MVA.R

Yshah

Fri Apr 19 16:30:50 2019

```r
#ggplot2 is used to plot the bar plot
#install.packages("ggplot2")
library("ggplot2")
#corrplot is used to plot the correlation matrix
#install.packages("corrplot")
library("corrplot")
```

```
## corrplot 0.84 loaded
```

```r
#It is used to reshape a one-dimensional array into a two-dimensional array with one column and multiple arr
ays.
#install.packages("reshape")
library("reshape")

#Reading the dataset
wisc_bc_df <- read.csv("C://Users//Yshah//Downloads//Rutgers Sem 2//MVA//wisc_bc_data.csv")
head(wisc_bc_df)
```

```
##          id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1 87139402         B       12.32        12.39          78.85     464.1
## 2  8910251         B       10.60        18.95          69.28     346.4
## 3   905520         B       11.04        16.83          70.92     373.2
## 4   868871         B       11.28        13.39          73.00     384.8
## 5  9012568         B       15.19        13.21          97.65     711.8
## 6   906539         B       11.57        19.04          74.20     409.7
##   smoothness_mean compactness_mean concavity_mean points_mean
## 1         0.10280          0.06981        0.03987     0.03700
## 2         0.09688          0.11470        0.06387     0.02642
## 3         0.10770          0.07804        0.03046     0.02480
## 4         0.11640          0.11360        0.04635     0.04796
## 5         0.07963          0.06934        0.03393     0.02657
## 6         0.08546          0.07722        0.05485     0.01428
##   symmetry_mean dimension_mean radius_se texture_se perimeter_se area_se
## 1        0.1959        0.05955    0.2360     0.6656        1.670   17.43
## 2        0.1922        0.06491    0.4505     1.1970        3.430   27.10
## 3        0.1714        0.06340    0.1967     1.3870        1.342   13.54
## 4        0.1771        0.06072    0.3384     1.3430        1.851   26.33
## 5        0.1721        0.05544    0.1783     0.4125        1.338   17.72
## 6        0.2031        0.06267    0.2864     1.4400        2.206   20.30
##   smoothness_se compactness_se concavity_se points_se symmetry_se
## 1      0.008045       0.011800      0.01683  0.012410     0.01924
## 2      0.007470       0.035810      0.03354  0.013650     0.03504
## 3      0.005158       0.009355      0.01056  0.007483     0.01718
## 4      0.011270       0.034980      0.02187  0.019650     0.01580
## 5      0.005012       0.014850      0.01551  0.009155     0.01647
## 6      0.007278       0.020470      0.04447  0.008799     0.01868
##   dimension_se radius_worst texture_worst perimeter_worst area_worst
## 1     0.002248        13.50         15.64           86.97      549.1
## 2     0.003318        11.88         22.94           78.28      424.8
## 3     0.002198        12.41         26.44           79.93      471.4
## 4     0.003442        11.92         15.77           76.53      434.0
## 5     0.001767        16.20         15.73          104.50      819.1
## 6     0.003339        13.07         26.98           86.43      520.5
##   smoothness_worst compactness_worst concavity_worst points_worst
## 1           0.1385            0.1266         0.12420      0.09391
## 2           0.1213            0.2515         0.19160      0.07926
## 3           0.1369            0.1482         0.10670      0.07431
## 4           0.1367            0.1822         0.08669      0.08611
## 5           0.1126            0.1737         0.13620      0.08178
## 6           0.1249            0.1937         0.25600      0.06664
##   symmetry_worst dimension_worst
## 1         0.2827         0.06771
## 2         0.2940         0.07587
## 3         0.2998         0.07881
## 4         0.2102         0.06784
## 5         0.2487         0.06766
## 6         0.3035         0.08284
```

```
cancer<-wisc_bc_df

#Displaying the dataset using head function
head(cancer)
```

```
##         id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1 87139402         B       12.32        12.39          78.85     464.1
## 2  8910251         B       10.60        18.95          69.28     346.4
## 3   905520         B       11.04        16.83          70.92     373.2
## 4   868871         B       11.28        13.39          73.00     384.8
## 5  9012568         B       15.19        13.21          97.65     711.8
## 6   906539         B       11.57        19.04          74.20     409.7
##   smoothness_mean compactness_mean concavity_mean points_mean
## 1         0.10280          0.06981        0.03987     0.03700
## 2         0.09688          0.11470        0.06387     0.02642
## 3         0.10770          0.07804        0.03046     0.02480
## 4         0.11640          0.11360        0.04635     0.04796
## 5         0.07963          0.06934        0.03393     0.02657
## 6         0.08546          0.07722        0.05485     0.01428
##   symmetry_mean dimension_mean radius_se texture_se perimeter_se area_se
## 1        0.1959        0.05955    0.2360     0.6656        1.670   17.43
## 2        0.1922        0.06491    0.4505     1.1970        3.430   27.10
## 3        0.1714        0.06340    0.1967     1.3870        1.342   13.54
## 4        0.1771        0.06072    0.3384     1.3430        1.851   26.33
## 5        0.1721        0.05544    0.1783     0.4125        1.338   17.72
## 6        0.2031        0.06267    0.2864     1.4400        2.206   20.30
##   smoothness_se compactness_se concavity_se points_se symmetry_se
## 1      0.008045       0.011800      0.01683  0.012410     0.01924
## 2      0.007470       0.035810      0.03354  0.013650     0.03504
## 3      0.005158       0.009355      0.01056  0.007483     0.01718
## 4      0.011270       0.034980      0.02187  0.019650     0.01580
## 5      0.005012       0.014850      0.01551  0.009155     0.01647
## 6      0.007278       0.020470      0.04447  0.008799     0.01868
##   dimension_se radius_worst texture_worst perimeter_worst area_worst
## 1     0.002248        13.50         15.64           86.97      549.1
## 2     0.003318        11.88         22.94           78.28      424.8
## 3     0.002198        12.41         26.44           79.93      471.4
## 4     0.003442        11.92         15.77           76.53      434.0
## 5     0.001767        16.20         15.73          104.50      819.1
## 6     0.003339        13.07         26.98           86.43      520.5
##   smoothness_worst compactness_worst concavity_worst points_worst
## 1           0.1385            0.1266         0.12420      0.09391
## 2           0.1213            0.2515         0.19160      0.07926
## 3           0.1369            0.1482         0.10670      0.07431
## 4           0.1367            0.1822         0.08669      0.08611
## 5           0.1126            0.1737         0.13620      0.08178
## 6           0.1249            0.1937         0.25600      0.06664
##   symmetry_worst dimension_worst
## 1         0.2827         0.06771
## 2         0.2940         0.07587
## 3         0.2998         0.07881
## 4         0.2102         0.06784
## 5         0.2487         0.06766
## 6         0.3035         0.08284
```

```r
#Displays structure of the dataset
str(cancer)
```

```
## 'data.frame':    569 obs. of  32 variables:
##  $ id                : int  87139402 8910251 905520 868871 9012568 906539 925291 87880 862989 89827 ...
##  $ diagnosis         : Factor w/ 2 levels "B","M": 1 1 1 1 1 1 1 2 1 1 ...
##  $ radius_mean       : num  12.3 10.6 11 11.3 15.2 ...
##  $ texture_mean      : num  12.4 18.9 16.8 13.4 13.2 ...
##  $ perimeter_mean    : num  78.8 69.3 70.9 73 97.7 ...
##  $ area_mean         : num  464 346 373 385 712 ...
##  $ smoothness_mean   : num  0.1028 0.0969 0.1077 0.1164 0.0796 ...
##  $ compactness_mean  : num  0.0698 0.1147 0.078 0.1136 0.0693 ...
##  $ concavity_mean    : num  0.0399 0.0639 0.0305 0.0464 0.0339 ...
##  $ points_mean       : num  0.037 0.0264 0.0248 0.048 0.0266 ...
##  $ symmetry_mean     : num  0.196 0.192 0.171 0.177 0.172 ...
##  $ dimension_mean    : num  0.0595 0.0649 0.0634 0.0607 0.0554 ...
##  $ radius_se         : num  0.236 0.451 0.197 0.338 0.178 ...
##  $ texture_se        : num  0.666 1.197 1.387 1.343 0.412 ...
##  $ perimeter_se      : num  1.67 3.43 1.34 1.85 1.34 ...
##  $ area_se           : num  17.4 27.1 13.5 26.3 17.7 ...
##  $ smoothness_se     : num  0.00805 0.00747 0.00516 0.01127 0.00501 ...
##  $ compactness_se    : num  0.0118 0.03581 0.00936 0.03498 0.01485 ...
##  $ concavity_se      : num  0.0168 0.0335 0.0106 0.0219 0.0155 ...
##  $ points_se         : num  0.01241 0.01365 0.00748 0.01965 0.00915 ...
##  $ symmetry_se       : num  0.0192 0.035 0.0172 0.0158 0.0165 ...
##  $ dimension_se      : num  0.00225 0.00332 0.0022 0.00344 0.00177 ...
##  $ radius_worst      : num  13.5 11.9 12.4 11.9 16.2 ...
##  $ texture_worst     : num  15.6 22.9 26.4 15.8 15.7 ...
##  $ perimeter_worst   : num  87 78.3 79.9 76.5 104.5 ...
##  $ area_worst        : num  549 425 471 434 819 ...
##  $ smoothness_worst  : num  0.139 0.121 0.137 0.137 0.113 ...
##  $ compactness_worst : num  0.127 0.252 0.148 0.182 0.174 ...
##  $ concavity_worst   : num  0.1242 0.1916 0.1067 0.0867 0.1362 ...
##  $ points_worst      : num  0.0939 0.0793 0.0743 0.0861 0.0818 ...
##  $ symmetry_worst    : num  0.283 0.294 0.3 0.21 0.249 ...
##  $ dimension_worst   : num  0.0677 0.0759 0.0788 0.0678 0.0677 ...
```

```
#Displays the names of the columns
names(cancer)
```

```
##  [1] "id"                "diagnosis"         "radius_mean"
##  [4] "texture_mean"      "perimeter_mean"    "area_mean"
##  [7] "smoothness_mean"   "compactness_mean"  "concavity_mean"
## [10] "points_mean"       "symmetry_mean"     "dimension_mean"
## [13] "radius_se"         "texture_se"        "perimeter_se"
## [16] "area_se"           "smoothness_se"     "compactness_se"
## [19] "concavity_se"      "points_se"         "symmetry_se"
## [22] "dimension_se"      "radius_worst"      "texture_worst"
## [25] "perimeter_worst"   "area_worst"        "smoothness_worst"
## [28] "compactness_worst" "concavity_worst"   "points_worst"
## [31] "symmetry_worst"    "dimension_worst"
```

```
#Displays the summary of the dataset
summary(cancer)
```

```
##        id              diagnosis  radius_mean      texture_mean
##  Min.   :     8670     B:357     Min.   : 6.981   Min.   : 9.71
##  1st Qu.:   869218     M:212     1st Qu.:11.700   1st Qu.:16.17
##  Median :   906024               Median :13.370   Median :18.84
##  Mean   : 30371831               Mean   :14.127   Mean   :19.29
##  3rd Qu.:  8813129               3rd Qu.:15.780   3rd Qu.:21.80
##  Max.   :911320502               Max.   :28.110   Max.   :39.28
##  perimeter_mean     area_mean       smoothness_mean    compactness_mean
##  Min.   : 43.79   Min.   : 143.5   Min.   :0.05263   Min.   :0.01938
##  1st Qu.: 75.17   1st Qu.: 420.3   1st Qu.:0.08637   1st Qu.:0.06492
##  Median : 86.24   Median : 551.1   Median :0.09587   Median :0.09263
##  Mean   : 91.97   Mean   : 654.9   Mean   :0.09636   Mean   :0.10434
##  3rd Qu.:104.10   3rd Qu.: 782.7   3rd Qu.:0.10530   3rd Qu.:0.13040
##  Max.   :188.50   Max.   :2501.0   Max.   :0.16340   Max.   :0.34540
##  concavity_mean     points_mean      symmetry_mean     dimension_mean
##  Min.   :0.00000   Min.   :0.00000   Min.   :0.1060   Min.   :0.04996
##  1st Qu.:0.02956   1st Qu.:0.02031   1st Qu.:0.1619   1st Qu.:0.05770
##  Median :0.06154   Median :0.03350   Median :0.1792   Median :0.06154
##  Mean   :0.08880   Mean   :0.04892   Mean   :0.1812   Mean   :0.06280
##  3rd Qu.:0.13070   3rd Qu.:0.07400   3rd Qu.:0.1957   3rd Qu.:0.06612
##  Max.   :0.42680   Max.   :0.20120   Max.   :0.3040   Max.   :0.09744
##     radius_se        texture_se       perimeter_se       area_se
##  Min.   :0.1115   Min.   :0.3602   Min.   : 0.757   Min.   :  6.802
##  1st Qu.:0.2324   1st Qu.:0.8339   1st Qu.: 1.606   1st Qu.: 17.850
##  Median :0.3242   Median :1.1080   Median : 2.287   Median : 24.530
##  Mean   :0.4052   Mean   :1.2169   Mean   : 2.866   Mean   : 40.337
##  3rd Qu.:0.4789   3rd Qu.:1.4740   3rd Qu.: 3.357   3rd Qu.: 45.190
##  Max.   :2.8730   Max.   :4.8850   Max.   :21.980   Max.   :542.200
##  smoothness_se       compactness_se      concavity_se
##  Min.   :0.001713   Min.   :0.002252   Min.   :0.00000
##  1st Qu.:0.005169   1st Qu.:0.013080   1st Qu.:0.01509
##  Median :0.006380   Median :0.020450   Median :0.02589
##  Mean   :0.007041   Mean   :0.025478   Mean   :0.03189
##  3rd Qu.:0.008146   3rd Qu.:0.032450   3rd Qu.:0.04205
##  Max.   :0.031130   Max.   :0.135400   Max.   :0.39600
##    points_se          symmetry_se        dimension_se        radius_worst
##  Min.   :0.000000   Min.   :0.007882   Min.   :0.0008948   Min.   : 7.93
##  1st Qu.:0.007638   1st Qu.:0.015160   1st Qu.:0.0022480   1st Qu.:13.01
##  Median :0.010930   Median :0.018730   Median :0.0031870   Median :14.97
##  Mean   :0.011796   Mean   :0.020542   Mean   :0.0037949   Mean   :16.27
##  3rd Qu.:0.014710   3rd Qu.:0.023480   3rd Qu.:0.0045580   3rd Qu.:18.79
##  Max.   :0.052790   Max.   :0.078950   Max.   :0.0298400   Max.   :36.04
##  texture_worst    perimeter_worst     area_worst       smoothness_worst
##  Min.   :12.02   Min.   : 50.41   Min.   : 185.2   Min.   :0.07117
##  1st Qu.:21.08   1st Qu.: 84.11   1st Qu.: 515.3   1st Qu.:0.11660
##  Median :25.41   Median : 97.66   Median : 686.5   Median :0.13130
##  Mean   :25.68   Mean   :107.26   Mean   : 880.6   Mean   :0.13237
##  3rd Qu.:29.72   3rd Qu.:125.40   3rd Qu.:1084.0   3rd Qu.:0.14600
##  Max.   :49.54   Max.   :251.20   Max.   :4254.0   Max.   :0.22260
##  compactness_worst concavity_worst   points_worst      symmetry_worst
##  Min.   :0.02729   Min.   :0.0000   Min.   :0.00000   Min.   :0.1565
##  1st Qu.:0.14720   1st Qu.:0.1145   1st Qu.:0.06493   1st Qu.:0.2504
##  Median :0.21190   Median :0.2267   Median :0.09993   Median :0.2822
##  Mean   :0.25427   Mean   :0.2722   Mean   :0.11461   Mean   :0.2901
##  3rd Qu.:0.33910   3rd Qu.:0.3829   3rd Qu.:0.16140   3rd Qu.:0.3179
##  Max.   :1.05800   Max.   :1.2520   Max.   :0.29100   Max.   :0.6638
##  dimension_worst
##  Min.   :0.05504
##  1st Qu.:0.07146
##  Median :0.08004
##  Mean   :0.08395
##  3rd Qu.:0.09208
##  Max.   :0.20750
```

