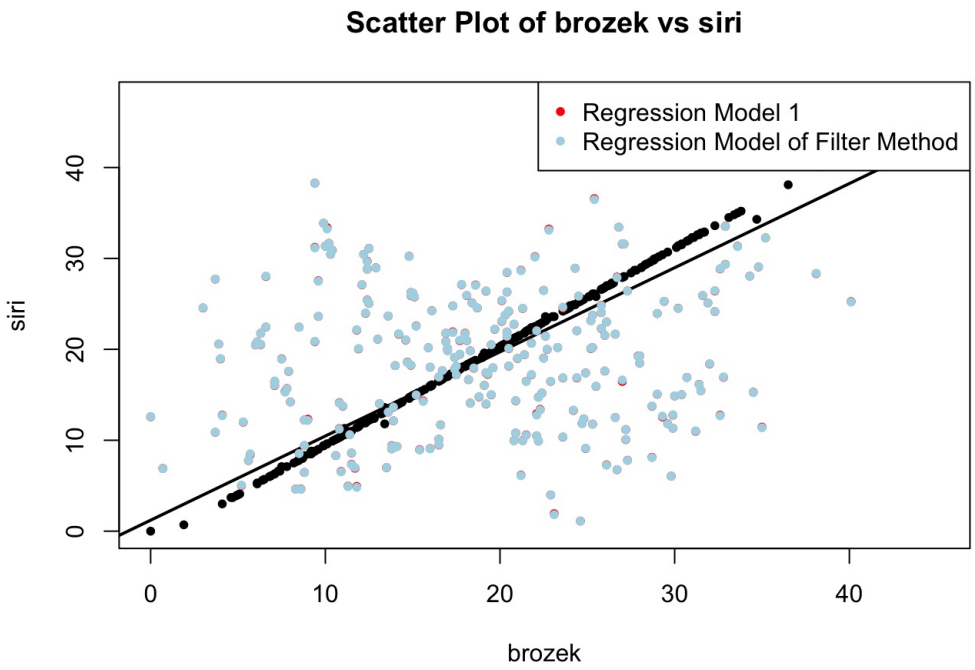
```
## Analysis of Variance Table
##
## Model 1: brozek ~ siri + density + weight + adipos + chest + abdom + hip +
##     thigh + knee
## Model 2: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##   Res.Df    RSS Df Sum of Sq      F  Pr(>F)
## 1    242 7.2088
## 2    234 6.8105  8   0.39831 1.7107 0.09669 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
par(mfrow = c(2, 2))
plot(lm_filter_model)
```



```
par(mfrow = c(1, 1))
plot(csv_file$brozek, csv_file$siri,
     main = "Scatter Plot of brozek vs siri",
     xlab = "brozek", ylab = "siri", pch = 20
)
abline(lm(brozek ~ siri, data = csv_file), col = "black", lwd = 2)
points(sort(csv_file$siri), lm_model1$fitted.values, col = "red", pch = 20)
points(sort(csv_file$siri), lm_filter_model$fitted.values, col = "lightblue", pch = 20)

legend("topright", legend = c("Regression Model 1", "Regression Model of Filter Method"),
       col = c("red", "lightblue"), pch = 20)
```




```
#wrapper method
#Forward Method:
forward_model <- step(lm_model1, direction = "forward", scope = formula(~ .))
```

```
## Start:  AIC=-873.96
## brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
```

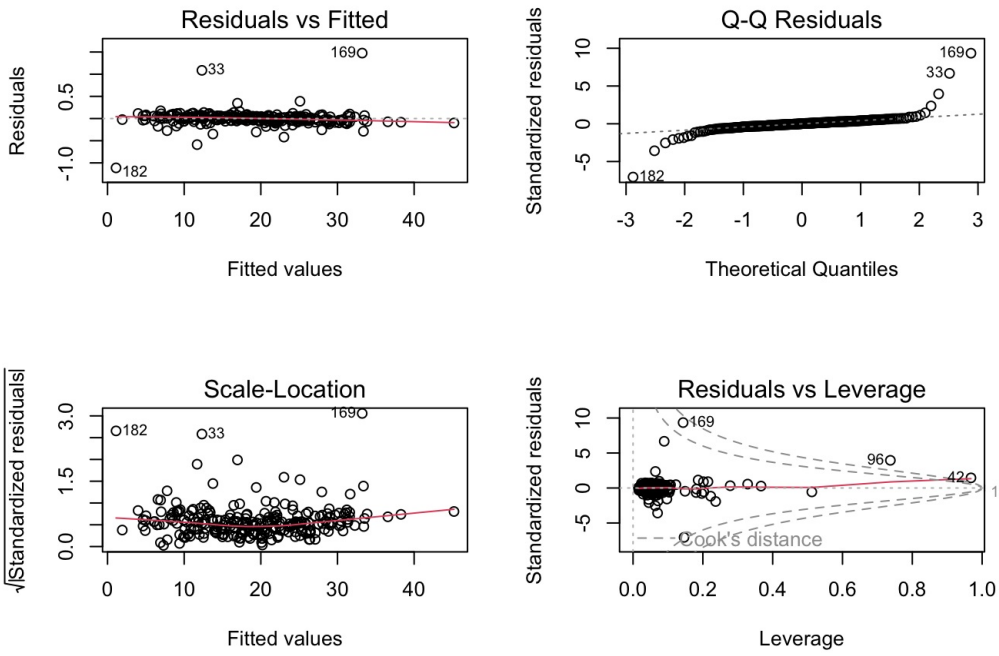
```
summary(forward_model)
```

```
##
## Call:
## lm(formula = brozek ~ siri + density + age + weight + height +
##     adipos + free + neck + chest + abdom + hip + thigh + knee +
##     ankle + biceps + forearm + wrist, data = csv_file)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.11191 -0.04847  0.00277  0.04625  1.47542
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) 12.1524013  4.1718589   2.913  0.00393 **