```r
#Remove the first column
bc_data <- cancer[,-c(0:1)]
#Remove the last column
bc_data <- bc_data[,-32]
#Tidy the data
bc_data$diagnosis <- as.factor(bc_data$diagnosis)

head(bc_data)
```

```
##   diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1         B       12.32        12.39          78.85     464.1
## 2         B       10.60        18.95          69.28     346.4
## 3         B       11.04        16.83          70.92     373.2
## 4         B       11.28        13.39          73.00     384.8
## 5         B       15.19        13.21          97.65     711.8
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## 1         0.10280          0.06981        0.03987     0.03700
## 2         0.09688          0.11470        0.06387     0.02642
## 3         0.10770          0.07804        0.03046     0.02480
## 4         0.11640          0.11360        0.04635     0.04796
## 5         0.07963          0.06934        0.03393     0.02657
## 6         0.08546          0.07722        0.05485     0.01428
##   symmetry_mean dimension_mean radius_se texture_se perimeter_se area_se
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## 3        0.1714        0.06340    0.1967     1.3870        1.342   13.54
## 4        0.1771        0.06072    0.3384     1.3430        1.851   26.33
## 5        0.1721        0.05544    0.1783     0.4125        1.338   17.72
## 6        0.2031        0.06267    0.2864     1.4400        2.206   20.30
##   smoothness_se compactness_se concavity_se points_se symmetry_se
## 1      0.008045       0.011800      0.01683  0.012410     0.01924
## 2      0.007470       0.035810      0.03354  0.013650     0.03504
## 3      0.005158       0.009355      0.01056  0.007483     0.01718
## 4      0.011270       0.034980      0.02187  0.019650     0.01580
## 5      0.005012       0.014850      0.01551  0.009155     0.01647
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##   dimension_se radius_worst texture_worst perimeter_worst area_worst
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## 2     0.003318        11.88         22.94           78.28      424.8
## 3     0.002198        12.41         26.44           79.93      471.4
## 4     0.003442        11.92         15.77           76.53      434.0
## 5     0.001767        16.20         15.73          104.50      819.1
## 6     0.003339        13.07         26.98           86.43      520.5
##   smoothness_worst compactness_worst concavity_worst points_worst
## 1           0.1385            0.1266         0.12420      0.09391
## 2           0.1213            0.2515         0.19160      0.07926
## 3           0.1369            0.1482         0.10670      0.07431
## 4           0.1367            0.1822         0.08669      0.08611
## 5           0.1126            0.1737         0.13620      0.08178
## 6           0.1249            0.1937         0.25600      0.06664
##   symmetry_worst dimension_worst
## 1         0.2827         0.06771
## 2         0.2940         0.07587
## 3         0.2998         0.07881
## 4         0.2102         0.06784
## 5         0.2487         0.06766
## 6         0.3035         0.08284
```

```r
#check for missing variables
sapply(bc_data, function(x) sum(is.na(x)))
```

```
##        diagnosis      radius_mean      texture_mean    perimeter_mean
##                0                0                 0                 0
##        area_mean  smoothness_mean  compactness_mean    concavity_mean
##                0                0                 0                 0
##      points_mean    symmetry_mean    dimension_mean         radius_se
##                0                0                 0                 0
##       texture_se     perimeter_se           area_se     smoothness_se
##                0                0                 0                 0
##   compactness_se     concavity_se         points_se       symmetry_se
##                0                0                 0                 0
##     dimension_se     radius_worst     texture_worst    perimeter_worst
##                0                0                 0                 0
##       area_worst smoothness_worst compactness_worst    concavity_worst
##                0                0                 0                 0
##     points_worst   symmetry_worst   dimension_worst
##                0                0                 0
```

summary(bc_data)

```
##        diagnosis      radius_mean      texture_mean    perimeter_mean
##                0                0                 0                 0
##        area_mean  smoothness_mean  compactness_mean    concavity_mean
##                0                0                 0                 0
##      points_mean    symmetry_mean    dimension_mean         radius_se
##                0                0                 0                 0
##       texture_se     perimeter_se           area_se     smoothness_se
##                0                0                 0                 0
##   compactness_se     concavity_se         points_se       symmetry_se
##                0                0                 0                 0
##     dimension_se     radius_worst     texture_worst    perimeter_worst
```

```
##  diagnosis  radius_mean      texture_mean    perimeter_mean
##  B:357     Min.   : 6.981   Min.   : 9.71   Min.   : 43.79
##  M:212     1st Qu.:11.700   1st Qu.:16.17   1st Qu.: 75.17
##            Median :13.370   Median :18.84   Median : 86.24
##            Mean   :14.127   Mean   :19.29   Mean   : 91.97
##            3rd Qu.:15.780   3rd Qu.:21.80   3rd Qu.:104.10
##            Max.   :28.110   Max.   :39.28   Max.   :188.50
##    area_mean       smoothness_mean  compactness_mean concavity_mean
##  Min.   : 143.5   Min.   :0.05263  Min.   :0.01938  Min.   :0.00000
##  1st Qu.: 420.3   1st Qu.:0.08637  1st Qu.:0.06492  1st Qu.:0.02956
##  Median : 551.1   Median :0.09587  Median :0.09263  Median :0.06154
##  Mean   : 654.9   Mean   :0.09636  Mean   :0.10434  Mean   :0.08880
##  3rd Qu.: 782.7   3rd Qu.:0.10530  3rd Qu.:0.13040  3rd Qu.:0.13070
##  Max.   :2501.0   Max.   :0.16340  Max.   :0.34540  Max.   :0.42680
##   points_mean     symmetry_mean    dimension_mean     radius_se
##  Min.   :0.00000  Min.   :0.1060   Min.   :0.04996  Min.   :0.1115
##  1st Qu.:0.02031  1st Qu.:0.1619   1st Qu.:0.05770  1st Qu.:0.2324
##  Median :0.03350  Median :0.1792   Median :0.06154  Median :0.3242
##  Mean   :0.04892  Mean   :0.1812   Mean   :0.06280  Mean   :0.4052
##  3rd Qu.:0.07400  3rd Qu.:0.1957   3rd Qu.:0.06612  3rd Qu.:0.4789
##  Max.   :0.20120  Max.   :0.3040   Max.   :0.09744  Max.   :2.8730
##    texture_se      perimeter_se      area_se         smoothness_se
##  Min.   :0.3602   Min.   : 0.757   Min.   :  6.802  Min.   :0.001713
##  1st Qu.:0.8339   1st Qu.: 1.606   1st Qu.: 17.850  1st Qu.:0.005169
##  Median :1.1080   Median : 2.287   Median : 24.530  Median :0.006380
##  Mean   :1.2169   Mean   : 2.866   Mean   : 40.337  Mean   :0.007041
##  3rd Qu.:1.4740   3rd Qu.: 3.357   3rd Qu.: 45.190  3rd Qu.:0.008146
##  Max.   :4.8850   Max.   :21.980   Max.   :542.200  Max.   :0.031130
##  compactness_se     concavity_se        points_se
##  Min.   :0.002252  Min.   :0.00000   Min.   :0.000000
##  1st Qu.:0.013080  1st Qu.:0.01509   1st Qu.:0.007638
##  Median :0.020450  Median :0.02589   Median :0.010930
##  Mean   :0.025478  Mean   :0.03189   Mean   :0.011796
##  3rd Qu.:0.032450  3rd Qu.:0.04205   3rd Qu.:0.014710
##  Max.   :0.135400  Max.   :0.39600   Max.   :0.052790
##   symmetry_se       dimension_se       radius_worst    texture_worst
##  Min.   :0.007882  Min.   :0.0008948  Min.   : 7.93   Min.   :12.02
##  1st Qu.:0.015160  1st Qu.:0.0022480  1st Qu.:13.01   1st Qu.:21.08
##  Median :0.018730  Median :0.0031870  Median :14.97   Median :25.41
##  Mean   :0.020542  Mean   :0.0037949  Mean   :16.27   Mean   :25.68
##  3rd Qu.:0.023480  3rd Qu.:0.0045580  3rd Qu.:18.79   3rd Qu.:29.72
##  Max.   :0.078950  Max.   :0.0298400  Max.   :36.04   Max.   :49.54
##  perimeter_worst    area_worst      smoothness_worst compactness_worst
##  Min.   : 50.41   Min.   : 185.2   Min.   :0.07117  Min.   :0.02729
##  1st Qu.: 84.11   1st Qu.: 515.3   1st Qu.:0.11660  1st Qu.:0.14720
##  Median : 97.66   Median : 686.5   Median :0.13130  Median :0.21190
##  Mean   :107.26   Mean   : 880.6   Mean   :0.13237  Mean   :0.25427
##  3rd Qu.:125.40   3rd Qu.:1084.0   3rd Qu.:0.14600  3rd Qu.:0.33910
##  Max.   :251.20   Max.   :4254.0   Max.   :0.22260  Max.   :1.05800
##  concavity_worst   points_worst     symmetry_worst   dimension_worst
##  Min.   :0.0000   Min.   :0.00000  Min.   :0.1565   Min.   :0.05504
##  1st Qu.:0.1145   1st Qu.:0.06493  1st Qu.:0.2504   1st Qu.:0.07146
##  Median :0.2267   Median :0.09993  Median :0.2822   Median :0.08004
##  Mean   :0.2722   Mean   :0.11461  Mean   :0.2901   Mean   :0.08395
##  3rd Qu.:0.3829   3rd Qu.:0.16140  3rd Qu.:0.3179   3rd Qu.:0.09208
##  Max.   :1.2520   Max.   :0.29100  Max.   :0.6638   Max.   :0.20750
```

```r
#To display the frequency table
diagnosis.table <- table(cancer$diagnosis)
#Displays the table
#This shows how many patients are benign and malignant
diagnosis.table
```

```
##
##   B   M
## 357 212
```

```r
#Generate barplot
ggplot(data=cancer, aes(x=diagnosis)) + geom_bar(stat = "count")
```
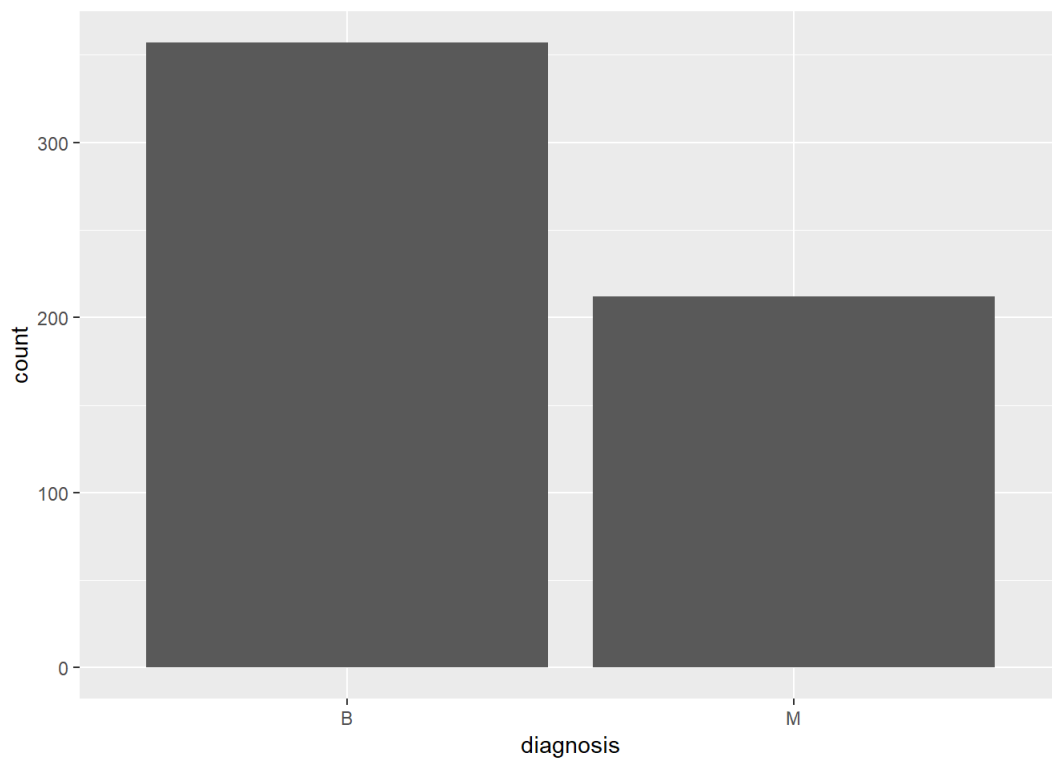
```
#Generate Pie chart represented in frequency
diagnosis.prop.table <- prop.table(diagnosis.table)*100
diagnosis.prop.df <- as.data.frame(diagnosis.prop.table)
pielabels <- sprintf("%s - %3.1f%s", diagnosis.prop.df[,1], diagnosis.prop.table, "%")
colors <- terrain.colors(2)
pie(diagnosis.prop.table,
    labels=pielabels,
    clockwise=TRUE,
    col=colors,
    border="gainsboro",
    radius=0.8,
    cex=0.8,
    main="frequency of cancer diagnosis")
legend(1, .4, legend=diagnosis.prop.df[,1], cex = 0.7, fill = colors)
```


frequency of cancer diagnosis
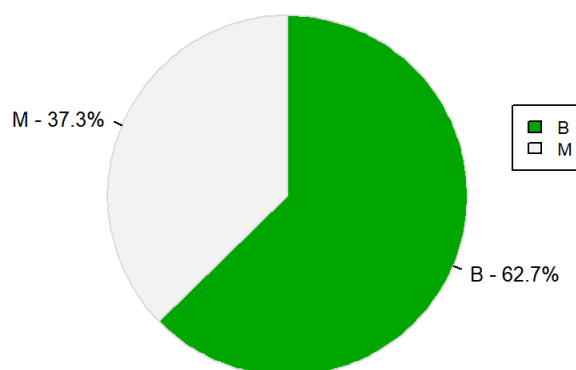
```
#To Plot histograms of "mean" variables group by diagnosis
data_mean <- cancer[ ,c("diagnosis", "radius_mean", "texture_mean","perimeter_mean", "area_mean", "smoothnes
s_mean", "compactness_mean", "concavity_mean", "symmetry_mean" )]
#Plot histograms
ggplot(data = melt(data_mean, id.var = "diagnosis"), mapping = aes(x = value)) +
  geom_histogram(bins = 10, aes(fill=diagnosis), alpha=0.5) + facet_wrap(~variable, scales ='free_x')
```
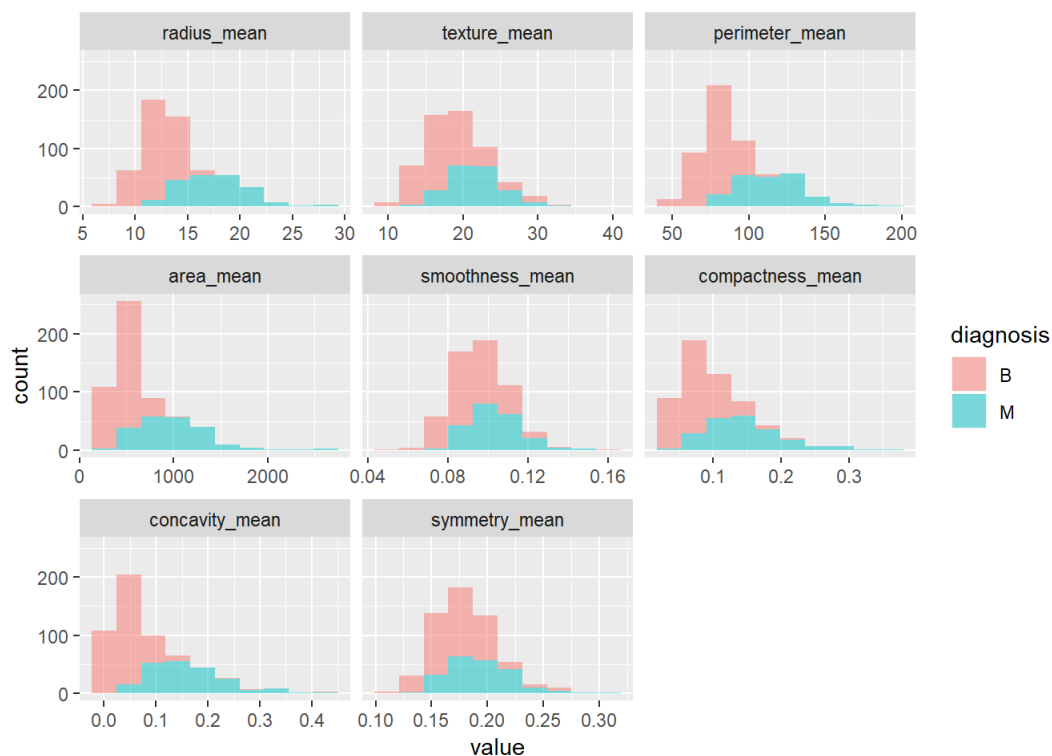


```
#Generate a Scatter plot of two varaible ie. concavity against radius
data <- cancer[,c('concavity_worst','radius_worst')]
plot(x = cancer$concavity_worst,y = cancer$radius_worst,
     xlab = "concavity_worst",
     ylab = "radius_worst",
     main = "Concavity_worst vs radius_worst",
     pch=15,
     col = c("red","blue")
     )
rug(cancer$concavity_worst, side = 1)
rug(cancer$radius_worst, side = 2)
```

Concavity_worst vs radius_worst
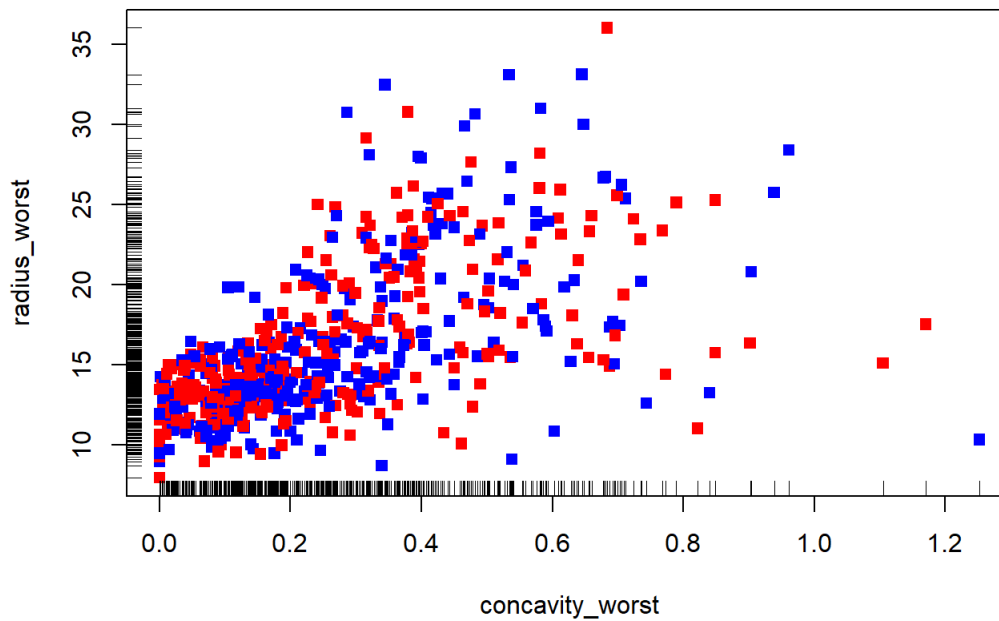

```
#Generate Corelation Matrix of columns
corMatMy <- cor(cancer[,3:32])
corrplot(corMatMy, order = "hclust", tl.cex = 0.7)
```
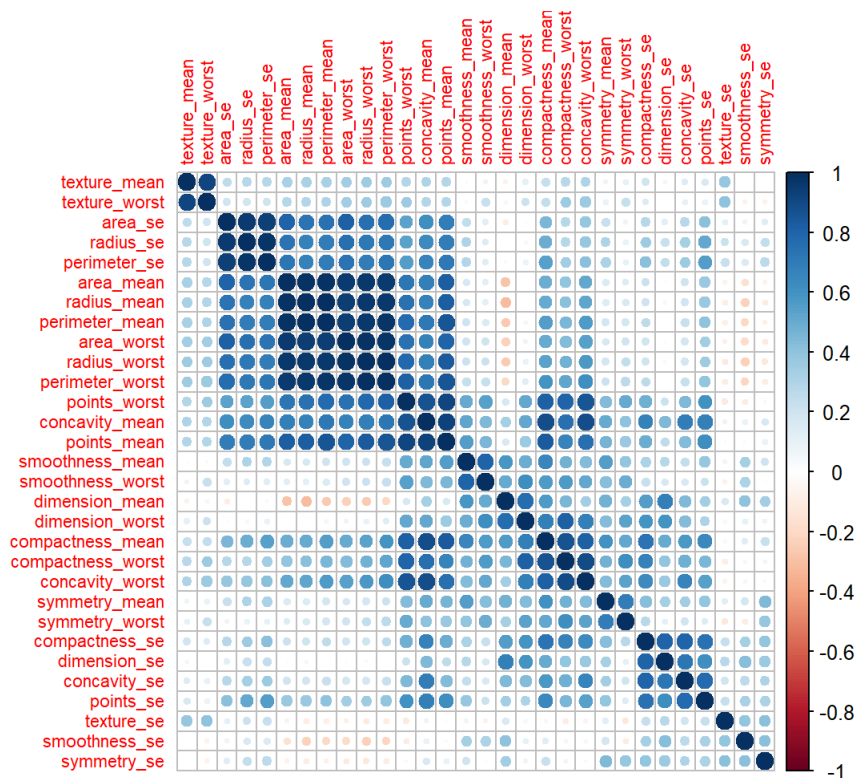


```
#Generate Scatterplot Matrix
pairs(~radius_mean+perimeter_mean+area_mean+compactness_mean+concavity_mean,data = cancer,main = "Scatterplot Matrix",col=c("red","blue","green","yellow"))
```

Scatterplot Matrix


```
#Multivariate analysis
#t-tEST
with(data=cancer,t.test(radius_mean[diagnosis=="B"],radius_mean[diagnosis=="M"],var.equal=TRUE))
```
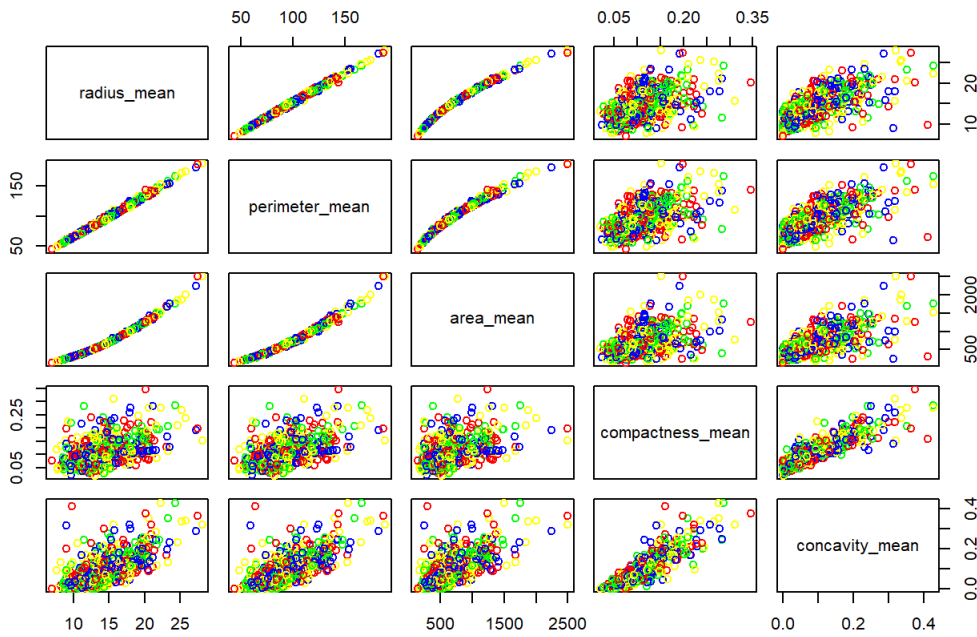
```
##
##  Two Sample t-test
##
## data:  radius_mean[diagnosis == "B"] and radius_mean[diagnosis == "M"]
## t = -25.436, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -5.726832 -4.905781
## sample estimates:
## mean of x mean of y
##  12.14652  17.46283
```

```
with(data=cancer,t.test(texture_mean[diagnosis=="B"],texture_mean[diagnosis=="M"],var.equal=TRUE))
```

```
##
##  Two Sample t-test
##
## data:  texture_mean[diagnosis == "B"] and texture_mean[diagnosis == "M"]
## t = -10.867, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.357107 -3.023181
## sample estimates:
## mean of x mean of y
##  17.91476  21.60491
```

```
with(data=cancer,t.test(perimeter_mean[diagnosis=="B"],perimeter_mean[diagnosis=="M"],var.equal=TRUE))
```

```
##
##  Two Sample t-test
##
## data:  perimeter_mean[diagnosis == "B"] and perimeter_mean[diagnosis == "M"]
## t = -26.405, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -40.06379 -34.51615
## sample estimates:
## mean of x mean of y
##  78.07541 115.36538
```

```
with(data=cancer,t.test(area_mean[diagnosis=="B"],area_mean[diagnosis=="M"],var.equal=TRUE))
```

```
##
##  Two Sample t-test
##
## data:  area_mean[diagnosis == "B"] and area_mean[diagnosis == "M"]
## t = -23.939, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -557.8898 -473.2826
## sample estimates:
## mean of x mean of y
##  462.7902  978.3764
```

```
with(data=cancer,t.test(smoothness_mean[diagnosis=="B"],smoothness_mean[diagnosis=="M"],var.equal=TRUE))
```

```
##
##  Two Sample t-test
##
## data:  smoothness_mean[diagnosis == "B"] and smoothness_mean[diagnosis == "M"]
## t = -9.1461, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.012658756 -0.008182931
## sample estimates:
##  mean of x  mean of y
## 0.09247765 0.10289849
```

```
with(data=cancer,t.test(compactness_mean[diagnosis=="B"],compactness_mean[diagnosis=="M"],var.equal=TRUE))
```

```
##
##  Two Sample t-test
##
## data:  compactness_mean[diagnosis == "B"] and compactness_mean[diagnosis == "M"]
## t = -17.698, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.07232827 -0.05787805
## sample estimates:
##  mean of x  mean of y
## 0.08008462 0.14518778
```

```
with(data=cancer,t.test(concavity_mean[diagnosis=="B"],concavity_mean[diagnosis=="M"],var.equal=TRUE))
```

```