## siri         0.8884085  0.0111341  79.792  < 2e-16 ***
## density     -9.8456305  3.7471770  -2.627  0.00917 **
## age         -0.0005268  0.0012935  -0.407  0.68421
## weight       0.0084855  0.0036200   2.344  0.01991 *
## height      -0.0005459  0.0044439  -0.123  0.90234
## adipos      -0.0153248  0.0124778  -1.228  0.22062
## free        -0.0097388  0.0044270  -2.200  0.02880 *
## neck         0.0005002  0.0094279   0.053  0.95773
## chest        0.0021454  0.0043013   0.499  0.61840
## abdom        0.0014464  0.0044217   0.327  0.74388
## hip         -0.0044514  0.0058941  -0.755  0.45087
## thigh        0.0156926  0.0059507   2.637  0.00892 **
## knee        -0.0252126  0.0098531  -2.559  0.01113 *
## ankle        0.0027790  0.0089580   0.310  0.75667
## biceps      -0.0147134  0.0069201  -2.126  0.03454 *
## forearm      0.0149983  0.0080832   1.855  0.06478 .
## wrist        0.0326518  0.0218000   1.498  0.13554
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1706 on 234 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 3.046e+04 on 17 and 234 DF,  p-value: < 2.2e-16
```

```
par(mfrow = c(2, 2))
plot(forward_model)
```

```
## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced

## Warning in sqrt(crit * p * (1 - hh)/hh): NaNs produced
```




```
par(mfrow = c(1, 1))
anova_result <- anova(forward_model,lm_model1)
print(anova_result)
```

```
## Analysis of Variance Table
##
## Model 1: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
## Model 2: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##   Res.Df    RSS Df Sum of Sq F Pr(>F)
## 1    234 6.8105
## 2    234 6.8105  0         0
```

```
# Backward stepwise regression
backward_model <- step(lm_model1, direction = "backward")
```

```
## Start:  AIC=-873.96
## brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - neck     1     0.000   6.811 -875.96
## - height   1     0.000   6.811 -875.95
## - ankle    1     0.003   6.813 -875.86
## - abdom    1     0.003   6.814 -875.85
## - age      1     0.005   6.815 -875.78
## - chest    1     0.007   6.818 -875.69
## - hip      1     0.017   6.827 -875.35
## - adipos   1     0.044   6.854 -874.34
## <none>                   6.811 -873.96
## - wrist    1     0.065   6.876 -873.56
## - forearm  1     0.100   6.911 -872.28
## - biceps   1     0.132   6.942 -871.14
## - free     1     0.141   6.951 -870.80
## - weight   1     0.160   6.970 -870.11
## - knee     1     0.191   7.001 -869.01
## - density  1     0.201   7.011 -868.64
## - thigh    1     0.202   7.013 -868.58
## - siri     1   185.301 192.112  -34.38
##
## Step:  AIC=-875.96
## brozek ~ siri + density + age + weight + height + adipos + free +
##     chest + abdom + hip + thigh + knee + ankle + biceps + forearm +
##     wrist
##
##           Df Sum of Sq     RSS     AIC
## - height   1     0.000   6.811 -877.94
## - ankle    1     0.003   6.813 -877.86
## - abdom    1     0.003   6.814 -877.84
## - age      1     0.005   6.815 -877.78
## - chest    1     0.007   6.818 -877.69
## - hip      1     0.018   6.828 -877.30
## - adipos   1     0.045   6.855 -876.32
## <none>                   6.811 -875.96
## - wrist    1     0.070   6.881 -875.37
## - forearm  1     0.102   6.913 -874.21
## - biceps   1     0.132   6.942 -873.13
## - free     1     0.141   6.952 -872.79
## - weight   1     0.162   6.973 -872.03
## - knee     1     0.194   7.005 -870.88
## - density  1     0.201   7.011 -870.64
## - thigh    1     0.204   7.015 -870.51
## - siri     1   185.431 192.242  -36.21
##
## Step:  AIC=-877.94
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     abdom + hip + thigh + knee + ankle + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - ankle    1     0.003   6.814 -879.84
## - abdom    1     0.003   6.814 -879.83
## - age      1     0.004   6.816 -879.78
## - chest    1     0.007   6.818 -879.67
## - hip      1     0.017   6.828 -879.30
## - adipos   1     0.051   6.862 -878.06
## <none>                   6.811 -877.94
## - wrist    1     0.070   6.881 -877.37
```

```
## - forearm  1     0.102   6.913 -876.18
## - biceps   1     0.132   6.943 -875.11
## - free     1     0.144   6.955 -874.66
## - weight   1     0.164   6.975 -873.94
## - knee     1     0.194   7.005 -872.88
## - density  1     0.201   7.012 -872.63
## - thigh    1     0.209   7.020 -872.34
## - siri     1   185.679 192.490  -37.89
##
## Step:  AIC=-879.84
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     abdom + hip + thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - abdom    1     0.002   6.816 -881.76