## 
##  Two Sample t-test
## 
## data:  concavity_mean[diagnosis == "B"] and concavity_mean[diagnosis == "M"]
## t = -23.104, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1244696 -0.1049646
## sample estimates:
##  mean of x  mean of y
## 0.04605762 0.16077472
```

```
with(data=cancer,t.test(points_mean[diagnosis=="B"],points_mean[diagnosis=="M"],var.equal=TRUE))
```

```
## 
##  Two Sample t-test
## 
## data:  points_mean[diagnosis == "B"] and points_mean[diagnosis == "M"]
## t = -29.354, df = 567, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.06643938 -0.05810581
## sample estimates:
##  mean of x  mean of y
## 0.02571741 0.08799000
```

```
with(data=cancer,t.test(symmetry_mean[diagnosis=="B"],symmetry_mean[diagnosis=="M"],var.equal=TRUE))
```

```
## 
##  Two Sample t-test
## 
## data:  symmetry_mean[diagnosis == "B"] and symmetry_mean[diagnosis == "M"]
## t = -8.3383, df = 567, p-value = 5.733e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02313331 -0.01431262
## sample estimates:
## mean of x mean of y
##  0.174186  0.192909
```

```
with(data=cancer,t.test(dimension_mean[diagnosis=="B"],dimension_mean[diagnosis=="M"],var.equal=TRUE))
```

```
## 
##  Two Sample t-test
## 
## data:  dimension_mean[diagnosis == "B"] and dimension_mean[diagnosis == "M"]
## t = 0.30571, df = 567, p-value = 0.7599
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.001016083  0.001390684
## sample estimates:
##  mean of x  mean of y
## 0.06286739 0.06268009
```

```
#Hotelling's T2 test
#install.packages("Hotelling")
library(Hotelling)
```

```
## Loading required package: corpcor
```

```
t2testcan <- hotelling.test(radius_mean + texture_mean + perimeter_mean + area_mean + smoothness_mean + comp
actness_mean + concavity_mean + points_mean + symmetry_mean + dimension_mean ~ diagnosis, data=cancer)
# Output of the function hotelling.test is given
cat("T2 statistic =",t2testcan$stat[[1]],"\n")
```

```
## T2 statistic = 1220.313
```

```
print(t2testcan)
```

```
## Test stat:  120.09
## Numerator df:  10
## Denominator df:  558
## P-value:  0
```

```
#  T2 statistic is located in the first element of the list "stat"
#View(t2testcan)
#View(cancer)


#Levene's tests based on absolute differences around means using t-tests. Standarizing the data set with sca
le()
matstand <- scale(cancer[,3:10])
head(matstand)
```

```
##      radius_mean texture_mean perimeter_mean  area_mean smoothness_mean
## [1,]  -0.5128453  -1.60418301     -0.5399006 -0.5421468       0.4578825
## [2,]  -1.0009202  -0.07896900     -0.9337442 -0.8766033       0.0369535
## [3,]  -0.8760638  -0.57187353     -0.8662517 -0.8004484       0.8062867
## [4,]  -0.8079604  -1.37168088     -0.7806514 -0.7674858       1.4248817
## [5,]   0.3015589  -1.41353126      0.2337944  0.1617181      -1.1895712
## [6,]  -0.7256686  -0.05804381     -0.7312666 -0.6967299      -0.7750414
##      compactness_mean concavity_mean points_mean
## [1,]       -0.6538379     -0.6137661 -0.30717196
## [2,]        0.1961461     -0.3127117 -0.57983238
## [3,]       -0.4980044     -0.7318045 -0.62158190
## [4,]        0.1753178     -0.5324814 -0.02471844
## [5,]       -0.6627373     -0.6882771 -0.57596668
## [6,]       -0.5135309     -0.4258580 -0.89269604
```

```
matben <- matstand[cancer$diagnosis =="B",]
head(matben)
```

```
##      radius_mean texture_mean perimeter_mean  area_mean smoothness_mean
## [1,]  -0.5128453  -1.60418301     -0.5399006 -0.5421468       0.4578825
## [2,]  -1.0009202  -0.07896900     -0.9337442 -0.8766033       0.0369535
## [3,]  -0.8760638  -0.57187353     -0.8662517 -0.8004484       0.8062867
## [4,]  -0.8079604  -1.37168088     -0.7806514 -0.7674858       1.4248817
## [5,]   0.3015589  -1.41353126      0.2337944  0.1617181      -1.1895712
## [6,]  -0.7256686  -0.05804381     -0.7312666 -0.6967299      -0.7750414
##      compactness_mean concavity_mean points_mean
## [1,]       -0.6538379     -0.6137661 -0.30717196
## [2,]        0.1961461     -0.3127117 -0.57983238
## [3,]       -0.4980044     -0.7318045 -0.62158190
## [4,]        0.1753178     -0.5324814 -0.02471844
## [5,]       -0.6627373     -0.6882771 -0.57596668
## [6,]       -0.5135309     -0.4258580 -0.89269604
```

```
matmalign <- matstand[cancer$diagnosis == "M",]
vecmedianben <- apply(matben, 2, median)
# in the above 2 represents column. Hence, we are asking for column median
vecmedianben
```

```
##      radius_mean     texture_mean    perimeter_mean       area_mean
##       -0.5468970       -0.4416723       -0.5674737      -0.5583439
##  smoothness_mean compactness_mean   concavity_mean     points_mean
##       -0.3981961       -0.5500751       -0.6486382      -0.6566309
```

```
vecmedianmalign <- apply(matmalign, 2, median)
matabsdevben <- abs(matben - matrix(rep(vecmedianben,nrow(matben)),nrow=nrow(matben), byrow=TRUE))

matabsdevmalign <- abs(matmalign - matrix(rep(vecmedianmalign,nrow(matmalign)),nrow=nrow(matmalign), byrow=T
RUE))

head(matabsdevmalign)
```

```
##      radius_mean texture_mean perimeter_mean area_mean smoothness_mean
## [1,]   0.9974323   0.53242989      0.9317263 0.9496635      2.14019666
## [2,]   0.9264911   0.05115047      0.9712341 1.1025417      0.44794814
## [3,]   0.6427266   0.82305756      0.5555789 0.7359750      0.07110288
## [4,]   0.7846089   0.55800512      0.8436568 0.8951047      0.41239670
## [5,]   1.0002699   1.31828711      0.9782303 0.9885934      0.10665432
## [6,]   0.5746231   0.88583314      0.4856171 0.5671838      0.42661727
##      compactness_mean concavity_mean points_mean
## [1,]       0.84165269     0.05582051  0.14122676
## [2,]       0.60686094     0.84608833  0.66541513
## [3,]       0.63696730     0.17749666  0.11210518
## [4,]       0.97419643     0.96525570  1.07517890
## [5,]       0.08236646     0.92147737  0.91720079
## [6,]       0.70721548     0.21261968  0.03169871
```

```
matabsdev.all <- rbind(matabsdevben,matabsdevmalign)
matabsdev.all <- data.frame(cancer$diagnosis, matabsdev.all)

t.test(matabsdev.all$radius_mean[cancer$diagnosis == "B"],matabsdev.all$radius_mean[cancer$diagnosis == "M"]
, alternative="less",var.equal = TRUE)
```

```
##
##  Two Sample t-test
##
## data:  matabsdev.all$radius_mean[cancer$diagnosis == "B"] and matabsdev.all$radius_mean[cancer$diagnosis
== "M"]
## t = 0.32562, df = 567, p-value = 0.6276
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf 0.07485419
## sample estimates:
## mean of x mean of y
## 0.5301158 0.5177632
```

```
t.test(matabsdev.all$texture_mean[cancer$diagnosis == "B"],matabsdev.all$texture_mean[cancer$diagnosis == "M
"], alternative="less",var.equal = TRUE)
```

```
##
##  Two Sample t-test
##
## data:  matabsdev.all$texture_mean[cancer$diagnosis == "B"] and matabsdev.all$texture_mean[cancer$diagnosi
s == "M"]
## t = -2.1618, df = 567, p-value = 0.01553
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##         -Inf -0.02723094
## sample estimates:
## mean of x mean of y
## 0.6364762 0.7509490
```

```
t.test(matabsdev.all$perimeter_mean[cancer$diagnosis == "B"],matabsdev.all$perimeter_mean[cancer$diagnosis =
= "M"], alternative="less",var.equal = TRUE)
```

```
## 
##  Two Sample t-test
## 
## data:  matabsdev.all$perimeter_mean[cancer$diagnosis == "B"] and matabsdev.all$perimeter_mean[cancer$diag
nosis == "M"]
## t = 0.2439, df = 567, p-value = 0.5963
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf 0.07148672
## sample estimates:
## mean of x mean of y
## 0.5125724 0.5033541
```

```
t.test(matabsdev.all$area_mean[cancer$diagnosis == "B"],matabsdev.all$area_mean[cancer$diagnosis == "M"], al
ternative="less",var.equal = TRUE)
```

```
## 
##  Two Sample t-test
## 
## data:  matabsdev.all$area_mean[cancer$diagnosis == "B"] and matabsdev.all$area_mean[cancer$diagnosis == "
M"]
## t = 0.40112, df = 567, p-value = 0.6558
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf 0.0909786
## sample estimates:
## mean of x mean of y
## 0.4981297 0.4803166
```

```
t.test(matabsdev.all$smoothness_mean[cancer$diagnosis == "B"],matabsdev.all$smoothness_mean[cancer$diagnosis
== "M"], alternative="less",var.equal = TRUE)
```

```
## 
##  Two Sample t-test
## 
## data:  matabsdev.all$smoothness_mean[cancer$diagnosis == "B"] and matabsdev.all$smoothness_mean[cancer$di
agnosis == "M"]
## t = 1.6742, df = 567, p-value = 0.9527
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##      -Inf 0.167207
## sample estimates:
## mean of x mean of y
## 0.7680704 0.6837950
```

```
t.test(matabsdev.all$compactness_mean[cancer$diagnosis == "B"],matabsdev.all$compactness_mean[cancer$diagnos
is == "M"], alternative="less",var.equal = TRUE)
```

```
## 
##  Two Sample t-test
## 
## data:  matabsdev.all$compactness_mean[cancer$diagnosis == "B"] and matabsdev.all$compactness_mean[cancer$
diagnosis == "M"]
## t = 1.8406, df = 567, p-value = 0.9669
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf 0.1710355
## sample estimates:
## mean of x mean of y
## 0.6249227 0.5346711
```

```
t.test(matabsdev.all$concavity_mean[cancer$diagnosis == "B"],matabsdev.all$concavity_mean[cancer$diagnosis =
= "M"], alternative="less",var.equal = TRUE)
```

```
## 
##   Two Sample t-test
## 
## data:  matabsdev.all$concavity_mean[cancer$diagnosis == "B"] and matabsdev.all$concavity_mean[cancer$diag
nosis == "M"]
## t = 1.0995, df = 567, p-value = 0.864
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##        -Inf 0.1302286
## sample estimates:
## mean of x mean of y
## 0.4977532 0.4456302
```

```
t.test(matabsdev.all$points_mean[cancer$diagnosis == "B"],matabsdev.all$points_mean[cancer$diagnosis == "M"]
, alternative="less",var.equal = TRUE)
```

```
## 
##   Two Sample t-test
## 
## data:  matabsdev.all$points_mean[cancer$diagnosis == "B"] and matabsdev.all$points_mean[cancer$diagnosis
== "M"]
## t = 0.31387, df = 567, p-value = 0.6231
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##         -Inf 0.07740908
## sample estimates:
## mean of x mean of y
## 0.4434506 0.4310634
```

```
head(matstand)
```

```
##       radius_mean texture_mean perimeter_mean  area_mean smoothness_mean
## [1,]  -0.5128453  -1.60418301     -0.5399006 -0.5421468       0.4578825
## [2,]  -1.0009202  -0.07896900     -0.9337442 -0.8766033       0.0369535
## [3,]  -0.8760638  -0.57187353     -0.8662517 -0.8004484       0.8062867
## [4,]  -0.8079604  -1.37168088     -0.7806514 -0.7674858       1.4248817
## [5,]   0.3015589  -1.41353126      0.2337944  0.1617181      -1.1895712
## [6,]  -0.7256686  -0.05804381     -0.7312666 -0.6967299      -0.7750414
##      compactness_mean concavity_mean points_mean
## [1,]       -0.6538379     -0.6137661 -0.30717196
## [2,]        0.1961461     -0.3127117 -0.57983238
## [3,]       -0.4980044     -0.7318045 -0.62158190
## [4,]        0.1753178     -0.5324814 -0.02471844
## [5,]       -0.6627373     -0.6882771 -0.57596668
## [6,]       -0.5135309     -0.4258580 -0.89269604
```

```
matstand.all <- data.frame(cancer$diagnosis, matstand)
head(matstand.all)
```

```
##   cancer.diagnosis radius_mean texture_mean perimeter_mean  area_mean
## 1                B  -0.5128453  -1.60418301     -0.5399006 -0.5421468
## 2                B  -1.0009202  -0.07896900     -0.9337442 -0.8766033
## 3                B  -0.8760638  -0.57187353     -0.8662517 -0.8004484
## 4                B  -0.8079604  -1.37168088     -0.7806514 -0.7674858
## 5                B   0.3015589  -1.41353126      0.2337944  0.1617181
## 6                B  -0.7256686  -0.05804381     -0.7312666 -0.6967299
##   smoothness_mean compactness_mean concavity_mean points_mean
## 1       0.4578825       -0.6538379     -0.6137661 -0.30717196
## 2       0.0369535        0.1961461     -0.3127117 -0.57983238
## 3       0.8062867       -0.4980044     -0.7318045 -0.62158190
## 4       1.4248817        0.1753178     -0.5324814 -0.02471844
## 5      -1.1895712       -0.6627373     -0.6882771 -0.57596668
## 6      -0.7750414       -0.5135309     -0.4258580 -0.89269604
```

```
colnames(matstand.all) <- colnames(cancer[2:10])
t2testcan <- hotelling.test(radius_mean + texture_mean + perimeter_mean + area_mean + smoothness_mean + comp
actness_mean + concavity_mean + points_mean + symmetry_mean + dimension_mean ~ diagnosis, data=cancer)
cat("T2 statistic =",t2testcan$stat[[1]],"\n")
```

```
## T2 statistic = 1220.313
```

```
print(t2testcan)
```

```
## Test stat:  120.09
## Numerator df:  10
## Denominator df:  558
## P-value:  0
```

```
# In the above we standardized using scale function
head(matabsdev.all)
```

```
##   cancer.diagnosis radius_mean texture_mean perimeter_mean   area_mean
## 1                B  0.03405174    1.1625107     0.02757317 0.01619713
## 2                B  0.45402322    0.3627033     0.36627050 0.31825946
## 3                B  0.32916684    0.1302012     0.29877796 0.24210452
## 4                B  0.26106335    0.9300085     0.21317766 0.20914193
## 5                B  0.84845589    0.9718589     0.80126817 0.72006202
## 6                B  0.17877164    0.3836285     0.16379288 0.13838603
##   smoothness_mean compactness_mean concavity_mean points_mean
## 1       0.8560787       0.10376281     0.03487214  0.34945891
## 2       0.4351496       0.74622121     0.33592655  0.07679849
## 3       1.2044828       0.05207075     0.08316628  0.03504898
## 4       1.8230778       0.72539291     0.11615683  0.63191243
## 5       0.7913750       0.11266217     0.03963883  0.08066419
## 6       0.3768453       0.03654420     0.22278026  0.23606517
```

```
#install.packages("car")
library(car)
```

```
## Loading required package: carData
```

```
#leveneTest() produces a two-sided test
# Leverne test is used to verify Homoscedasticity. It tests if the variance of two samples are # #equal. Lev
ene's test is an inferential statistic used to assess the equality of variances for a #variable calculated f
or two or more groups.[1] Some common statistical procedures assume that #variances of the populations from
which different samples are drawn are equal. Levene's test #assesses this assumption.
leveneTest(radius_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  90.477 < 2.2e-16 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(texture_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1   0.684 0.4086
##       567
```

```
leveneTest(perimeter_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  91.237 < 2.2e-16 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(area_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  170.21 < 2.2e-16 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(smoothness_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1  0.8377 0.3604
##       567
```

```
leveneTest(compactness_mean~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  39.892 5.428e-10 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(concavity_mean~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  70.484 3.723e-16 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(points_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  94.906 < 2.2e-16 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
leveneTest(symmetry_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1   2.036 0.1542
##       567
```

```
leveneTest(dimension_mean ~ diagnosis, data=cancer)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value  Pr(>F)
## group  1   6.113 0.01371 *
##      567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#PCA
dim(cancer)
```

```
## [1] 569  32
```

```
attach(cancer)
head(cancer)
```

```
##         id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1 87139402         B       12.32        12.39          78.85     464.1
## 2  8910251         B       10.60        18.95          69.28     346.4
## 3   905520         B       11.04        16.83          70.92     373.2
## 4   868871         B       11.28        13.39          73.00     384.8
## 5  9012568         B       15.19        13.21          97.65     711.8
## 6   906539         B       11.57        19.04          74.20     409.7
##   smoothness_mean compactness_mean concavity_mean points_mean
## 1         0.10280          0.06981        0.03987     0.03700
## 2         0.09688          0.11470        0.06387     0.02642
## 3         0.10770          0.07804        0.03046     0.02480
## 4         0.11640          0.11360        0.04635     0.04796
## 5         0.07963          0.06934        0.03393     0.02657
## 6         0.08546          0.07722        0.05485     0.01428
##   symmetry_mean dimension_mean radius_se texture_se perimeter_se area_se
## 1        0.1959        0.05955    0.2360     0.6656        1.670   17.43
## 2        0.1922        0.06491    0.4505     1.1970        3.430   27.10
## 3        0.1714        0.06340    0.1967     1.3870        1.342   13.54
## 4        0.1771        0.06072    0.3384     1.3430        1.851   26.33
## 5        0.1721        0.05544    0.1783     0.4125        1.338   17.72
## 6        0.2031        0.06267    0.2864     1.4400        2.206   20.30
##   smoothness_se compactness_se concavity_se points_se symmetry_se
## 1      0.008045       0.011800      0.01683  0.012410     0.01924
## 2      0.007470       0.035810      0.03354  0.013650     0.03504
## 3      0.005158       0.009355      0.01056  0.007483     0.01718
## 4      0.011270       0.034980      0.02187  0.019650     0.01580
## 5      0.005012       0.014850      0.01551  0.009155     0.01647
## 6      0.007278       0.020470      0.04447  0.008799     0.01868
##   dimension_se radius_worst texture_worst perimeter_worst area_worst
## 1     0.002248        13.50         15.64           86.97      549.1
## 2     0.003318        11.88         22.94           78.28      424.8
## 3     0.002198        12.41         26.44           79.93      471.4
## 4     0.003442        11.92         15.77           76.53      434.0
## 5     0.001767        16.20         15.73          104.50      819.1
## 6     0.003339        13.07         26.98           86.43      520.5
##   smoothness_worst compactness_worst concavity_worst points_worst
## 1           0.1385            0.1266         0.12420      0.09391
## 2           0.1213            0.2515         0.19160      0.07926
## 3           0.1369            0.1482         0.10670      0.07431
## 4           0.1367            0.1822         0.08669      0.08611
## 5           0.1126            0.1737         0.13620      0.08178
## 6           0.1249            0.1937         0.25600      0.06664
##   symmetry_worst dimension_worst
## 1         0.2827         0.06771
## 2         0.2940         0.07587
## 3         0.2998         0.07881
## 4         0.2102         0.06784
## 5         0.2487         0.06766
## 6         0.3035         0.08284
```

```
#Get the Correlations between the measurements
cor(cancer[-2])
```

```
##                            id  radius_mean texture_mean perimeter_mean
## id                1.0000000000  0.074626470  0.099769891    0.073159412
## radius_mean       0.0746264697  1.000000000  0.323781891    0.997855281
## texture_mean      0.0997698912  0.323781891  1.000000000    0.329533059
## perimeter_mean    0.0731594119  0.997855281  0.329533059    1.000000000
## area_mean         0.0968928233  0.987357170  0.321085696    0.986506804
## smoothness_mean  -0.0129681975  0.170581187 -0.023388516    0.207278164
## compactness_mean  0.0000957011  0.506123578  0.236702222    0.556936211
## concavity_mean    0.0500799532  0.676763550  0.302417828    0.716135650
## points_mean       0.0441580956  0.822528522  0.293464051    0.850977041
## symmetry_mean    -0.0221140609  0.147741242  0.071400980    0.183027212
## dimension_mean   -0.0525114476 -0.311630826 -0.076437183   -0.261476908
## radius_se         0.1430475814  0.679090388  0.275868676    0.691765014
## texture_se       -0.0075261904 -0.097317443  0.386357623   -0.086761078
## perimeter_se      0.1373310660  0.674171616  0.281673115    0.693134890
## area_se           0.1777419152  0.735863663  0.259844987    0.744982694
## smoothness_se     0.0967805739 -0.222600125  0.006613777   -0.202694026
## compactness_se    0.0339609721  0.205999980  0.191974611    0.250743681
## concavity_se      0.0552393174  0.194203623  0.143293077    0.228082345
## points_se         0.0787680711  0.376168956  0.163851025    0.407216916
## symmetry_se      -0.0173062948 -0.104320881  0.009127168   -0.081629327
## dimension_se      0.0257253243 -0.042641269  0.054457520   -0.005523391
## radius_worst      0.0824053373  0.969538973  0.352572947    0.969476363
## texture_worst     0.0647195454  0.297007644  0.912044589    0.303038372
## perimeter_worst   0.0799858731  0.965136514  0.358039575    0.970386887
## area_worst        0.1071865233  0.941082460  0.343545947    0.941549808
## smoothness_worst  0.0103380343  0.119616140  0.077503359    0.150549404
## compactness_worst -0.0029680998 0.413462823  0.277829592    0.455774228
## concavity_worst   0.0232027439  0.526911462  0.301025224    0.563879263
## points_worst      0.0351735794  0.744214198  0.295315843    0.771240789
## symmetry_worst   -0.0442242529  0.163953335  0.105007910    0.189115040
## dimension_worst  -0.0298656360  0.007065886  0.119205351    0.051018530
##                   area_mean smoothness_mean compactness_mean
## id               0.096892823     -0.01296820     0.0000957011
## radius_mean      0.987357170      0.17058119     0.5061235775
## texture_mean     0.321085696     -0.02338852     0.2367022221
## perimeter_mean   0.986506804      0.20727816     0.5569362109
## area_mean        1.000000000      0.17702838     0.4985016822
## smoothness_mean  0.177028377      1.00000000     0.6591232152
## compactness_mean 0.498501682      0.65912322     1.0000000000
## concavity_mean   0.685982829      0.52198377     0.8831206702
## points_mean      0.823268869      0.55369517     0.8311350431
## symmetry_mean    0.151293079      0.55777479     0.6026410484
## dimension_mean  -0.283109812      0.58479200     0.5653686634
## radius_se        0.732562227      0.30146710     0.4974734461
## texture_se      -0.066280214      0.06840645     0.0462048307
## perimeter_se     0.726628328      0.29609193     0.5489052646
## area_se          0.800085921      0.24655243     0.4556528520
## smoothness_se   -0.166776667      0.33237544     0.1352992677
## compactness_se   0.212582551      0.31894330     0.7387217897
## concavity_se     0.207660060      0.24839568     0.5705168715
## points_se        0.372320282      0.38067569     0.6422618510
## symmetry_se     -0.072496588      0.20077438     0.2299765908
## dimension_se    -0.019886963      0.28360670     0.5073181269
## radius_worst     0.962746086      0.21312014     0.5353153982
## texture_worst    0.287488627      0.03607180     0.2481328333
## perimeter_worst  0.959119574      0.23885263     0.5902104277
## area_worst       0.959213326      0.20671836     0.5096038056
## smoothness_worst 0.123522939      0.80532420     0.5655411664
## compactness_worst 0.390410309     0.47246844     0.8658090398
## concavity_worst  0.512605920      0.43492571     0.8162752498
## points_worst     0.722016626      0.50305335     0.8155732236
## symmetry_worst   0.143569914      0.39430948     0.5102234299
## dimension_worst  0.003737597      0.49931637     0.6873823228
##                  concavity_mean points_mean symmetry_mean dimension_mean
## id                  0.05007995  0.04415810   -0.02211406   -0.0525114476
## radius_mean         0.67676355  0.82252852    0.14774124   -0.3116308263
## texture_mean        0.30241783  0.29346405    0.07140098   -0.0764371834
## perimeter_mean      0.71613565  0.85097704    0.18302721   -0.2614769081
## area_mean           0.68598283  0.82326887    0.15129308   -0.2831098117
## smoothness_mean     0.52198377  0.55369517    0.55777479    0.5847920019
## compactness_mean    0.88312067  0.83113504    0.60264105    0.5653686634
## concavity_mean      1.00000000  0.92139103    0.50066662    0.3367833594
```

```
##                     -_
## points_mean          0.92139103  1.00000000  0.46249739  0.1669173832
## symmetry_mean        0.50066662  0.46249739  1.00000000  0.4799213301
## dimension_mean       0.33678336  0.16691738  0.47992133  1.0000000000
## radius_se            0.63192482  0.69804983  0.30337926  0.0001109951
## texture_se           0.07621835  0.02147958  0.12805293  0.1641739659
## perimeter_se         0.66039079  0.71064987  0.31389276  0.0398299316
## area_se              0.61742681  0.69029854  0.22397022 -0.0901702475
## smoothness_se        0.09856375  0.02765331  0.18732117  0.4019644254
## compactness_se       0.67027882  0.49042425  0.42165915  0.5598366906
## concavity_se         0.69127021  0.43916707  0.34262702  0.4466303217
## points_se            0.68325992  0.61563413  0.39329787  0.3411980444
## symmetry_se          0.17800921  0.09535079  0.44913654  0.3450073971
## dimension_se         0.44930075  0.25758375  0.33178615  0.6881315775
## radius_worst         0.68823641  0.83031763  0.18572775 -0.2536914949
## texture_worst        0.29987889  0.29275171  0.09065069 -0.0512692020
## perimeter_worst      0.72956492  0.85592313  0.21916856 -0.2051512113
## area_worst           0.67598723  0.80962962  0.17719338 -0.2318544512
## smoothness_worst     0.44882204  0.45275305  0.42667503  0.5049420754
## compactness_worst    0.75496802  0.66745368  0.47320001  0.4587981567
## concavity_worst      0.88410264  0.75239950  0.43372101  0.3462338763
## points_worst         0.86132303  0.91015531  0.43029661  0.1753254492
## symmetry_worst       0.40946413  0.37574415  0.69982580  0.3340186839
## dimension_worst      0.51492989  0.36866113  0.43841350  0.7672967792
##                      radius_se  texture_se perimeter_se     area_se
## id                  0.1430475814 -0.00752619   0.13733107  0.17774192
## radius_mean         0.6790903880 -0.09731744   0.67417162  0.73586366
## texture_mean        0.2758686762  0.38635762   0.28167311  0.25984499
## perimeter_mean      0.6917650135 -0.08676108   0.69313489  0.74498269
## area_mean           0.7325622270 -0.06628021   0.72662833  0.80008592
## smoothness_mean     0.3014670983  0.06840645   0.29609193  0.24655243
## compactness_mean    0.4974734461  0.04620483   0.54890526  0.45565285
## concavity_mean      0.6319248221  0.07621835   0.66039079  0.61742681
## points_mean         0.6980498336  0.02147958   0.71064987  0.69029854
## symmetry_mean       0.3033792632  0.12805293   0.31389276  0.22397022
## dimension_mean      0.0001109951  0.16417397   0.03982993 -0.09017025
## radius_se           1.0000000000  0.21324734   0.97279368  0.95183011
## texture_se          0.2132473373  1.00000000   0.22317073  0.11156725
## perimeter_se        0.9727936770  0.22317073   1.00000000  0.93765541
## area_se             0.9518301121  0.11156725   0.93765541  1.00000000
## smoothness_se       0.1645142198  0.39724285   0.15107533  0.07515034
## compactness_se      0.3560645755  0.23169970   0.41632237  0.28484006
## concavity_se        0.3323575376  0.19499846   0.36248158  0.27089473
## points_se           0.5133464414  0.23028340   0.55626408  0.41572957
## symmetry_se         0.2405673625  0.41162068   0.26648709  0.13410898
## dimension_se        0.2277535327  0.27972275   0.24414277  0.12707090
## radius_worst        0.7150651951 -0.11169031   0.69720059  0.75737319
## texture_worst       0.1947985568  0.40900277   0.20037085  0.19649665
## perimeter_worst     0.7196838037 -0.10224192   0.72103131  0.76121264
## area_worst          0.7515484761 -0.08319499   0.73071297  0.81140796
## smoothness_worst    0.1419185529 -0.07365766   0.13005439  0.12538943
## compactness_worst   0.2871031656 -0.09243935   0.34191945  0.28325654
## concavity_worst     0.3805846346 -0.06895622   0.41889882  0.38510014
## points_worst        0.5310623278 -0.11963752   0.55489723  0.53816631
## symmetry_worst      0.0945428304 -0.12821476   0.10993043  0.07412629
## dimension_worst     0.0495594325 -0.04565457   0.08543257  0.01753930
##                     smoothness_se compactness_se concavity_se  points_se
## id                   0.096780574     0.03396097   0.05523932 0.07876807
## radius_mean         -0.222600125     0.20599998   0.19420362 0.37616896
## texture_mean         0.006613777     0.19197461   0.14329308 0.16385103
## perimeter_mean      -0.202694026     0.25074368   0.22808235 0.40721692
## area_mean           -0.166776667     0.21258255   0.20766006 0.37232028
## smoothness_mean      0.332375443     0.31894330   0.24839568 0.38067569
## compactness_mean     0.135299268     0.73872179   0.57051687 0.64226185
## concavity_mean       0.098563746     0.67027882   0.69127021 0.68325992
## points_mean          0.027653308     0.49042425   0.43916707 0.61563413
## symmetry_mean        0.187321165     0.42165915   0.34262702 0.39329787
## dimension_mean       0.401964425     0.55983669   0.44663032 0.34119804
## radius_se            0.164514220     0.35606458   0.33235754 0.51334644
## texture_se           0.397242853     0.23169970   0.19499846 0.23028340
## perimeter_se         0.151075331     0.41632237   0.36248158 0.55626408
## area_se              0.075150338     0.28484006   0.27089473 0.41572957
## smoothness_se        1.000000000     0.33669608   0.26868476 0.32842950
## compactness_se       0.336696081     1.00000000   0.80126834 0.74408267
```

```