## - age      1     0.005   6.819 -881.64
## - chest    1     0.007   6.820 -881.60
## - hip      1     0.018   6.832 -881.18
## - adipos   1     0.049   6.862 -880.05
## <none>                   6.814 -879.84
## - wrist    1     0.079   6.893 -878.93
## - forearm  1     0.101   6.914 -878.14
## - biceps   1     0.136   6.950 -876.87
## - free     1     0.142   6.956 -876.65
## - weight   1     0.165   6.979 -875.81
## - knee     1     0.192   7.006 -874.84
## - thigh    1     0.206   7.020 -874.32
## - density  1     0.207   7.021 -874.29
## - siri     1   185.676 192.490  -39.88
##
## Step:  AIC=-881.76
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     hip + thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - age      1     0.004   6.820 -883.62
## - chest    1     0.009   6.825 -883.41
## - hip      1     0.016   6.832 -883.16
## - adipos   1     0.046   6.862 -882.05
## <none>                   6.816 -881.76
## - wrist    1     0.079   6.895 -880.87
## - forearm  1     0.099   6.915 -880.14
## - free     1     0.141   6.957 -878.61
## - biceps   1     0.145   6.961 -878.44
## - weight   1     0.171   6.987 -877.52
## - knee     1     0.194   7.010 -876.68
## - thigh    1     0.206   7.022 -876.25
## - density  1     0.214   7.030 -875.96
## - siri     1   186.665 193.481  -40.59
##
## Step:  AIC=-883.62
## brozek ~ siri + density + weight + adipos + free + chest + hip +
##     thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - chest    1     0.008   6.828 -885.32
## - hip      1     0.016   6.836 -885.03
## - adipos   1     0.051   6.871 -883.75
## <none>                   6.820 -883.62
## - wrist    1     0.077   6.897 -882.78
## - forearm  1     0.112   6.931 -881.53
## - free     1     0.140   6.960 -880.49
## - biceps   1     0.147   6.967 -880.23
## - weight   1     0.177   6.997 -879.15
## - knee     1     0.217   7.036 -877.74
## - density  1     0.217   7.036 -877.74
## - thigh    1     0.260   7.079 -876.21
## - siri     1   187.939 194.759  -40.93
##
## Step:  AIC=-885.32
## brozek ~ siri + density + weight + adipos + free + hip + thigh +
##     knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - hip      1     0.021   6.849 -886.54
## - adipos   1     0.045   6.873 -885.66
## <none>                   6.828 -885.32
## - wrist    1     0.075   6.903 -884.58
## - forearm  1     0.112   6.940 -883.22
```

```
## - free     1     0.132   6.960 -882.49
## - biceps   1     0.149   6.977 -881.88
## - weight   1     0.179   7.007 -880.81
## - density  1     0.212   7.040 -879.61
## - knee     1     0.219   7.046 -879.38
## - thigh    1     0.256   7.084 -878.03
## - siri     1   199.520 206.348  -28.37
##
## Step:  AIC=-886.54
## brozek ~ siri + density + weight + adipos + free + thigh + knee +
##     biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## <none>                   6.849 -886.54
## - adipos   1     0.064   6.913 -886.21
## - wrist    1     0.084   6.933 -885.47
## - free     1     0.129   6.978 -883.84
## - forearm  1     0.129   6.978 -883.84
## - biceps   1     0.137   6.986 -883.57
## - weight   1     0.159   7.008 -882.75
## - density  1     0.218   7.067 -880.65
## - knee     1     0.235   7.084 -880.04
## - thigh    1     0.241   7.090 -879.84
## - siri     1   199.499 206.349  -30.37
```

```
summary(backward_model)
```

```
##
## Call:
## lm(formula = brozek ~ siri + density + weight + adipos + free +
##     thigh + knee + biceps + forearm + wrist, data = csv_file)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.11458 -0.04464  0.00166  0.04655  1.49738
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  12.371521   4.027406   3.072  0.00237 **
## siri          0.889480   0.010616  83.785  < 2e-16 ***
## density     -10.102443   3.647967  -2.769  0.00605 **
## weight        0.007927   0.003351   2.366  0.01878 *
## adipos       -0.012311   0.008223  -1.497  0.13564
## free         -0.008923   0.004191  -2.129  0.03426 *
## thigh         0.013664   0.004696   2.909  0.00396 **
## knee         -0.026414   0.009189  -2.875  0.00441 **
## biceps       -0.014554   0.006641  -2.192  0.02936 *
## forearm       0.016214   0.007613   2.130  0.03420 *
## wrist         0.032168   0.018730   1.717  0.08718 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1686 on 241 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 5.303e+04 on 10 and 241 DF,  p-value: < 2.2e-16
```

```
anova_result <- anova(backward_model,lm_model1)
print(anova_result)
```

```
## Analysis of Variance Table
##
## Model 1: brozek ~ siri + density + weight + adipos + free + thigh + knee +
##     biceps + forearm + wrist
## Model 2: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    241 6.8490
## 2    234 6.8105  7   0.03854 0.1892 0.9875
```

```