## compactness_se     0.330696061      1.00000000    0.80126834 0.74408267
## concavity_se        0.268684760      0.80126834    1.00000000 0.77180399
## points_se           0.328429499      0.74408267    0.77180399 1.00000000
## symmetry_se         0.413506125      0.39471283    0.30942858 0.31278022
## dimension_se        0.427374207      0.80326882    0.72737218 0.61104414
## radius_worst       -0.230690710      0.20460717    0.18690352 0.35812667
## texture_worst      -0.074742965      0.14300258    0.10024098 0.08674121
## perimeter_worst    -0.217303755      0.26051584    0.22668043 0.39499925
## area_worst         -0.182195478      0.19937133    0.18835265 0.34227116
## smoothness_worst    0.314457456      0.22739423    0.16848132 0.21535060
## compactness_worst  -0.055558139      0.67878035    0.48485780 0.45288838
## concavity_worst    -0.058298387      0.63914670    0.66256413 0.54959238
## points_worst       -0.102006796      0.48320833    0.44047226 0.60244961
## symmetry_worst     -0.107342098      0.27787843    0.19778782 0.14311567
## dimension_worst     0.101480315      0.59097276    0.43932927 0.31065455
##                    symmetry_se dimension_se radius_worst texture_worst
## id                 -0.017306295  0.025725324   0.08240534   0.064719545
## radius_mean        -0.104320881 -0.042641269   0.96953897   0.297007644
## texture_mean        0.009127168  0.054457520   0.35257295   0.912044589
## perimeter_mean     -0.081629327 -0.005523391   0.96947636   0.303038372
## area_mean          -0.072496588 -0.019886963   0.96274609   0.287488627
## smoothness_mean     0.200774376  0.283606699   0.21312014   0.036071799
## compactness_mean    0.229976591  0.507318127   0.53531540   0.248132833
## concavity_mean      0.178009208  0.449300749   0.68823641   0.299878889
## points_mean         0.095350787  0.257583746   0.83031763   0.292751713
## symmetry_mean       0.449136542  0.331786146   0.18572775   0.090650688
## dimension_mean      0.345007397  0.688131577  -0.25369149  -0.051269202
## radius_se           0.240567362  0.227753533   0.71506520   0.194798557
## texture_se          0.411620680  0.279722748  -0.11169031   0.409002766
## perimeter_se        0.266487092  0.244142773   0.69720059   0.200370854
## area_se             0.134108980  0.127070903   0.75737319   0.196496649
## smoothness_se       0.413506125  0.427374207  -0.23069071  -0.074742965
## compactness_se      0.394712835  0.803268818   0.20460717   0.143002583
## concavity_se        0.309428578  0.727372184   0.18690352   0.100240984
## points_se           0.312780223  0.611044139   0.35812667   0.086741210
## symmetry_se         1.000000000  0.369078083  -0.12812077  -0.077473420
## dimension_se        0.369078083  1.000000000  -0.03748762  -0.003195029
## radius_worst       -0.128120769 -0.037487618   1.00000000   0.359920754
## texture_worst      -0.077473420 -0.003195029   0.35992075   1.000000000
## perimeter_worst    -0.103753044 -0.001000398   0.99370792   0.365098245
## area_worst         -0.110342743 -0.022736147   0.98401456   0.345842283
## smoothness_worst   -0.012661800  0.170568316   0.21657443   0.225429415
## compactness_worst   0.060254879  0.390158842   0.47582004   0.360832339
## concavity_worst     0.037119049  0.379974661   0.57397471   0.368365607
## points_worst       -0.030413396  0.215204013   0.78742385   0.359754610
## symmetry_worst      0.389402485  0.111093956   0.24352920   0.233027461
## dimension_worst     0.078079476  0.591328066   0.09349198   0.219122425
##                    perimeter_worst   area_worst smoothness_worst
## id                     0.079985873   0.10718652       0.01033803
## radius_mean            0.965136514   0.94108246       0.11961614
## texture_mean           0.358039575   0.34354595       0.07750336
## perimeter_mean         0.970386887   0.94154981       0.15054940
## area_mean              0.959119574   0.95921333       0.12352294
## smoothness_mean        0.238852626   0.20671836       0.80532420
## compactness_mean       0.590210428   0.50960381       0.56554117
## concavity_mean         0.729564917   0.67598723       0.44882204
## points_mean            0.855923128   0.80962962       0.45275305
## symmetry_mean          0.219168559   0.17719338       0.42667503
## dimension_mean        -0.205151211  -0.23185445       0.50494208
## radius_se              0.719683804   0.75154848       0.14191855
## texture_se            -0.102241922  -0.08319499      -0.07365766
## perimeter_se           0.721031310   0.73071297       0.13005439
## area_se                0.761212636   0.81140796       0.12538943
## smoothness_se         -0.217303755  -0.18219548       0.31445746
## compactness_se         0.260515840   0.19937133       0.22739423
## concavity_se           0.226680426   0.18835265       0.16848132
## points_se              0.394999252   0.34227116       0.21535060
## symmetry_se           -0.103753044  -0.11034274      -0.01266180
## dimension_se          -0.001000398  -0.02273615       0.17056832
## radius_worst           0.993707916   0.98401456       0.21657443
## texture_worst          0.365098245   0.34584228       0.22542941
## perimeter_worst        1.000000000   0.97757809       0.23677460
## area_worst             0.977578091   1.00000000       0.20914533
```

```
## smoothness_worst       0.236774604  0.20914533          1.00000000
## compactness_worst      0.529407690  0.43829628          0.56818652
## concavity_worst        0.618344080  0.54333053          0.51852329
## points_worst           0.816322102  0.74741880          0.54769090
## symmetry_worst         0.269492769  0.20914551          0.49383833
## dimension_worst        0.138956862  0.07964703          0.61762419
##                      compactness_worst concavity_worst points_worst
## id                        -0.00296810      0.02320274   0.03517358
## radius_mean                0.41346282      0.52691146   0.74421420
## texture_mean               0.27782959      0.30102522   0.29531584
## perimeter_mean             0.45577423      0.56387926   0.77124079
## area_mean                  0.39041031      0.51260592   0.72201663
## smoothness_mean            0.47246844      0.43492571   0.50305335
## compactness_mean           0.86580904      0.81627525   0.81557322
## concavity_mean             0.75496802      0.88410264   0.86132303
## points_mean                0.66745368      0.75239950   0.91015531
## symmetry_mean              0.47320001      0.43372101   0.43029661
## dimension_mean             0.45879816      0.34623388   0.17532545
## radius_se                  0.28710317      0.38058463   0.53106233
## texture_se                -0.09243935     -0.06895622  -0.11963752
## perimeter_se               0.34191945      0.41889882   0.55489723
## area_se                    0.28325654      0.38510014   0.53816631
## smoothness_se             -0.05555814     -0.05829839  -0.10200680
## compactness_se             0.67878035      0.63914670   0.48320833
## concavity_se               0.48485780      0.66256413   0.44047226
## points_se                  0.45288838      0.54959238   0.60244961
## symmetry_se                0.06025488      0.03711905  -0.03041340
## dimension_se               0.39015884      0.37997466   0.21520401
## radius_worst               0.47582004      0.57397471   0.78742385
## texture_worst              0.36083234      0.36836561   0.35975461
## perimeter_worst            0.52940769      0.61834408   0.81632210
## area_worst                 0.43829628      0.54333053   0.74741880
## smoothness_worst           0.56818652      0.51852329   0.54769090
## compactness_worst          1.00000000      0.89226090   0.80108036
## concavity_worst            0.89226090      1.00000000   0.85543386
## points_worst               0.80108036      0.85543386   1.00000000
## symmetry_worst             0.61444050      0.53251973   0.50252849
## dimension_worst            0.81045486      0.68651092   0.51111415
##                      symmetry_worst dimension_worst
## id                      -0.04422425    -0.029865636
## radius_mean              0.16395333     0.007065886
## texture_mean             0.10500791     0.119205351
## perimeter_mean           0.18911504     0.051018530
## area_mean                0.14356991     0.003737597
## smoothness_mean          0.39430948     0.499316369
## compactness_mean         0.51022343     0.687382323
## concavity_mean           0.40946413     0.514929891
## points_mean              0.37574415     0.368661134
## symmetry_mean            0.69982580     0.438413498
## dimension_mean           0.33401868     0.767296779
## radius_se                0.09454283     0.049559432
## texture_se              -0.12821476    -0.045654569
## perimeter_se             0.10993043     0.085432572
## area_se                  0.07412629     0.017539295
## smoothness_se           -0.10734210     0.101480315
## compactness_se           0.27787843     0.590972763
## concavity_se             0.19778782     0.439329269
## points_se                0.14311567     0.310654551
## symmetry_se              0.38940248     0.078079476
## dimension_se             0.11109396     0.591328066
## radius_worst             0.24352920     0.093491979
## texture_worst            0.23302746     0.219122425
## perimeter_worst          0.26949277     0.138956862
## area_worst               0.20914551     0.079647034
## smoothness_worst         0.49383833     0.617624192
## compactness_worst        0.61444050     0.810454856
## concavity_worst          0.53251973     0.686510921
## points_worst             0.50252849     0.511114146
## symmetry_worst           1.00000000     0.537848206
## dimension_worst          0.53784821     1.000000000
```

```
c <- (cor(cancer[-2]))
plot(c)
```
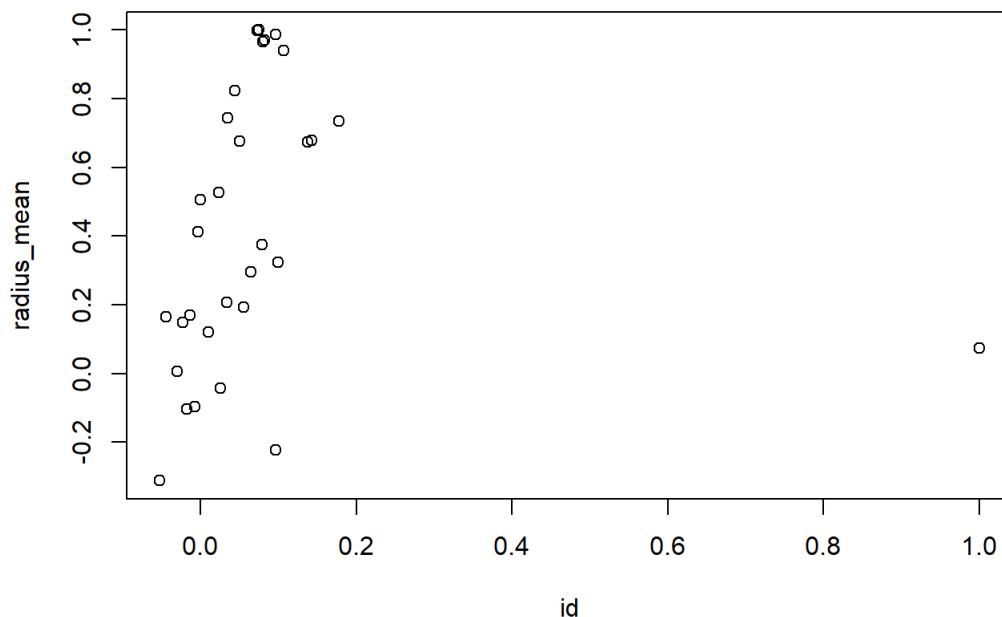


```
# Using prcomp to compute the principal components (eigenvalues and eigenvectors). With scale=TRUE, variable
means are set to zero, and variances set to one
cancer_pca <- prcomp(cancer[,-2],scale=TRUE)
cancer_pca
```

```
## Standard deviations (1, .., p=31):
##  [1] 3.64527878 2.38679814 1.68386313 1.40760690 1.28406203 1.11115827
##  [7] 0.98907696 0.81960537 0.67881693 0.63492763 0.59089337 0.54211662
## [13] 0.51102537 0.49125372 0.39619900 0.30680373 0.28250655 0.24299439
## [19] 0.22932770 0.22163467 0.17626907 0.17303527 0.16562163 0.15572098
## [25] 0.13431069 0.12441756 0.09039745 0.08305482 0.03986650 0.02735646
## [31] 0.01153431
##
## Rotation (n x k) = (31 x 31):
##                          PC1          PC2          PC3          PC4
## id                -0.02291216  0.034068491  0.096938436 -0.026598045
## radius_mean       -0.21891302  0.233271401 -0.011393786  0.042187950
## texture_mean      -0.10384388  0.060044199  0.066892342 -0.602954308
## perimeter_mean    -0.22753491  0.214589002 -0.012124791  0.042752797
## area_mean         -0.22104577  0.230668816  0.026293150  0.054114724
## smoothness_mean   -0.14241471 -0.186422211 -0.103182400  0.158098177
## compactness_mean  -0.23906730 -0.152454726 -0.074768623  0.031818117
## concavity_mean    -0.25828025 -0.060541625  0.001758736  0.019497124
## points_mean       -0.26073811  0.034167392 -0.027579607  0.065785353
## symmetry_mean     -0.13797774 -0.190684979 -0.040962032  0.067502543
## dimension_mean    -0.06414779 -0.366531055 -0.020817875  0.047957856
## radius_se         -0.20611747  0.105935702  0.266917221  0.099114446
## texture_se        -0.01741339 -0.089547789  0.371439885 -0.356497230
## perimeter_se      -0.21144652  0.089807043  0.264925682  0.090293055
## area_se           -0.20307642  0.152771289  0.215790250  0.108568705
## smoothness_se     -0.01467821 -0.203189876  0.311787845  0.044368664
## compactness_se    -0.17028840 -0.232503362  0.154557465 -0.026425360
## concavity_se      -0.15354367 -0.196846081  0.176560052  0.002248291
## points_se         -0.18340675 -0.129965181  0.223850479  0.075252232
## symmetry_se       -0.04241552 -0.183558627  0.285265066  0.046936126
## dimension_se      -0.10249607 -0.279584139  0.211893354  0.016212450
## radius_worst      -0.22800935  0.219296044 -0.049406340  0.015659705
## texture_worst     -0.10451545  0.045501223 -0.039828934 -0.633119655
## perimeter_worst   -0.23663734  0.199295985 -0.050431945  0.014068572
## area_worst        -0.22493214  0.218985461 -0.013188891  0.025970672
## smoothness_worst  -0.12782441 -0.172562959 -0.255328751  0.014523359
```
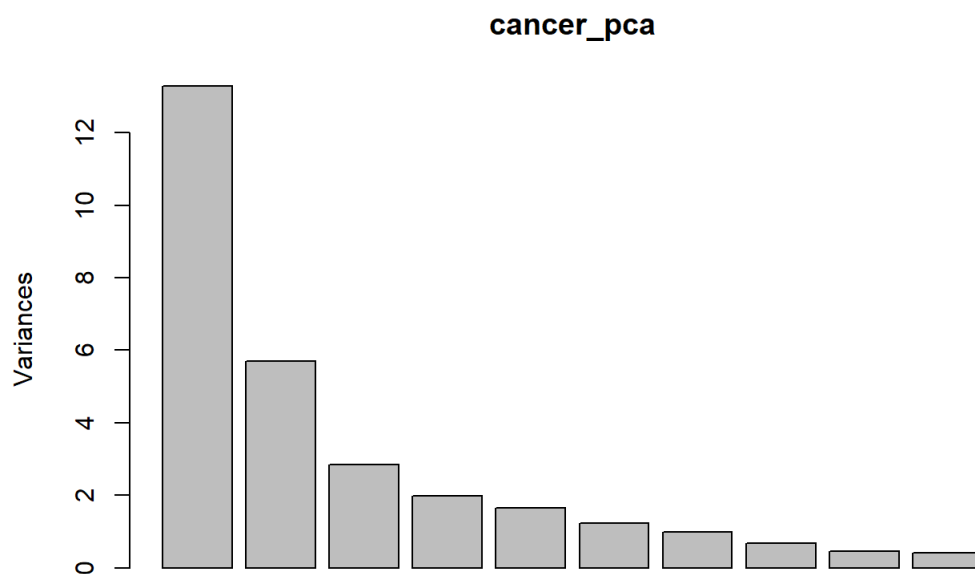
```
## smoothness_worst      0.12702111  0.172502999  0.255520751  0.011525555
## compactness_worst    -0.20988456 -0.144253637 -0.234513609 -0.092562168
## concavity_worst      -0.22860218 -0.098526524 -0.172024941 -0.074807188
## points_worst         -0.25074620  0.007534367 -0.170480673  0.005305980
## symmetry_worst       -0.12267993 -0.142619436 -0.270515902 -0.037129466
## dimension_worst      -0.13156024 -0.275702077 -0.229474476 -0.078971489
##                                PC5          PC6          PC7          PC8
## id                    0.011327587 -0.316733438  0.9071156324 -0.096362415
## radius_mean          -0.038129861  0.029588521 -0.0422987777 -0.116427419
## texture_mean          0.049091450 -0.031394323  0.0149935618  0.001875482
## perimeter_mean       -0.037715592  0.028394008 -0.0435888242 -0.106272097
## area_mean            -0.010562229  0.006113155 -0.0289256668 -0.047414568
## smoothness_mean       0.365750055 -0.262508993 -0.1403403617 -0.123541189
## compactness_mean     -0.011786637 -0.004903894 -0.0453031106  0.043145968
## concavity_mean       -0.086512506 -0.002356338 -0.0325530646 -0.102436021
## points_mean           0.043667412 -0.034509273 -0.0814216298 -0.136923237
## symmetry_mean         0.305378893  0.335082168  0.1182592361 -0.098874531
## dimension_mean        0.044767906 -0.112784169 -0.0410588768  0.306499872
## radius_se             0.154254367 -0.023261199  0.0167882718  0.307415709
## texture_se            0.190001500  0.022856912 -0.1902676469 -0.052632477
## perimeter_se          0.120703357  0.003820151  0.0195081762  0.311265679
## area_se               0.127765023 -0.051958835  0.0565606078  0.334287959
## smoothness_se         0.232745603 -0.330867850 -0.0678348099 -0.260833914
## compactness_se       -0.280298048  0.066788120  0.0222220211  0.021001944
## concavity_se         -0.354164595  0.049699104  0.0336810725 -0.219193299
## points_se            -0.195758558 -0.023197526 -0.0378517870 -0.370217167
## symmetry_se           0.251331178  0.477530515  0.1184032606 -0.084854768
## dimension_se         -0.263395188 -0.048462373 -0.0157602244  0.194418818
## radius_worst          0.004280034  0.004521737 -0.0166458140 -0.007508307
## texture_worst         0.092551860 -0.045174516 -0.0094601240  0.006617640
## perimeter_worst      -0.007599144  0.012921166 -0.0145260986  0.002162488
## area_worst            0.027413595 -0.024033338 -0.0007372602  0.066173186
## smoothness_worst      0.325860028 -0.365048687 -0.0670682168 -0.116496117
## compactness_worst    -0.121503371  0.034042714  0.0507556727  0.136509363
## concavity_worst      -0.188280510  0.017962040  0.0352007117 -0.067085744
## points_worst         -0.043123573 -0.029549100 -0.0207238959 -0.166500918
## symmetry_worst        0.244245936  0.451404312  0.2340143294 -0.041439633
## dimension_worst      -0.093699078 -0.092479698  0.0347167538  0.372034479
##                                PC9         PC10         PC11         PC12
## id                    0.149115642 -0.16926751  0.058188997 -0.006721252
## radius_mean          -0.046270835 -0.22402704 -0.079466081 -0.042213788
## texture_mean         -0.088727168  0.11945674 -0.253258091  0.304032359
## perimeter_mean       -0.036230738 -0.22634517 -0.069865929 -0.017573055
## area_mean            -0.080649856 -0.18600385 -0.062795372 -0.110760120
## smoothness_mean       0.278996404 -0.06133822  0.084661549  0.135321954
## compactness_mean      0.099214048 -0.19518602  0.005172841  0.307036205
## concavity_mean        0.075750464  0.03395563  0.134664686 -0.124553100
## points_mean           0.116569072 -0.14261678  0.006124860  0.071564686
## symmetry_mean         0.315150303  0.13561452 -0.574417320 -0.161058144
## dimension_mean        0.130639482 -0.15848117 -0.066456112  0.037318709
## radius_se             0.026200456  0.26504403  0.025847282  0.027030250
## texture_se            0.372989606 -0.31521084  0.323158815 -0.348396233
## perimeter_se          0.052860114  0.23789288  0.094867442  0.168501485
## area_se              -0.030627892  0.24966405  0.071991560 -0.050731496
## smoothness_se        -0.580789293 -0.01015980 -0.179568831 -0.081753374
## compactness_se       -0.148593714 -0.11518343 -0.038615749  0.206959272
## concavity_se          0.034715098  0.36592141  0.113536362 -0.348342358
## points_se             0.189022962  0.21518752 -0.094066850  0.342855186
## symmetry_se          -0.292785738 -0.22049558  0.328314881  0.185998712
## dimension_se         -0.060203202 -0.22637997 -0.353844543 -0.250428852
## radius_worst         -0.070224590 -0.09981025 -0.073013014 -0.105030701
## texture_worst        -0.008571809  0.10669296 -0.038561250 -0.012490348
## perimeter_worst      -0.058854223 -0.09821693 -0.045750979 -0.051125158
## area_worst           -0.097034650 -0.06179787 -0.068822329 -0.184460981
## smoothness_worst     -0.173257498  0.16912753  0.109278029 -0.142996001
## compactness_worst    -0.111218083 -0.06445290  0.175401648  0.196805544
## concavity_worst      -0.035467377  0.19661986  0.295581609 -0.184959562
## points_worst          0.052322473  0.05121611  0.075496752  0.117518361
## symmetry_worst       -0.188266324  0.10308901  0.019223451 -0.157210098
## dimension_worst      -0.087222442 -0.11291399 -0.007071634 -0.118625115
##                               PC13         PC14         PC15         PC16
## id                   -0.004841084 -0.006500099  0.006885943 -0.002753492
## radius_mean           0.050603927 -0.012496988 -0.059054553  0.050789156
```