# Both-direction stepwise regression
both_model <- step(lm_model1, direction = "both")
```

```
## Start:  AIC=-873.96
```

```
## brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - neck     1     0.000   6.811 -875.96
## - height   1     0.000   6.811 -875.95
## - ankle    1     0.003   6.813 -875.86
## - abdom    1     0.003   6.814 -875.85
## - age      1     0.005   6.815 -875.78
## - chest    1     0.007   6.818 -875.69
## - hip      1     0.017   6.827 -875.35
## - adipos   1     0.044   6.854 -874.34
## <none>                   6.811 -873.96
## - wrist    1     0.065   6.876 -873.56
## - forearm  1     0.100   6.911 -872.28
## - biceps   1     0.132   6.942 -871.14
## - free     1     0.141   6.951 -870.80
## - weight   1     0.160   6.970 -870.11
## - knee     1     0.191   7.001 -869.01
## - density  1     0.201   7.011 -868.64
## - thigh    1     0.202   7.013 -868.58
## - siri     1   185.301 192.112  -34.38
##
## Step:  AIC=-875.96
## brozek ~ siri + density + age + weight + height + adipos + free +
##     chest + abdom + hip + thigh + knee + ankle + biceps + forearm +
##     wrist
##
##           Df Sum of Sq     RSS     AIC
## - height   1     0.000   6.811 -877.94
## - ankle    1     0.003   6.813 -877.86
## - abdom    1     0.003   6.814 -877.84
## - age      1     0.005   6.815 -877.78
## - chest    1     0.007   6.818 -877.69
## - hip      1     0.018   6.828 -877.30
## - adipos   1     0.045   6.855 -876.32
## <none>                   6.811 -875.96
## - wrist    1     0.070   6.881 -875.37
## - forearm  1     0.102   6.913 -874.21
## + neck     1     0.000   6.811 -873.96
## - biceps   1     0.132   6.942 -873.13
## - free     1     0.141   6.952 -872.79
## - weight   1     0.162   6.973 -872.03
## - knee     1     0.194   7.005 -870.88
## - density  1     0.201   7.011 -870.64
## - thigh    1     0.204   7.015 -870.51
## - siri     1   185.431 192.242  -36.21
##
## Step:  AIC=-877.94
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     abdom + hip + thigh + knee + ankle + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - ankle    1     0.003   6.814 -879.84
## - abdom    1     0.003   6.814 -879.83
## - age      1     0.004   6.816 -879.78
## - chest    1     0.007   6.818 -879.67
## - hip      1     0.017   6.828 -879.30
## - adipos   1     0.051   6.862 -878.06
## <none>                   6.811 -877.94
## - wrist    1     0.070   6.881 -877.37
## - forearm  1     0.102   6.913 -876.18
## + height   1     0.000   6.811 -875.96
## + neck     1     0.000   6.811 -875.95
## - biceps   1     0.132   6.943 -875.11
## - free     1     0.144   6.955 -874.66
## - weight   1     0.164   6.975 -873.94
## - knee     1     0.194   7.005 -872.88
## - density  1     0.201   7.012 -872.63
## - thigh    1     0.209   7.020 -872.34
## - siri     1   185.679 192.490  -37.89
##
## Step:  AIC=-879.84
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     abdom + hip + thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - abdom    1     0.002   6.816 -881.76
```

```
## - age      1     0.005   6.819 -881.64
## - chest    1     0.007   6.820 -881.60
## - hip      1     0.018   6.832 -881.18
## - adipos   1     0.049   6.862 -880.05
## <none>                   6.814 -879.84
## - wrist    1     0.079   6.893 -878.93
## - forearm  1     0.101   6.914 -878.14
## + ankle    1     0.003   6.811 -877.94
## + height   1     0.000   6.813 -877.86
## + neck     1     0.000   6.814 -877.84
## - biceps   1     0.136   6.950 -876.87
## - free     1     0.142   6.956 -876.65
## - weight   1     0.165   6.979 -875.81
## - knee     1     0.192   7.006 -874.84
## - thigh    1     0.206   7.020 -874.32
## - density  1     0.207   7.021 -874.29
## - siri     1   185.676 192.490  -39.88
##
## Step:  AIC=-881.76
## brozek ~ siri + density + age + weight + adipos + free + chest +
##     hip + thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - age      1     0.004   6.820 -883.62
## - chest    1     0.009   6.825 -883.41
## - hip      1     0.016   6.832 -883.16
## - adipos   1     0.046   6.862 -882.05
## <none>                   6.816 -881.76
## - wrist    1     0.079   6.895 -880.87
## - forearm  1     0.099   6.915 -880.14
## + abdom    1     0.002   6.814 -879.84
## + ankle    1     0.002   6.814 -879.83
## + height   1     0.000   6.816 -879.77
## + neck     1     0.000   6.816 -879.76
## - free     1     0.141   6.957 -878.61
## - biceps   1     0.145   6.961 -878.44
## - weight   1     0.171   6.987 -877.52
## - knee     1     0.194   7.010 -876.68
## - thigh    1     0.206   7.022 -876.25
## - density  1     0.214   7.030 -875.96
## - siri     1   186.665 193.481  -40.59
##
## Step:  