```
## texture_mean          0.256273666 -0.201876125  0.020701124  0.108089530
## perimeter_mean        0.038470392 -0.044684430 -0.048019221  0.039590476
## area_mean             0.065047550 -0.067879244 -0.010152279 -0.014636050
## smoothness_mean       0.315872261 -0.046461624 -0.444044654  0.117493291
## compactness_mean     -0.104264618 -0.230005458 -0.007661166 -0.230759682
## concavity_mean        0.065723393 -0.387349680  0.189733740  0.128386008
## points_mean           0.042253113 -0.132637847  0.245219266  0.217299938
## symmetry_mean        -0.288054252 -0.189570545 -0.030903840  0.073950596
## dimension_mean        0.236120382 -0.106390748  0.377436108 -0.518333769
## radius_se            -0.015625578  0.069635807 -0.011959877  0.111103952
## texture_se           -0.308499115  0.165408488  0.012614192 -0.033389049
## perimeter_se         -0.100597125  0.038865462  0.044358477  0.008991734
## area_se              -0.017226446 -0.055687709 -0.083203050  0.045171638
## smoothness_se        -0.293287983 -0.149148603  0.200139961 -0.018414232
## compactness_se       -0.263398426 -0.010320713 -0.491903153 -0.167886977
## concavity_se          0.251864823 -0.157777595 -0.135322845 -0.250292522
## points_se            -0.006430584  0.494527095  0.199547389 -0.062548716
## symmetry_se           0.319874237 -0.010836031  0.047340593  0.113219397
## dimension_se          0.275943072  0.240767973 -0.145958050  0.353782637
## radius_worst          0.039582217  0.138036550 -0.023526025 -0.166213790
## texture_worst         0.080142089  0.080737140 -0.053897961 -0.100862417
## perimeter_worst      -0.009084762  0.097004376 -0.012559001 -0.182407021
## area_worst            0.047986766  0.101235629  0.006646192 -0.315142865
## smoothness_worst      0.056931408  0.206026671 -0.163389545 -0.045226715
## compactness_worst    -0.371991007 -0.013117334 -0.165941776  0.049613607
## concavity_worst      -0.086870368 -0.218055908  0.066854662  0.204743734
## points_worst         -0.068367254  0.254345228  0.276401728  0.169597618
## symmetry_worst        0.043937722  0.256766084 -0.005448734 -0.139913723
## dimension_worst      -0.035134642  0.172524501  0.212520491  0.255448214
##                              PC17         PC18         PC19         PC20
## id                   -0.007779983 -0.019707372  0.005442248  0.020454908
## radius_mean           0.150008977  0.209908003 -0.156773206  0.211821385
## texture_mean          0.159152972 -0.034161758  0.040048687  0.029931705
## perimeter_mean        0.113792993  0.201233658 -0.168413120  0.227079273
## area_mean             0.130173978  0.251460456 -0.269145594 -0.045499625
## smoothness_mean       0.203117911  0.168171613  0.354463321 -0.160358262
## compactness_mean     -0.170379447 -0.016302860 -0.014259132  0.292092522
## concavity_mean       -0.270010606 -0.005071590  0.027973937  0.007197446
## points_mean          -0.381111880  0.028741889  0.087065594 -0.153991624
## symmetry_mean         0.165691481 -0.194702559 -0.169168737 -0.058503329
## dimension_mean        0.039119713  0.046298986 -0.086779501 -0.062879947
## radius_se            -0.055118880 -0.124562479  0.231233991  0.181436577
## texture_se            0.032768777  0.041652813  0.009177450  0.038681291
## perimeter_se         -0.023929011 -0.009084130  0.014508488  0.364045783
## area_se              -0.045538238  0.313148246 -0.296273515 -0.433949999
## smoothness_se         0.058326686  0.145306166  0.228819703 -0.013932678
## compactness_se       -0.190065826 -0.015610691 -0.094108380 -0.250216687
## concavity_se          0.126034946  0.092345618 -0.005794297  0.119490304
## points_se             0.197671940  0.106747906 -0.046944796 -0.015851066
## symmetry_se           0.158541381 -0.279918359 -0.180195394 -0.084242460
## dimension_se         -0.267180143 -0.122002438  0.059970839  0.097082660
## radius_worst          0.083459877 -0.235215809  0.218781792  0.027741137
## texture_worst        -0.185972310  0.065992656 -0.057250572 -0.080880841
## perimeter_worst       0.056649279 -0.228493742  0.189279122  0.105666112
## area_worst            0.090325036 -0.286471546  0.158722686 -0.393681440
## smoothness_worst     -0.142781922 -0.276751162 -0.504565504  0.228506719
## compactness_worst     0.153347954 -0.003683424  0.073627229  0.025544372
## concavity_worst       0.216302398 -0.190307542  0.107894455 -0.035839305
## points_worst         -0.178353485 -0.085180057 -0.067182996 -0.261323873
## symmetry_worst       -0.260033510  0.436706158  0.269313654  0.111738683
## dimension_worst       0.404957673  0.162920272 -0.026674889 -0.022516600
##                              PC21         PC22         PC23         PC24
## id                    0.009870917  0.006195707  0.003190337 -0.010289027
## radius_mean           0.046009507  0.070394387 -0.073021974 -0.098704322
## texture_mean          0.264801220 -0.436269565 -0.095890704  0.001311285
## perimeter_mean        0.015122205  0.070963404 -0.074821704 -0.040500943
## area_mean             0.087345298  0.021672998 -0.097428804  0.009396470
## smoothness_mean      -0.023842011  0.117945821 -0.063741313 -0.020088204
## compactness_mean     -0.476395571 -0.213187888  0.094254664  0.058295270
## concavity_mean        0.037771062 -0.001270114  0.188862925  0.321062737
## points_mean           0.231546040  0.017493297  0.313280824 -0.057974684
## symmetry_mean        -0.030776761  0.085067786  0.018331111 -0.052004767
## dimension_mean        0.172565576  0.085104005 -0.286892578 -0.084701081
```

```
## radius_se          0.090564458 -0.085660592  0.147793165 -0.263799753
## texture_se         0.083589382 -0.212168357 -0.048761201 -0.001150858
## perimeter_se       0.169586632  0.317246026 -0.153859020  0.081384223
## area_se           -0.270679518 -0.207916141 -0.068745790  0.110258620
## smoothness_se     -0.095370809  0.066602974 -0.051852247 -0.057154068
## compactness_se     0.451033960  0.159332265  0.048970757  0.003993806
## concavity_se      -0.070203251 -0.071023842  0.200850815 -0.388573085
## points_se         -0.064848884 -0.035557778  0.074494143  0.354040783
## symmetry_se       -0.112133933  0.092193625  0.084324570 -0.043455477
## dimension_se      -0.214213177 -0.069171668 -0.245408452  0.089594196
## radius_worst       0.006481267 -0.007068180  0.096292694 -0.057768458
## texture_worst     -0.330244412  0.578095532  0.111968438 -0.009473435
## perimeter_worst   -0.010544107  0.094457678 -0.014952244  0.058698441
## area_worst        -0.053510824 -0.149328216  0.096798702  0.193293235
## smoothness_worst   0.140127867 -0.156936236  0.069660581  0.091134610
## compactness_worst -0.220884131 -0.191897773 -0.033373706 -0.145389941
## concavity_worst    0.047166544  0.139729448 -0.456817799  0.290302924
## points_worst      -0.039740929 -0.006870640 -0.305694162 -0.563297713
## symmetry_worst     0.125617213 -0.155827542 -0.096426675  0.122996111
## dimension_worst    0.095366679  0.092769737  0.470358007  0.002775112
##                           PC25        PC26        PC27        PC28
## id                -0.004233388 -0.00132610 -0.002571324 -0.001623875
## radius_mean       -0.183664583  0.01859418  0.128713229  0.131697326
## texture_mean       0.099441545 -0.08442059  0.024821224  0.017622634
## perimeter_mean    -0.117262178 -0.02743488  0.124670225  0.115650274
## area_mean          0.070557041  0.21057100 -0.361014547 -0.467489167
## smoothness_mean    0.068940049 -0.02876100  0.037372832 -0.069482805
## compactness_mean  -0.102198309 -0.39651346 -0.262695425 -0.098624638
## concavity_mean     0.045550527  0.09717977  0.550227716 -0.363040016
## points_mean        0.082349955  0.18630114 -0.389316679  0.453345398
## symmetry_mean      0.018841491  0.02451053  0.015910368  0.015157593
## dimension_mean    -0.134601525  0.20670502  0.096796804  0.101343150
## radius_se         -0.561133900  0.17339784 -0.050411953 -0.213735821
## texture_se         0.023938591 -0.05709165  0.010893175  0.009925699
## perimeter_se       0.516048248 -0.07217201 -0.103485879 -0.041989200
## area_se           -0.018546693 -0.13093723  0.155929011  0.314758068
## smoothness_se      0.016193934 -0.03100551  0.008066566  0.009312365
## compactness_se    -0.122457873 -0.17364984  0.049404535 -0.046651501
## concavity_se       0.186159613 -0.01600952 -0.091931364  0.083824645
## points_se         -0.107166573  0.12999049  0.018674110  0.011675700
## symmetry_se        0.002613811  0.01936313  0.016991197  0.019891112
## dimension_se       0.076177800  0.08458109 -0.035156906  0.012141785
## radius_worst      -0.158114412 -0.07144112  0.195812320  0.178796461
## texture_worst     -0.118609952  0.11802219 -0.036347107 -0.021473842
## perimeter_worst    0.236463109 -0.11790535  0.243266456  0.241658719
## area_worst         0.146339946  0.03921251 -0.229813188 -0.237323945
## smoothness_worst  -0.011224935  0.04787154 -0.012860335  0.040730207
## compactness_worst  0.185437121  0.62471727  0.100772153  0.071087434
## concavity_worst   -0.286701322 -0.11586768 -0.267236886  0.142148446
## points_worst       0.105286798 -0.26352782  0.133749940 -0.230794105
## symmetry_worst    -0.013193455 -0.04505357 -0.027824916 -0.022695808
## dimension_worst    0.037882167 -0.28015574 -0.004500884 -0.060081371
##                           PC29          PC30          PC31
## id                -1.891724e-05 -0.0006852263 -7.122581e-05
## radius_mean        2.111968e-01 -0.2114371011 -7.024325e-01
## texture_mean      -6.362507e-05  0.0106165839 -2.644366e-04
## perimeter_mean     8.434280e-02 -0.3838889617  6.898676e-01
## area_mean         -2.725167e-01  0.4227208085  3.297173e-02
## smoothness_mean    1.480038e-03  0.0034638648  4.850746e-03
## compactness_mean  -5.466656e-03  0.0409079834 -4.468229e-02
## concavity_mean     4.554138e-02  0.0101122808 -2.512860e-02
## points_mean       -8.885707e-03  0.0041142627  1.067984e-03
## symmetry_mean      1.432581e-03  0.0075571475  1.279594e-03
## dimension_mean    -6.312291e-03 -0.0073311823  4.751885e-03
## radius_se         -1.922290e-01 -0.1186768422  8.679321e-03
## texture_se        -5.624974e-03  0.0086942153  1.063104e-03
## perimeter_se       2.631905e-01  0.0060612569 -1.373310e-02
## area_se           -4.205668e-02  0.0863645419 -1.054698e-03
## smoothness_se      9.795835e-03 -0.0016737982  1.618711e-03
## compactness_se    -1.539757e-02 -0.0032295613 -1.923037e-03
## concavity_se       5.819985e-03 -0.0161202167  8.921294e-03
## points_se         -2.900497e-02  0.0241014722  2.178643e-03
## symmetry se       -7.637856e-03  0.0051771158 -3.338380e-04
```

```
## symmetry_se          7.037030e-05  0.003171130  3.330300e-01
## dimension_se         1.975791e-02  0.0083971145 -1.792802e-03
## radius_worst         4.126296e-01  0.6356796555  1.356846e-01
## texture_worst       -3.896988e-04 -0.0172219636 -1.020237e-03
## perimeter_worst     -7.286790e-01 -0.0228830657 -7.974244e-02
## area_worst           2.389679e-01 -0.4448733182 -3.976788e-02
## smoothness_worst    -1.535941e-03 -0.0074142082 -4.586820e-03
## compactness_worst    4.869512e-02  0.0001075081  1.285262e-02
## concavity_worst     -1.764174e-02  0.0126547542 -4.031809e-04
## points_worst         2.247340e-02 -0.0353341030  2.276561e-03
## symmetry_worst       4.922100e-03 -0.0133523613 -3.910451e-04
## dimension_worst     -2.356283e-02 -0.0115053741 -1.897779e-03
```

```
plot(cancer_pca)
```


cancer_pca

```
summary(cancer_pca)
```

```
## Importance of components:
##                            PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation      3.6453  2.3868 1.68386 1.40761 1.28406 1.11116
## Proportion of Variance  0.4286  0.1838 0.09146 0.06391 0.05319 0.03983
## Cumulative Proportion   0.4286  0.6124 0.70388 0.76779 0.82098 0.86081
##                            PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation     0.98908 0.81961 0.67882  0.6349 0.59089 0.54212
## Proportion of Variance 0.03156 0.02167 0.01486  0.0130 0.01126 0.00948
## Cumulative Proportion  0.89237 0.91404 0.92890  0.9419 0.95317 0.96265
##                           PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation     0.51103 0.49125 0.39620 0.30680 0.28251  0.2430
## Proportion of Variance 0.00842 0.00778 0.00506 0.00304 0.00257  0.0019
## Cumulative Proportion  0.97107 0.97886 0.98392 0.98696 0.98953  0.9914
##                           PC19    PC20   PC21    PC22    PC23    PC24
## Standard deviation      0.2293 0.22163 0.1763 0.17304 0.16562 0.15572
## Proportion of Variance  0.0017 0.00158 0.0010 0.00097 0.00088 0.00078
## Cumulative Proportion   0.9931 0.99472 0.9957 0.99669 0.99757 0.99835
##                           PC25   PC26    PC27    PC28    PC29    PC30
## Standard deviation     0.13431 0.1244 0.09040 0.08305 0.03987 0.02736
## Proportion of Variance 0.00058 0.0005 0.00026 0.00022 0.00005 0.00002
## Cumulative Proportion  0.99893 0.9994 0.99970 0.99992 0.99997 1.00000
##                           PC31
## Standard deviation     0.01153
## Proportion of Variance 0.00000
## Cumulative Proportion  1.00000
```

```
#View(cancer_pca)
head(cancer_pca$x)
```

```