AIC=-883.62
## brozek ~ siri + density + weight + adipos + free + chest + hip +
##     thigh + knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - chest    1     0.008   6.828 -885.32
## - hip      1     0.016   6.836 -885.03
## - adipos   1     0.051   6.871 -883.75
## <none>                   6.820 -883.62
## - wrist    1     0.077   6.897 -882.78
## + age      1     0.004   6.816 -881.76
## + ankle    1     0.003   6.817 -881.73
## + abdom    1     0.001   6.819 -881.64
## + height   1     0.000   6.820 -881.62
## + neck     1     0.000   6.820 -881.62
## - forearm  1     0.112   6.931 -881.53
## - free     1     0.140   6.960 -880.49
## - biceps   1     0.147   6.967 -880.23
## - weight   1     0.177   6.997 -879.15
## - knee     1     0.217   7.036 -877.74
## - density  1     0.217   7.036 -877.74
## - thigh    1     0.260   7.079 -876.21
## - siri     1   187.939 194.759  -40.93
##
## Step:  AIC=-885.32
## brozek ~ siri + density + weight + adipos + free + hip + thigh +
##     knee + biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## - hip      1     0.021   6.849 -886.54
## - adipos   1     0.045   6.873 -885.66
## <none>                   6.828 -885.32
## - wrist    1     0.075   6.903 -884.58
## + chest    1     0.008   6.820 -883.62
## + abdom    1     0.003   6.825 -883.42
## + age      1     0.002   6.825 -883.41
## + ankle    1     0.002   6.826 -883.38
```

```
## + height   1     0.000   6.828 -883.33
## + neck     1     0.000   6.828 -883.32
## - forearm  1     0.112   6.940 -883.22
## - free     1     0.132   6.960 -882.49
## - biceps   1     0.149   6.977 -881.88
## - weight   1     0.179   7.007 -880.81
## - density  1     0.212   7.040 -879.61
## - knee     1     0.219   7.046 -879.38
## - thigh    1     0.256   7.084 -878.03
## - siri     1   199.520 206.348  -28.37
##
## Step:  AIC=-886.54
## brozek ~ siri + density + weight + adipos + free + thigh + knee +
##     biceps + forearm + wrist
##
##           Df Sum of Sq     RSS     AIC
## <none>                   6.849 -886.54
## - adipos   1     0.064   6.913 -886.21
## - wrist    1     0.084   6.933 -885.47
## + hip      1     0.021   6.828 -885.32
## + chest    1     0.013   6.836 -885.03
## + ankle    1     0.002   6.847 -884.62
## + age      1     0.002   6.847 -884.61
## + abdom    1     0.001   6.848 -884.58
## + neck     1     0.001   6.848 -884.57
## + height   1     0.000   6.849 -884.54
## - free     1     0.129   6.978 -883.84
## - forearm  1     0.129   6.978 -883.84
## - biceps   1     0.137   6.986 -883.57
## - weight   1     0.159   7.008 -882.75
## - density  1     0.218   7.067 -880.65
## - knee     1     0.235   7.084 -880.04
## - thigh    1     0.241   7.090 -879.84
## - siri     1   199.499 206.349  -30.37
```

```
summary(both_model)
```

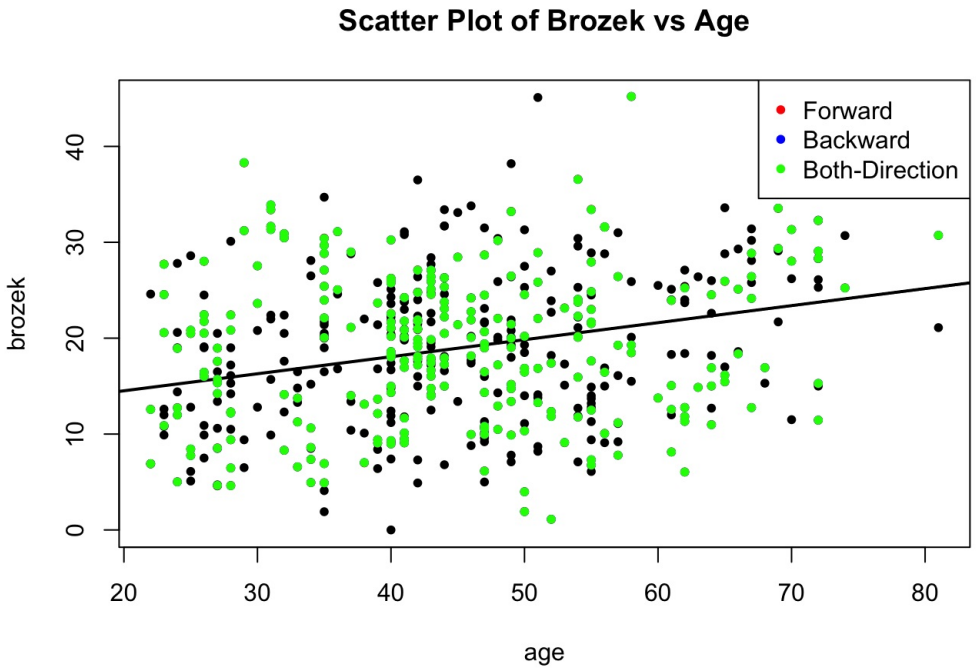
```
##
## Call:
## lm(formula = brozek ~ siri + density + weight + adipos + free +
##     thigh + knee + biceps + forearm + wrist, data = csv_file)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.11458 -0.04464  0.00166  0.04655  1.49738
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  12.371521   4.027406   3.072  0.00237 **
## siri          0.889480   0.010616  83.785  < 2e-16 ***
## density     -10.102443   3.647967  -2.769  0.00605 **
## weight        0.007927   0.003351   2.366  0.01878 *
## adipos       -0.012311   0.008223  -1.497  0.13564
## free         -0.008923   0.004191  -2.129  0.03426 *
## thigh         0.013664   0.004696   2.909  0.00396 **
## knee         -0.026414   0.009189  -2.875  0.00441 **
## biceps       -0.014554   0.006641  -2.192  0.02936 *
## forearm       0.016214   0.007613   2.130  0.03420 *
## wrist         0.032168   0.018730   1.717  0.08718 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1686 on 241 degrees of freedom
## Multiple R-squared:  0.9995, Adjusted R-squared:  0.9995
## F-statistic: 5.303e+04 on 10 and 241 DF,  p-value: < 2.2e-16
```

```
anova_result <- anova(both_model,lm_model1)
print(anova_result)
```

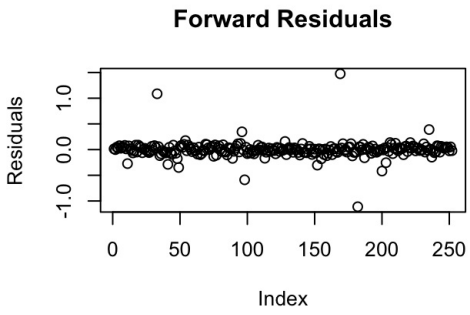
```
## Analysis of Variance Table
##
## Model 1: brozek ~ siri + density + weight + adipos + free + thigh + knee +
##     biceps + forearm + wrist
## Model 2: brozek ~ siri + density + age + weight + height + adipos + free +
##     neck + chest + abdom + hip + thigh + knee + ankle + biceps +
##     forearm + wrist
##   Res.Df    RSS Df Sum of Sq      F Pr(>F)
## 1    241 6.8490
## 2    234 6.8105  7   0.03854 0.1892 0.9875
```

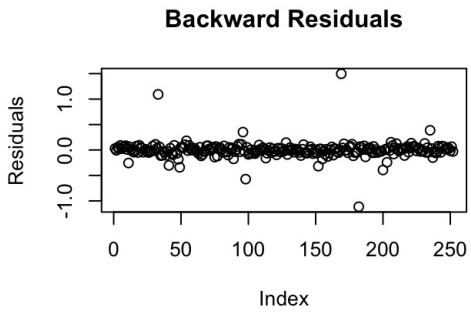
```
plot(csv_file$age, csv_file$brozek,
     main = "Scatter Plot of Brozek vs Age",
     xlab = "age", ylab = "brozek", pch = 20
     )
abline(lm(brozek ~ age, data = csv_file), col = "black", lwd = 2)
points(sort(csv_file$age), forward_model$fitted.values, col = "red", pch = 20)
points(sort(csv_file$age), backward_model$fitted.values, col = "blue", pch = 20)
points(sort(csv_file$age), both_model$fitted.values, col = "green", pch = 20)

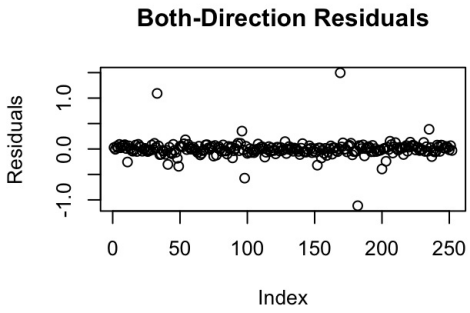
legend("topright", legend = c("Forward", "Backward", "Both-Direction"),
       col = c("red", "blue", "green"), pch = 20)
```




```
# Residual plots for each model
par(mfrow = c(2, 2))
plot(forward_model$residuals, main = "Forward Residuals", ylab = "Residuals")
plot(backward_model$residuals, main = "Backward Residuals", ylab = "Residuals")
plot(both_model$residuals, main = "Both-Direction Residuals", ylab = "Residuals")
par(mfrow = c(1, 1))
```




```
#LASSO
x_vars <- model.matrix(brozek~. , csv_file)[,-1]
y_var <- csv_file$brozek
y_var
```

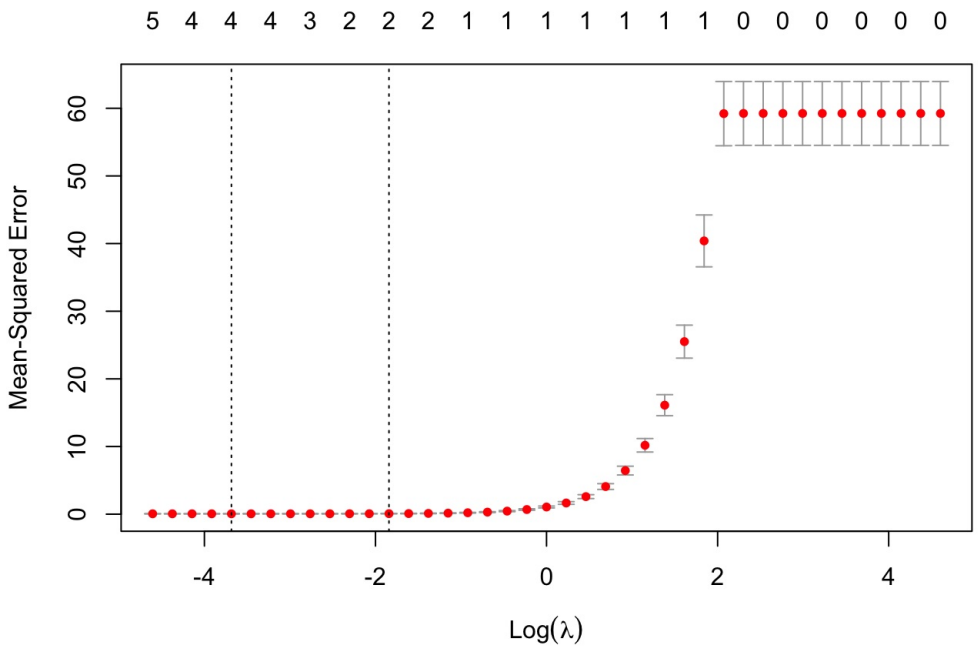
```
##   [1] 12.6  6.9 24.6 10.9 27.8 20.6 19.0 12.8  5.1 12.0  7.5  8.5 20.5 20.8 21.7
##  [16] 20.5 28.1 22.4 16.1 16.5 19.0 15.3 15.7 17.6 14.2  4.6  8.5 22.4  4.7  9.4
##  [31] 12.3  6.5 13.4 20.9 31.1 38.2 23.6 27.5 33.8 31.3 33.1 31.7 30.4 30.8  8.4
##  [46] 14.1 11.2  6.4 13.4  5.0 10.7  7.4  8.7  7.1  4.9 22.2 20.1 27.1 30.4 24.0
##  [61] 25.4 28.8 29.6 25.1 31.0 28.9 21.1 14.0  7.1 13.2 23.7  9.4  9.1 13.7 12.0
##  [76] 18.3  9.2 21.7 21.1 18.6 30.2 26.0 18.2 26.2 26.1 25.8 15.0 22.6  8.8 14.3
##  [91] 20.2 18.1  9.2 24.2  9.6 17.3 10.1 11.1 17.7 21.7 20.8 20.1 19.8 21.9 24.7
## [106] 17.8 19.1 18.2 17.2 21.0 19.5 27.1 21.6 20.9 25.9 16.7 19.8 14.1 25.1 17.9
## [121] 27.0 24.6 14.8 16.0 14.0 17.4 26.4 17.4 20.4 15.0 18.0 22.2 23.1 25.3 23.8
## [136] 26.3 21.4 28.4 21.8 20.1 24.3 18.1 22.7  9.9 10.8 14.4 19.0 28.6  6.1 24.5
## [151]  9.9 19.1 10.6 16.5 20.5 17.2 30.1 10.5 12.8 22.0  9.9 14.8 13.3 15.2 26.5
## [166] 19.0 21.4 20.0 34.7 16.5  4.1  1.9 20.2 16.8 24.6 10.4 13.4 28.8 22.0 16.8
## [181] 25.8  0.0 11.9 12.4 17.4  9.2 23.0 20.1 20.2 23.8 11.8 36.5 16.0 24.0 22.3
## [196] 24.8 21.5 17.6  7.3 22.6 12.5 21.7 27.7  6.8 33.4 16.6 31.7 31.5 10.1 11.3
## [211]  7.8 26.4 19.3 18.5 19.3 45.1 13.8  8.2 23.9 15.1 12.7 25.3 11.9  6.1 11.3
## [226] 12.8 14.9 24.5 15.0 16.9 11.1 16.1 15.5 25.9 25.5 18.4 24.0 26.4 12.7 28.8
## [241] 17.0 33.6 29.3 31.4 28.1 15.3 29.1 11.5 32.3 28.3 25.3 30.7
```

```
lambda_seq <- 10^seq(2, -2, by = -.1)
set.seed(86)
train = sample(1:nrow(x_vars), nrow(x_vars)/2)
x_test = (-train)
y_test = y_var[x_test]
x_test;y_test
```

```
##   [1] -195 -157   -1  -29 -236  -91 -114  -87 -177 -229 -130 -166 -154 -221  -48
##  [16]  -46 -150 -225 -207 -191 -125 -100  -85 -187 -170 -220  -57 -137 -181 -238
##  [31]  -51  -64 -240 -206 -204 -104 -133  -78 -129  -90 -208 -249 -237 -213  -96
##  [46]  -98 -116 -196 -201 -146  -82 -168 -164 -243 -223 -120 -197 -176 -132 -234
##  [61] -178  -26 -131  -81 -242 -103 -167  -17  -39 -182  -67 -241 -190 -118 -151
##  [76]  -49 -188 -110 -128  -25  -14 -232 -217  -12 -169 -123  -41 -161 -173 -210
##  [91]  -38 -109 -142 -147  -95  -54  -72  -75 -113  -94 -216 -136  -44 -102 -205
## [106] -175   -2   -3 -183 -239 -209 -156  -47 -145  -24 -135 -235  -15  -35  -70
## [121]  -63  -88   -8   -6  -59  -60
```

```
##   [1] 10.9 27.8 19.0  5.1 12.0  7.5 20.5 20.5 22.4 16.1 16.5 19.0 15.3 15.7  8.5
##  [16] 22.4  9.4 12.3  6.5 13.4 20.9 38.2 23.6 31.3 31.7 30.4  8.4  5.0  7.4  8.7
##  [31]  4.9 22.2 27.1 25.4 28.8 31.0 28.9 14.0  7.1 23.7  9.1 13.7 18.3  9.2 21.1
##  [46] 18.6 18.2 26.2 25.8  8.8 18.1  9.2 10.1 17.7 20.8 24.7 17.8 19.1 18.2 19.5
##  [61] 27.1 25.9 19.8 25.1 27.0 24.6 16.0 17.4 26.4 25.3 28.4 21.8 20.1 24.3 22.7
##  [76]  9.9 28.6  6.1 19.1 10.6 20.5 10.5 12.8 22.0 14.8 13.3 26.5  4.1  1.9 16.8
##  [91] 22.0 16.8 12.4 17.4  9.2 20.2 36.5 16.0 24.0 17.6  7.3 22.6 21.7 27.7  7.8
## [106] 26.4 18.5 19.3  8.2 23.9 25.3  6.1 12.8 14.9 24.5 16.9 11.1 15.5 31.4 28.1
## [121] 15.3 29.1 11.5 28.3 25.3 30.7
```

```
cv_output <- cv.glmnet(x_vars[train,], y_var[train], alpha = 1, lambda = lambda_seq, nfolds = 5)
plot(cv_output)
```




```
best_lam <- cv_output$lambda.min
best_lam
```

```
## [1] 0.02511886
```

```
# Rebuilding the model with best lamda value identified
lasso_best <- glmnet(x_vars[train,], y_var[train], alpha = 1, lambda = best_lam)
pred <- predict(lasso_best, s = best_lam, newx = x_vars[x_test,])
final <- cbind(y_test, pred)
head(final)
```

```
##    y_test        s1
## 4    10.9 10.842849
## 5    27.8 27.785422
## 7    19.0 18.976935
## 9     5.1  5.025379
## 10   12.0 12.060518
## 11    7.5  7.783503
```

```
final
```

```