##             PC1         PC2        PC3        PC4         PC5        PC6
## [1,] 2.501946 -0.09694805 -0.4489597  2.3341176  0.69771548 -0.2430058
## [2,] 1.467439 -1.68630059  1.1542039  0.3362109  0.45962538  1.2308248
## [3,] 2.929028 -0.38319924 -0.8955891 -0.1164828  0.98441377 -0.2587872
## [4,] 1.995342 -1.33046592  1.1172876  2.0502761  0.25303846 -1.5539634
## [5,] 2.500252  2.01035097 -0.7584035  1.9862169 -1.13537096  0.5940361
## [6,] 2.018308 -0.78242095  0.1125197 -0.6532280  0.01841577  0.6914453
##            PC7         PC8        PC9       PC10       PC11        PC12
## [1,]  0.5092015 -1.11423307  0.2840243  0.32463197 -0.3245353  0.04981306
## [2,]  0.2937434  0.10000461 -0.0668399  0.42612180  0.4564029  1.19357566
## [3,] -0.3303385  0.03599041  0.8734350  0.02222192  0.4208602 -0.06687286
## [4,] -0.9692185 -1.31852134  0.6254396  0.05666470 -0.0691646  0.97082409
## [5,]  0.1198201 -0.48279704 -0.2727816 -0.29439485 -0.3577533  0.03266208
## [6,]  0.1454026  0.06214539  0.2342454  0.73681239 -0.3671239 -0.77029743
##             PC13       PC14        PC15        PC16        PC17
## [1,] -0.19760220  0.1134403 -0.059302558  0.16637723 -0.04286656
## [2,]  0.01807424 -0.2824292 -0.204858888 -0.07067959  0.03088787
## [3,]  0.37435458  0.2585457 -0.330274216 -0.13000189 -0.24616091
## [4,] -0.90968379  0.2179117 -0.665825669  0.10213387 -0.10289446
## [5,] -0.35547138 -0.1480140 -0.005540503 -0.06495881  0.22273309
## [6,] -0.49542291 -0.2992431  0.049952835 -0.20161083  0.14920422
##              PC18        PC19        PC20        PC21        PC22
## [1,] -0.104542766 -0.03484189 -0.09691187 -0.02846306 -0.00673628
## [2,] -0.405534243 -0.02886103 -0.05262226 -0.05987170  0.05868642
## [3,]  0.327711259  0.15937793 -0.13804895 -0.13489743  0.10080029
## [4,]  0.197085181  0.36251771 -0.40018239 -0.10302093 -0.28821708
## [5,] -0.129129156 -0.35877054  0.08515543 -0.08500541 -0.06332008
## [6,] -0.002229379 -0.08178568  0.18970936 -0.06872875  0.09669594
##             PC23        PC24         PC25        PC26         PC27
## [1,] -0.038971937  0.062212075  0.088438866  0.04872948 -0.007000724
## [2,]  0.070978613 -0.030822339 -0.016741580  0.04173030 -0.059332996
## [3,]  0.053909008  0.085484364  0.038277664 -0.04151896 -0.035546410
## [4,]  0.182045907  0.222848059 -0.115720065 -0.03676948 -0.148171674
## [5,]  0.043591030  0.008165322  0.002738052  0.05983731  0.046167735
## [6,] -0.001458054 -0.031338348  0.042784223 -0.08646068 -0.030944690
##             PC28        PC29         PC30         PC31
## [1,]  0.05356131  0.015184882  0.015985406  0.001396101
## [2,] -0.18696553  0.027011311 -0.000803330  0.008096490
## [3,] -0.07653067 -0.014640388  0.010307894  0.009074601
## [4,] -0.01711665 -0.047828494  0.023862995  0.000265075
## [5,]  0.03835364  0.032450800 -0.002312178 -0.002563269
## [6,]  0.00955434 -0.004403431  0.003869919 -0.002931194
```

```
# sample scores stored in cancer_pca$x
# singular values (square roots of eigenvalues) stored in cancer_pca$sdev
# loadings (eigenvectors) are stored in cancer_pca$rotation
# variable means stored in cancer_pca$center
# variable standard deviations stored in sparrows_pca$scale
# A table containing eigenvalues and %'s accounted, follows
# Eigenvalues are sdev^2
(eigen_cancer <- cancer_pca$sdev^2) ## brackets for print
```

```
##  [1] 1.328806e+01 5.696805e+00 2.835395e+00 1.981357e+00 1.648815e+00
##  [6] 1.234673e+00 9.782732e-01 6.717530e-01 4.607924e-01 4.031331e-01
## [11] 3.491550e-01 2.938904e-01 2.611469e-01 2.413302e-01 1.569736e-01
## [16] 9.412853e-02 7.980995e-02 5.904627e-02 5.259119e-02 4.912193e-02
## [21] 3.107078e-02 2.994121e-02 2.743052e-02 2.424902e-02 1.803936e-02
## [26] 1.547973e-02 8.171699e-03 6.898103e-03 1.589338e-03 7.483761e-04
## [31] 1.330402e-04
```

```
names(eigen_cancer) <- paste("PC",1:31,sep="")
eigen_cancer
```

```
##          PC1          PC2          PC3          PC4          PC5
## 1.328806e+01 5.696805e+00 2.835395e+00 1.981357e+00 1.648815e+00
##          PC6          PC7          PC8          PC9         PC10
## 1.234673e+00 9.782732e-01 6.717530e-01 4.607924e-01 4.031331e-01
##         PC11         PC12         PC13         PC14         PC15
## 3.491550e-01 2.938904e-01 2.611469e-01 2.413302e-01 1.569736e-01
##         PC16         PC17         PC18         PC19         PC20
## 9.412853e-02 7.980995e-02 5.904627e-02 5.259119e-02 4.912193e-02
##         PC21         PC22         PC23         PC24         PC25
## 3.107078e-02 2.994121e-02 2.743052e-02 2.424902e-02 1.803936e-02
##         PC26         PC27         PC28         PC29         PC30
## 1.547973e-02 8.171699e-03 6.898103e-03 1.589338e-03 7.483761e-04
##         PC31
## 1.330402e-04
```

```
sumlambdas <- sum(eigen_cancer)
sumlambdas
```

```
## [1] 31
```

```
propvar <- eigen_cancer/sumlambdas
propvar
```

```
##          PC1          PC2          PC3          PC4          PC5
## 4.286470e-01 1.837679e-01 9.146436e-02 6.391475e-02 5.318759e-02
##          PC6          PC7          PC8          PC9         PC10
## 3.982815e-02 3.155720e-02 2.166945e-02 1.486427e-02 1.300429e-02
##         PC11         PC12         PC13         PC14         PC15
## 1.126306e-02 9.480337e-03 8.424094e-03 7.784846e-03 5.063666e-03
##         PC16         PC17         PC18         PC19         PC20
## 3.036404e-03 2.574514e-03 1.904718e-03 1.696490e-03 1.584578e-03
##         PC21         PC22         PC23         PC24         PC25
## 1.002283e-03 9.658453e-04 8.848556e-04 7.822265e-04 5.819149e-04
##         PC26         PC27         PC28         PC29         PC30
## 4.993461e-04 2.636032e-04 2.225194e-04 5.126895e-05 2.414116e-05
##         PC31
## 4.291620e-06
```

```
summary(eigen_cancer)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.      Max.
##  0.000133 0.025840 0.094129 1.000000 0.566273 13.288057
```

```
summary(cancer_pca)
```

```
## Importance of components:
##                             PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation       3.6453  2.3868 1.68386 1.40761 1.28406 1.11116
## Proportion of Variance   0.4286  0.1838 0.09146 0.06391 0.05319 0.03983
## Cumulative Proportion    0.4286  0.6124 0.70388 0.76779 0.82098 0.86081
##                             PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation       0.98908 0.81961 0.67882  0.6349 0.59089 0.54212
## Proportion of Variance   0.03156 0.02167 0.01486  0.0130 0.01126 0.00948
## Cumulative Proportion    0.89237 0.91404 0.92890  0.9419 0.95317 0.96265
##                            PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation       0.51103 0.49125 0.39620 0.30680 0.28251  0.2430
## Proportion of Variance   0.00842 0.00778 0.00506 0.00304 0.00257  0.0019
## Cumulative Proportion    0.97107 0.97886 0.98392 0.98696 0.98953  0.9914
##                            PC19    PC20    PC21    PC22    PC23    PC24
## Standard deviation        0.2293 0.22163  0.1763 0.17304 0.16562 0.15572
## Proportion of Variance    0.0017 0.00158  0.0010 0.00097 0.00088 0.00078
## Cumulative Proportion     0.9931 0.99472  0.9957 0.99669 0.99757 0.99835
##                            PC25    PC26    PC27    PC28    PC29    PC30
## Standard deviation       0.13431  0.1244 0.09040 0.08305 0.03987 0.02736
## Proportion of Variance   0.00058  0.0005 0.00026 0.00022 0.00005 0.00002
## Cumulative Proportion    0.99893  0.9994 0.99970 0.99992 0.99997 1.00000
##                            PC31
## Standard deviation       0.01153
## Proportion of Variance   0.00000
## Cumulative Proportion    1.00000
```

```
cumvar_cancer <- cumsum(propvar)
cumvar_cancer
```

```
##       PC1       PC2       PC3       PC4       PC5       PC6       PC7
## 0.4286470 0.6124149 0.7038793 0.7677940 0.8209816 0.8608098 0.8923670
##       PC8       PC9      PC10      PC11      PC12      PC13      PC14
## 0.9140364 0.9289007 0.9419050 0.9531681 0.9626484 0.9710725 0.9788573
##      PC15      PC16      PC17      PC18      PC19      PC20      PC21
## 0.9839210 0.9869574 0.9895319 0.9914366 0.9931331 0.9947177 0.9957200
##      PC22      PC23      PC24      PC25      PC26      PC27      PC28
## 0.9966858 0.9975707 0.9983529 0.9989348 0.9994342 0.9996978 0.9999203
##      PC29      PC30      PC31
## 0.9999716 0.9999957 1.0000000
```

```
matlambdas <- rbind(eigen_cancer,propvar,cumvar_cancer)
rownames(matlambdas) <- c("Eigenvalues","Prop. variance","Cum. prop. variance")
round(matlambdas,4)
```

```
##                         PC1     PC2     PC3     PC4     PC5     PC6     PC7
## Eigenvalues          13.2881  5.6968  2.8354  1.9814  1.6488  1.2347  0.9783
## Prop. variance        0.4286  0.1838  0.0915  0.0639  0.0532  0.0398  0.0316
## Cum. prop. variance   0.4286  0.6124  0.7039  0.7678  0.8210  0.8608  0.8924
##                         PC8     PC9    PC10    PC11    PC12    PC13    PC14
## Eigenvalues           0.6718  0.4608  0.4031  0.3492  0.2939  0.2611  0.2413
## Prop. variance        0.0217  0.0149  0.0130  0.0113  0.0095  0.0084  0.0078
## Cum. prop. variance   0.9140  0.9289  0.9419  0.9532  0.9626  0.9711  0.9789
##                        PC15    PC16    PC17    PC18    PC19    PC20    PC21
## Eigenvalues           0.1570  0.0941  0.0798  0.0590  0.0526  0.0491  0.0311
## Prop. variance        0.0051  0.0030  0.0026  0.0019  0.0017  0.0016  0.0010
## Cum. prop. variance   0.9839  0.9870  0.9895  0.9914  0.9931  0.9947  0.9957
##                        PC22    PC23    PC24    PC25    PC26    PC27    PC28
## Eigenvalues           0.0299  0.0274  0.0242  0.0180  0.0155  0.0082  0.0069
## Prop. variance        0.0010  0.0009  0.0008  0.0006  0.0005  0.0003  0.0002
## Cum. prop. variance   0.9967  0.9976  0.9984  0.9989  0.9994  0.9997  0.9999
##                       PC29   PC30   PC31
## Eigenvalues          0.0016  7e-04  1e-04
## Prop. variance       0.0001  0e+00  0e+00
## Cum. prop. variance  1.0000  1e+00  1e+00
```

```
summary(cancer_pca)
```

```
## Importance of components:
##                            PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation      3.6453  2.3868  1.68386 1.40761 1.28406 1.11116
## Proportion of Variance  0.4286  0.1838  0.09146 0.06391 0.05319 0.03983
## Cumulative Proportion   0.4286  0.6124  0.70388 0.76779 0.82098 0.86081
##                            PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation      0.98908 0.81961 0.67882 0.6349  0.59089 0.54212
## Proportion of Variance  0.03156 0.02167 0.01486 0.0130  0.01126 0.00948
## Cumulative Proportion   0.89237 0.91404 0.92890 0.9419  0.95317 0.96265
##                           PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation      0.51103 0.49125 0.39620 0.30680 0.28251 0.2430
## Proportion of Variance  0.00842 0.00778 0.00506 0.00304 0.00257 0.0019
## Cumulative Proportion   0.97107 0.97886 0.98392 0.98696 0.98953 0.9914
##                           PC19    PC20    PC21    PC22    PC23    PC24
## Standard deviation      0.2293  0.22163 0.1763  0.17304 0.16562 0.15572
## Proportion of Variance  0.0017  0.00158 0.0010  0.00097 0.00088 0.00078
## Cumulative Proportion   0.9931  0.99472 0.9957  0.99669 0.99757 0.99835
##                           PC25    PC26    PC27    PC28    PC29    PC30
## Standard deviation      0.13431 0.1244  0.09040 0.08305 0.03987 0.02736
## Proportion of Variance  0.00058 0.0005  0.00026 0.00022 0.00005 0.00002
## Cumulative Proportion   0.99893 0.9994  0.99970 0.99992 0.99997 1.00000
##                           PC31
## Standard deviation      0.01153
## Proportion of Variance  0.00000
## Cumulative Proportion   1.00000
```

```
cancer_pca$rotation
```

```
##                            PC1          PC2          PC3          PC4
## id                 -0.02291216  0.034068491  0.096938436 -0.026598045
## radius_mean        -0.21891302  0.233271401 -0.011393786  0.042187950
## texture_mean       -0.10384388  0.060044199  0.066892342 -0.602954308
## perimeter_mean     -0.22753491  0.214589002 -0.012124791  0.042752797
## area_mean          -0.22104577  0.230668816  0.026293150  0.054114724
## smoothness_mean    -0.14241471 -0.186422211 -0.103182400  0.158098177
## compactness_mean   -0.23906730 -0.152454726 -0.074768623  0.031818117
## concavity_mean     -0.25828025 -0.060541625  0.001758736  0.019497124
## points_mean        -0.26073811  0.034167392 -0.027579607  0.065785353
## symmetry_mean      -0.13797774 -0.190684979 -0.040962032  0.067502543
## dimension_mean     -0.06414779 -0.366531055 -0.020817875  0.047957856
## radius_se          -0.20611747  0.105935702  0.266917221  0.099114446
## texture_se         -0.01741339 -0.089547789  0.371439885 -0.356497230
## perimeter_se       -0.21144652  0.089807043  0.264925682  0.090293055
## area_se            -0.20307642  0.152771289  0.215790250  0.108568705
## smoothness_se      -0.01467821 -0.203189876  0.311787845  0.044368664
## compactness_se     -0.17028840 -0.232503362  0.154557465 -0.026425360
## concavity_se       -0.15354367 -0.196846081  0.176560052  0.002248291
## points_se          -0.18340675 -0.129965181  0.223850479  0.075252232
## symmetry_se        -0.04241552 -0.183558627  0.285265066  0.046936126
## dimension_se       -0.10249607 -0.279584139  0.211893354  0.016212450
## radius_worst       -0.22800935  0.219296044 -0.049406340  0.015659705
## texture_worst      -0.10451545  0.045501223 -0.039828934 -0.633119655
## perimeter_worst    -0.23663734  0.199295985 -0.050431945  0.014068572
## area_worst         -0.22493214  0.218985461 -0.013188891  0.025970672
## smoothness_worst   -0.12782441 -0.172562959 -0.255328751  0.014523359
## compactness_worst  -0.20988456 -0.144253637 -0.234513609 -0.092562168
## concavity_worst    -0.22860218 -0.098526524 -0.172024941 -0.074807188
## points_worst       -0.25074620  0.007534367 -0.170480673  0.005305980
## symmetry_worst     -0.12267993 -0.142619436 -0.270515902 -0.037129466
## dimension_worst    -0.13156024 -0.275702077 -0.229474476 -0.078971489
##                            PC5          PC6          PC7          PC8
## id                  0.011327587 -0.316733438  0.9071156324 -0.096362415
## radius_mean        -0.038129861  0.029588521 -0.0422987777 -0.116427419
## texture_mean        0.049091450 -0.031394323  0.0149935618  0.001875482
## perimeter_mean     -0.037715592  0.028394008 -0.0435888242 -0.106272097
## area_mean          -0.010562229  0.006113155 -0.0289256668 -0.047414568
## smoothness_mean     0.365750055 -0.262508993 -0.1403403617 -0.123541189
## compactness_mean   -0.011786637 -0.004903894 -0.0453031106  0.043145968
## concavity_mean     -0.086512506 -0.002356338 -0.0325530646 -0.102436021
## points_mean         0.043667412 -0.034509273 -0.0814216298 -0.136923237
## symmetry_mean       0.305378893  0.335082168  0.1182592361 -0.098874531
```

```
##                   --
## dimension_mean      0.044767906 -0.112784169 -0.0410588768  0.306499872
## radius_se           0.154254367 -0.023261199  0.0167882718  0.307415709
## texture_se          0.190001500  0.022856912 -0.1902676469 -0.052632477
## perimeter_se        0.120703357  0.003820151  0.0195081762  0.311265679
## area_se             0.127765023 -0.051958835  0.0565606078  0.334287959
## smoothness_se       0.232745603 -0.330867850 -0.0678348099 -0.260833914
## compactness_se     -0.280298048  0.066788120  0.0222220211  0.021001944
## concavity_se       -0.354164595  0.049699104  0.0336810725 -0.219193299
## points_se          -0.195758558 -0.023197526 -0.0378517870 -0.370217167
## symmetry_se         0.251331178  0.477530515  0.1184032606 -0.084854768
## dimension_se       -0.263395188 -0.048462373 -0.0157602244  0.194418818
## radius_worst        0.004280034  0.004521737 -0.0166458140 -0.007508307
## texture_worst       0.092551860 -0.045174516 -0.0094601240  0.006617640
## perimeter_worst    -0.007599144  0.012921166 -0.0145260986  0.002162488
## area_worst          0.027413595 -0.024033338 -0.0007372602  0.066173186
## smoothness_worst    0.325860028 -0.365048687 -0.0670682168 -0.116496117
## compactness_worst  -0.121503371  0.034042714  0.0507556727  0.136509363
## concavity_worst    -0.188280510  0.017962040  0.0352007117 -0.067085744
## points_worst       -0.043123573 -0.029549100 -0.0207238959 -0.166500918
## symmetry_worst      0.244245936  0.451404312  0.2340143294 -0.041439633
## dimension_worst    -0.093699078 -0.092479698  0.0347167538  0.372034479
##                             PC9        PC10         PC11         PC12
## id                   0.149115642 -0.16926751  0.058188997 -0.006721252
## radius_mean         -0.046270835 -0.22402704 -0.079466081 -0.042213788
## texture_mean        -0.088727168  0.11945674 -0.253258091  0.304032359
## perimeter_mean      -0.036230738 -0.22634517 -0.069865929 -0.017573055
## area_mean           -0.080649856 -0.18600385 -0.062795372 -0.110760120
## smoothness_mean      0.278996404 -0.06133822  0.084661549  0.135321954
## compactness_mean     0.099214048 -0.19518602  0.005172841  0.307036205
## concavity_mean       0.075750464  0.03395563  0.134664686 -0.124553100
## points_mean          0.116569072 -0.14261678  0.006124860  0.071564686
## symmetry_mean        0.315150303  0.13561452 -0.574417320 -0.161058144
## dimension_mean       0.130639482 -0.15848117 -0.066456112  0.037318709
## radius_se            0.026200456  0.26504403  0.025847282  0.027030250
## texture_se           0.372989606 -0.31521084  0.323158815 -0.348396233