##     y_test        s1
## 4     10.9 10.842849
## 5     27.8 27.785422
## 7     19.0 18.976935
## 9      5.1  5.025379
## 10    12.0 12.060518
## 11     7.5  7.783503
## 13    20.5 20.481213
## 16    20.5 20.561489
## 18    22.4 22.451172
## 19    16.1 16.049537
## 20    16.5 16.517248
```

```
## 21    19.0 18.916146
## 22    15.3 15.316641
## 23    15.7 15.631240
## 27     8.5  8.482204
## 28    22.4 22.391092
## 30     9.4  9.342526
## 31    12.3 12.214036
## 32     6.5  6.468603
## 33    13.4 12.130912
## 34    20.9 20.971850
## 36    38.2 38.330340
## 37    23.6 23.637032
## 40    31.3 31.399409
## 42    31.7 31.703578
## 43    30.4 30.494231
## 45     8.4  8.273257
## 50     5.0  4.859488
## 52     7.4  7.273693
## 53     8.7  8.561906
## 55     4.9  4.779430
## 56    22.2 22.130216
## 58    27.1 27.146771
## 61    25.4 25.393374
## 62    28.8 28.803222
## 65    31.0 31.137165
## 66    28.9 29.004655
## 68    14.0 13.958977
## 69     7.1  7.023153
## 71    23.7 23.685011
## 73     9.1  9.044688
## 74    13.7 13.659895
## 76    18.3 18.241208
## 77     9.2  9.345587
## 79    21.1 21.081533
## 80    18.6 18.602096
## 83    18.2 18.246110
## 84    26.2 26.182695
## 86    25.8 25.809230
## 89     8.8  8.900905
## 92    18.1 18.055047
## 93     9.2  9.065207
## 97    10.1 10.106892
## 99    17.7 17.664177
## 101   20.8 20.844096
## 105   24.7 24.715597
## 106   17.8 17.857826
## 107   19.1 19.083541
## 108   18.2 18.142276
## 111   19.5 19.455127
## 112   27.1 27.140418
## 115   25.9 25.917742
## 117   19.8 19.812322
## 119   25.1 25.115838
## 121   27.0 27.042876
## 122   24.6 24.625018
## 124   16.0 16.011011
## 126   17.4 17.423736
## 127   26.4 26.399853
## 134   25.3 25.358847
## 138   28.4 28.437678
## 139   21.8 21.933169
## 140   20.1 20.128683
## 141   24.3 24.255337
## 143   22.7 22.763976
## 144    9.9  9.890304
## 148   28.6 28.646616
## 149    6.1  6.065591
## 152   19.1 19.430511
## 153   10.6 10.525115
## 155   20.5 20.663034
## 158   10.5 10.468126
## 159   12.8 12.773046
## 160   22.0 22.035736
## 162   14.8 14.736992
## 163   13.3 13.272014
## 165   26.5 26.509244
## 171    4.1  3.957021
## 172    1.9  1.799147
## 174   16.8 16.852401
```

```
## 179   22.0 22.066256
## 180   16.8 16.911801
## 184   12.4 12.394031
## 185   17.4 17.396948
## 186    9.2  9.163615
## 189   20.2 20.218738
## 192   36.5 36.515510
## 193   16.0 15.941203
## 194   24.0 24.102086
## 198   17.6 17.603580
## 199    7.3  7.315059
## 200   22.6 23.046575
## 202   21.7 21.644133
## 203   27.7 27.812916
## 211    7.8  7.747757
## 212   26.4 26.414848
## 214   18.5 18.530133
## 215   19.3 19.243897
## 218    8.2  8.119233
## 219   23.9 23.914160
## 222   25.3 25.311401
## 224    6.1  5.991118
## 226   12.8 12.716281
## 227   14.9 14.902796
## 228   24.5 24.560111
## 230   16.9 16.936000
## 231   11.1 10.991435
## 233   15.5 15.461864
## 244   31.4 31.411983
## 245   28.1 28.050514
## 246   15.3 15.254722
## 247   29.1 29.195918
## 248   11.5 11.340926
## 250   28.3 28.326105
## 251   25.3 25.267210
## 252   30.7 30.740857
```

```
previous_model_prediction <- predict(lm_model1, newdata = csv_file)
previous_model_value <- mean((previous_model_prediction - csv_file$brozek)^2)
previous_model_prediction
```

```
##         1         2         3         4         5         6         7         8
## 12.585148  6.901333 24.552229 10.871970 27.723834 20.574254 18.946966 12.754137
##         9        10        11        12        13        14        15        16
##  5.017908 11.987376  7.772853  8.428183 20.482624 20.818473 21.765042 20.523131
##        17        18        19        20        21        22        23        24
## 28.013369 22.448342 16.012998 16.442949 18.958268 15.361261 15.691733 17.576148
##        25        26        27        28        29        30        31        32
## 14.215645  4.637163  8.558865 22.435863  4.637567  9.412490 12.222074  6.459295
##        33        34        35        36        37        38        39        40
## 12.313725 20.842781 31.217849 38.283101 23.618485 27.543402 33.866596 31.351205
##        41        42        43        44        45        46        47        48
## 33.387424 31.655799 30.457085 30.891559  8.313382 14.126704 11.271323  6.575782
##        49        50        51        52        53        54        55        56
## 13.748740  4.940534 10.617225  7.355500  8.599059  6.925097  4.921933 22.113128
##        57        58        59        60        61        62        63        64
## 20.053082 27.095445 30.440334 23.964094 25.420359 28.819862 29.688060 25.052533
##        65        66        67        68        69        70        71        72
## 31.100152 28.977608 21.114635 14.024706  6.994054 13.104055 23.665475  9.399158
##        73        74        75        76        77        78        79        80
##  9.053078 13.633037 12.130945 18.209388  9.309003 21.666820 21.026275 18.594369
##        81        82        83        84        85        86        87        88
## 30.237210 25.906735 18.235665 26.248848 26.204350 25.762219 14.973013 22.577279
##        89        90        91        92        93        94        95        96
##  8.971116 14.333094 20.176694 18.030352  9.086497 24.246660  9.480468 16.954115
##        97        98        99       100       101       102       103       104
## 10.107104 11.688072 17.653431 21.778800 20.859644 20.098590 19.867318 21.925926
##       105       106       107       108       109       110       111       112
## 24.782866 17.823093 19.111888 18.114998 17.205817 20.955632 19.449678 27.116166
##       113       114       115       116       117       118       119       120
## 21.768400 20.951824 25.917196 16.669817 19.836147 14.082002 25.110368 17.920253
##       121       122       123       124       125       126       127       128
## 27.081620 24.557033 14.772977 16.036958 13.979944 17.417230 26.404455 17.242245
##       129       130       131       132       133       134       135       136
## 20.498345 14.991623 17.960186 22.207277 23.076464 25.352854 23.766390 26.304440
##       137       138       139       140       141       142       143       144
## 21.403809 28.456450 21.906382 20.087774 24.181592 18.152787 22.754031  9.961961
##       145       146       147       148       149       150       151       152
## 10.790831 14.337538 18.986367 28.694862  6.154326 24.491456  9.962113 19.402752
##       153       154       155       156       157       158       159       160
## 10.585522 16.490237 20.678896 17.201603 30.197028 10.487848 12.919399 22.072415
##       161       162       163       164       165       166       167       168
##  9.908105 14.740086 13.398626 15.186763 26.480691 19.036986 21.454901 19.989269
##       169       170       171       172       173       174       175       176
## 33.224576 16.469228  3.985753  1.923216 20.200219 16.849296 24.552710 10.347869
##       177       178       179       180       181       182       183       184
## 13.285191 28.923370 22.054456 16.855154 25.846590  1.111911 11.847048 12.351687
##       185       186       187       188       189       190       191       192
## 17.406027  9.098095 23.158967 20.094062 20.194296 23.754353 11.773103 36.573409
##       193       194       195       196       197       198       199       200
## 15.928566 24.040537 22.290279 24.852587 21.530624 17.613091  7.300125 23.018483
##       201       202       203       204       205       206       207       208
## 12.507366 21.667176 27.954956  6.758173 33.434333 16.463348 31.598452 31.578686
##       209       210       211       212       213       214       215       216
## 10.073737 11.177076  7.795876 26.423449 19.262415 18.479576 19.281616 45.199951
##       217       218       219       220       221       222       223       224
## 13.742737  8.132629 23.938179 15.060071 12.563537 25.276575 11.829990  6.046410
##       225       226       227       228       229       230       231       232
## 11.324785 12.771415 14.869205 24.518406 15.012539 16.908469 10.987722 16.149199
##       233       234       235       236       237       238       239       240
## 15.449574 25.914665 25.110525 18.391758 24.147308 26.415349 12.761362 28.844479
##       241       242       243       244       245       246       247       248
## 16.924613 33.533044 29.350532 31.336776 28.053856 15.274540 29.060905 11.447086
##       249       250       251       252
## 32.261485 28.325209 25.246938 30.720836
```

```
previous_model_value
```

```
## [1] 0.02702583
```

```
lasso_model_predictions <- predict(lasso_best, s = best_lam, newx = x_vars[x_test,])
lasso_model_value <- mean((lasso_model_predictions - y_test)^2)
lasso_model_value
```

```
## [1] 0.02022329
```

```
if (previous_model_value < lasso_model_value) {
  print("Previous model performs better in terms of MSE.")
} else if (previous_model_value > lasso_model_value) {
  print("LASSO model performs better in terms of MSE.")
} else {
  print("Both models perform equally in terms of MSE.")
}
```

```
## [1] "LASSO model performs better in terms of MSE."
```

```
#AIC
residuals <- y_test - lasso_model_predictions
RSS <- sum(residuals^2)
k <- length(coef(lasso_best))
n <- length(y_test)
AIC <- 2 * k - 2 * log(sqrt(2 * pi * (RSS / n))) - 2
print(AIC)
```

```
## [1] 36.06304
```

```
aic_value <- AIC(lm_model1)
print(aic_value)
```

```
## [1] -156.8174
```