## perimeter_se         0.052860114  0.23789288  0.094867442  0.168501485
## area_se             -0.030627892  0.24966405  0.071991560 -0.050731496
## smoothness_se       -0.580789293 -0.01015980 -0.179568831 -0.081753374
## compactness_se      -0.148593714 -0.11518343 -0.038615749  0.206959272
## concavity_se         0.034715098  0.36592141  0.113536362 -0.348342358
## points_se            0.189022962  0.21518752 -0.094066850  0.342855186
## symmetry_se         -0.292785738 -0.22049558  0.328314881  0.185998712
## dimension_se        -0.060203202 -0.22637997 -0.353844543 -0.250428852
## radius_worst        -0.070224590 -0.09981025 -0.073013014 -0.105030701
## texture_worst       -0.008571809  0.10669296 -0.038561250 -0.012490348
## perimeter_worst     -0.058854223 -0.09821693 -0.045750979 -0.051125158
## area_worst          -0.097034650 -0.06179787 -0.068822329 -0.184460981
## smoothness_worst    -0.173257498  0.16912753  0.109278029 -0.142996001
## compactness_worst   -0.111218083 -0.06445290  0.175401648  0.196805544
## concavity_worst     -0.035467377  0.19661986  0.295581609 -0.184959562
## points_worst         0.052322473  0.05121611  0.075496752  0.117518361
## symmetry_worst      -0.188266324  0.10308901  0.019223451 -0.157210098
## dimension_worst     -0.087222442 -0.11291399 -0.007071634 -0.118625115
##                            PC13         PC14         PC15         PC16
## id                  -0.004841084 -0.006500099  0.006885943 -0.002753492
## radius_mean          0.050603927 -0.012496988 -0.059054553  0.050789156
## texture_mean         0.256273666 -0.201876125  0.020701124  0.108089530
## perimeter_mean       0.038470392 -0.044684430 -0.048019221  0.039590476
## area_mean            0.065047550 -0.067879244 -0.010152279 -0.014636050
## smoothness_mean      0.315872261 -0.046461624 -0.444044654  0.117493291
## compactness_mean    -0.104264618 -0.230005458 -0.007661166 -0.230759682
## concavity_mean       0.065723393 -0.387349680  0.189733740  0.128386008
## points_mean          0.042253113 -0.132637847  0.245219266  0.217299938
## symmetry_mean       -0.288054252 -0.189570545 -0.030903840  0.073950596
## dimension_mean       0.236120382 -0.106390748  0.377436108 -0.518333769
## radius_se           -0.015625578  0.069635807 -0.011959877  0.111103952
## texture_se          -0.308499115  0.165408488  0.012614192 -0.033389049
## perimeter_se        -0.100597125  0.038865462  0.044358477  0.008991734
## area_se             -0.017226446 -0.055687709 -0.083203050  0.045171638
## smoothness_se       -0.293287983 -0.149148603  0.200139961 -0.018414232
## compactness_se      -0.263398426 -0.010320713 -0.491903153 -0.167886977
## concavity_se         0.251864823 -0.157777595 -0.135322845 -0.250292522
## points_se           -0.006430584  0.494537095  0.199547389 -0.062548716
```

```
## points_se        -0.000430384  0.494527095  0.199547589 -0.002548710
## symmetry_se        0.319874237 -0.010836031  0.047340593  0.113219397
## dimension_se       0.275943072  0.240767973 -0.145958050  0.353782637
## radius_worst       0.039582217  0.138036550 -0.023526025 -0.166213790
## texture_worst      0.080142089  0.080737140 -0.053897961 -0.100862417
## perimeter_worst   -0.009084762  0.097004376 -0.012559001 -0.182407021
## area_worst         0.047986766  0.101235629  0.006646192 -0.315142865
## smoothness_worst   0.056931408  0.206026671 -0.163389545 -0.045226715
## compactness_worst -0.371991007 -0.013117334 -0.165941776  0.049613607
## concavity_worst   -0.086870368 -0.218055908  0.066854662  0.204743734
## points_worst      -0.068367254  0.254345228  0.276401728  0.169597618
## symmetry_worst     0.043937722  0.256766084 -0.005448734 -0.139913723
## dimension_worst   -0.035134642  0.172524501  0.212520491  0.255448214
##                             PC17         PC18         PC19         PC20
## id                -0.007779983 -0.019707372  0.005442248  0.020454908
## radius_mean        0.150008977  0.209908003 -0.156773206  0.211821385
## texture_mean       0.159152972 -0.034161758  0.040048687  0.029931705
## perimeter_mean     0.113792993  0.201233658 -0.168413120  0.227079273
## area_mean          0.130173978  0.251460456 -0.269145594 -0.045499625
## smoothness_mean    0.203117911  0.168171613  0.354463321 -0.160358262
## compactness_mean  -0.170379447 -0.016302860 -0.014259132  0.292092522
## concavity_mean    -0.270010606 -0.005071590  0.027973937  0.007197446
## points_mean       -0.381111880  0.028741889  0.087065594 -0.153991624
## symmetry_mean      0.165691481 -0.194702559 -0.169168737 -0.058503329
## dimension_mean     0.039119713  0.046298986 -0.086779501 -0.062879947
## radius_se         -0.055118880 -0.124562479  0.231233991  0.181436577
## texture_se         0.032768777  0.041652813  0.009177450  0.038681291
## perimeter_se      -0.023929011 -0.009084130  0.014508488  0.364045783
## area_se           -0.045538238  0.313148246 -0.296273515 -0.433949999
## smoothness_se      0.058326686  0.145306166  0.228819703 -0.013932678
## compactness_se    -0.190065826 -0.015610691 -0.094108380 -0.250216687
## concavity_se       0.126034946  0.092345618 -0.005794297  0.119490304
## points_se          0.197671940  0.106747906 -0.046944796 -0.015851066
## symmetry_se        0.158541381 -0.279918359 -0.180195394 -0.084242460
## dimension_se      -0.267180143 -0.122002438  0.059970839  0.097082660
## radius_worst       0.083459877 -0.235215809  0.218781792  0.027741137
## texture_worst     -0.185972310  0.065992656 -0.057250572 -0.080880841
## perimeter_worst    0.056649279 -0.228493742  0.189279122  0.105666112
## area_worst         0.090325036 -0.286471546  0.158722686 -0.393681440
## smoothness_worst  -0.142781922 -0.276751162 -0.504565504  0.228506719
## compactness_worst  0.153347954 -0.003683424  0.073627229  0.025544372
## concavity_worst    0.216302398 -0.190307542  0.107894455 -0.035839305
## points_worst      -0.178353485 -0.085180057 -0.067182996 -0.261323873
## symmetry_worst    -0.260033510  0.436706158  0.269313654  0.111738683
## dimension_worst    0.404957673  0.162920272 -0.026674889 -0.022516600
##                             PC21         PC22         PC23         PC24
## id                 0.009870917  0.006195707  0.003190337 -0.010289027
## radius_mean        0.046009507  0.070394387 -0.073021974 -0.098704322
## texture_mean       0.264801220 -0.436269565 -0.095890704  0.001311285
## perimeter_mean     0.015122205  0.070963404 -0.074821704 -0.040500943
## area_mean          0.087345298  0.021672998 -0.097428804  0.009396470
## smoothness_mean   -0.023842011  0.117945821 -0.063741313 -0.020088204
## compactness_mean  -0.476395571 -0.213187888  0.094254664  0.058295270
## concavity_mean     0.037771062 -0.001270114  0.188862925  0.321062737
## points_mean        0.231546040  0.017493297  0.313280824 -0.057974684
## symmetry_mean     -0.030776761  0.085067786  0.018331111 -0.052004767
## dimension_mean     0.172565576  0.085104005 -0.286892578 -0.084701081
## radius_se          0.090564458 -0.085660592  0.147793165 -0.263799753
## texture_se         0.083589382 -0.212168357 -0.048761201 -0.001150858
## perimeter_se       0.169586632  0.317246026 -0.153859020  0.081384223
## area_se           -0.270679518 -0.207916141 -0.068745790  0.110258620
## smoothness_se     -0.095370809  0.066602974 -0.051852247 -0.057154068
## compactness_se     0.451033960  0.159332265  0.048970757  0.003993806
## concavity_se      -0.070203251 -0.071023842  0.200850815 -0.388573085
## points_se         -0.064848884 -0.035557778  0.074494143  0.354040783
## symmetry_se       -0.112133933  0.092193625  0.084324570 -0.043455477
## dimension_se      -0.214213177 -0.069171668 -0.245408452  0.089594196
## radius_worst       0.006481267 -0.007068180  0.096292694 -0.057768458
## texture_worst     -0.330244412  0.578095532  0.111968438 -0.009473435
## perimeter_worst   -0.010544107  0.094457678 -0.014952244  0.058698441
## area_worst        -0.053510824 -0.149328216  0.096798702  0.193293235
## smoothness_worst   0.140127867 -0.156936236  0.069660581  0.091134610
## compactness_worst -0.220884131 -0.191897773 -0.033373706 -0.145389941
```

```
## concavity_worst     0.047166544  0.139729448 -0.456817799  0.290302924
## points_worst       -0.039740929 -0.006870640 -0.305694162 -0.563297713
## symmetry_worst      0.125617213 -0.155827542 -0.096426675  0.122996111
## dimension_worst     0.095366679  0.092769737  0.470358007  0.002775112
##                            PC25         PC26         PC27         PC28
## id                 -0.004233388 -0.00132610 -0.002571324 -0.001623875
## radius_mean        -0.183664583  0.01859418  0.128713229  0.131697326
## texture_mean        0.099441545 -0.08442059  0.024821224  0.017622634
## perimeter_mean     -0.117262178 -0.02743488  0.124670225  0.115650274
## area_mean           0.070557041  0.21057100 -0.361014547 -0.467489167
## smoothness_mean     0.068940049 -0.02876100  0.037372832 -0.069482805
## compactness_mean   -0.102198309 -0.39651346 -0.262695425 -0.098624638
## concavity_mean      0.045550527  0.09717977  0.550227716 -0.363040016
## points_mean         0.082349955  0.18630114 -0.389316679  0.453345398
## symmetry_mean       0.018841491  0.02451053  0.015910368  0.015157593
## dimension_mean     -0.134601525  0.20670502  0.096796804  0.101343150
## radius_se          -0.561133900  0.17339784 -0.050411953 -0.213735821
## texture_se          0.023938591 -0.05709165  0.010893175  0.009925699
## perimeter_se        0.516048248 -0.07217201 -0.103485879 -0.041989200
## area_se            -0.018546693 -0.13093723  0.155929011  0.314758068
## smoothness_se       0.016193934 -0.03100551  0.008066566  0.009312365
## compactness_se     -0.122457873 -0.17364984  0.049404535 -0.046651501
## concavity_se        0.186159613 -0.01600952 -0.091931364  0.083824645
## points_se          -0.107166573  0.12999049  0.018674110  0.011675700
## symmetry_se         0.002613811  0.01936313  0.016991197  0.019891112
## dimension_se        0.076177800  0.08458109 -0.035156906  0.012141785
## radius_worst       -0.158114412 -0.07144112  0.195812320  0.178796461
## texture_worst      -0.118609952  0.11802219 -0.036347107 -0.021473842
## perimeter_worst     0.236463109 -0.11790535  0.243266456  0.241658719
## area_worst          0.146339946  0.03921251 -0.229813188 -0.237323945
## smoothness_worst   -0.011224935  0.04787154 -0.012860335  0.040730207
## compactness_worst   0.185437121  0.62471727  0.100772153  0.071087434
## concavity_worst    -0.286701322 -0.11586768 -0.267236886  0.142148446
## points_worst        0.105286798 -0.26352782  0.133749940 -0.230794105
## symmetry_worst     -0.013193455 -0.04505357 -0.027824916 -0.022695808
## dimension_worst     0.037882167 -0.28015574 -0.004500884 -0.060081371
##                             PC29          PC30          PC31
## id                 -1.891724e-05 -0.0006852263 -7.122581e-05
## radius_mean         2.111968e-01 -0.2114371011 -7.024325e-01
## texture_mean       -6.362507e-05  0.0106165839 -2.644366e-04
## perimeter_mean      8.434280e-02 -0.3838889617  6.898676e-01
## area_mean          -2.725167e-01  0.4227208085  3.297173e-02
## smoothness_mean     1.480038e-03  0.0034638648  4.850746e-03
## compactness_mean   -5.466656e-03  0.0409079834 -4.468229e-02
## concavity_mean      4.554138e-02  0.0101122808 -2.512860e-02
## points_mean        -8.885707e-03  0.0041142627  1.067984e-03
## symmetry_mean       1.432581e-03  0.0075571475  1.279594e-03
## dimension_mean     -6.312291e-03 -0.0073311823  4.751885e-03
## radius_se          -1.922290e-01 -0.1186768422  8.679321e-03
## texture_se         -5.624974e-03  0.0086942153  1.063104e-03
## perimeter_se        2.631905e-01  0.0060612569 -1.373310e-02
## area_se            -4.205668e-02  0.0863645419 -1.054698e-03
## smoothness_se       9.795835e-03 -0.0016737982  1.618711e-03
## compactness_se     -1.539757e-02 -0.0032295613 -1.923037e-03
## concavity_se        5.819985e-03 -0.0161202167  8.921294e-03
## points_se          -2.900497e-02  0.0241014722  2.178643e-03
## symmetry_se        -7.637856e-03  0.0051771158 -3.338380e-04
## dimension_se        1.975791e-02  0.0083971145 -1.792802e-03
## radius_worst        4.126296e-01  0.6356796555  1.356846e-01
## texture_worst      -3.896988e-04 -0.0172219636 -1.020237e-03
## perimeter_worst    -7.286790e-01 -0.0228830657 -7.974244e-02
## area_worst          2.389679e-01 -0.4448733182 -3.976788e-02
## smoothness_worst   -1.535941e-03 -0.0074142082 -4.586820e-03
## compactness_worst   4.869512e-02  0.0001075081  1.285262e-02
## concavity_worst    -1.764174e-02  0.0126547542 -4.031809e-04
## points_worst        2.247340e-02 -0.0353341030  2.276561e-03
## symmetry_worst      4.922100e-03 -0.0133523613 -3.910451e-04
## dimension_worst    -2.356283e-02 -0.0115053741 -1.897779e-03
```

```
print(cancer_pca)
```

```
## Standard deviations (1    , p=31):
```

```
## Standard deviations (1, .., p=31):
##  [1] 3.64527878 2.38679814 1.68386313 1.40760690 1.28406203 1.11115827
##  [7] 0.98907696 0.81960537 0.67881693 0.63492763 0.59089337 0.54211662
## [13] 0.51102537 0.49125372 0.39619900 0.30680373 0.28250655 0.24299439
## [19] 0.22932770 0.22163467 0.17626907 0.17303527 0.16562163 0.15572098
## [25] 0.13431069 0.12441756 0.09039745 0.08305482 0.03986650 0.02735646
## [31] 0.01153431
##
## Rotation (n x k) = (31 x 31):
##                            PC1          PC2          PC3          PC4
## id                 -0.02291216  0.034068491  0.096938436 -0.026598045
## radius_mean        -0.21891302  0.233271401 -0.011393786  0.042187950
## texture_mean       -0.10384388  0.060044199  0.066892342 -0.602954308
## perimeter_mean     -0.22753491  0.214589002 -0.012124791  0.042752797
## area_mean          -0.22104577  0.230668816  0.026293150  0.054114724
## smoothness_mean    -0.14241471 -0.186422211 -0.103182400  0.158098177
## compactness_mean   -0.23906730 -0.152454726 -0.074768623  0.031818117
## concavity_mean     -0.25828025 -0.060541625  0.001758736  0.019497124
## points_mean        -0.26073811  0.034167392 -0.027579607  0.065785353
## symmetry_mean      -0.13797774 -0.190684979 -0.040962032  0.067502543
## dimension_mean     -0.06414779 -0.366531055 -0.020817875  0.047957856
## radius_se          -0.20611747  0.105935702  0.266917221  0.099114446
## texture_se         -0.01741339 -0.089547789  0.371439885 -0.356497230
## perimeter_se       -0.21144652  0.089807043  0.264925682  0.090293055
## area_se            -0.20307642  0.152771289  0.215790250  0.108568705
## smoothness_se      -0.01467821 -0.203189876  0.311787845  0.044368664
## compactness_se     -0.17028840 -0.232503362  0.154557465 -0.026425360
## concavity_se       -0.15354367 -0.196846081  0.176560052  0.002248291
## points_se          -0.18340675 -0.129965181  0.223850479  0.075252232
## symmetry_se        -0.04241552 -0.183558627  0.285265066  0.046936126
## dimension_se       -0.10249607 -0.279584139  0.211893354  0.016212450
## radius_worst       -0.22800935  0.219296044 -0.049406340  0.015659705
## texture_worst      -0.10451545  0.045501223 -0.039828934 -0.633119655
## perimeter_worst    -0.23663734  0.199295985 -0.050431945  0.014068572
## area_worst         -0.22493214  0.218985461 -0.013188891  0.025970672
## smoothness_worst   -0.12782441 -0.172562959 -0.255328751  0.014523359
## compactness_worst  -0.20988456 -0.144253637 -0.234513609 -0.092562168
## concavity_worst    -0.22860218 -0.098526524 -0.172024941 -0.074807188
## points_worst       -0.25074620  0.007534367 -0.170480673  0.005305980
## symmetry_worst     -0.12267993 -0.142619436 -0.270515902 -0.037129466
## dimension_worst    -0.13156024 -0.275702077 -0.229474476 -0.078971489
##                            PC5          PC6          PC7          PC8
## id                  0.011327587 -0.316733438  0.9071156324 -0.096362415
## radius_mean        -0.038129861  0.029588521 -0.0422987777 -0.116427419
## texture_mean        0.049091450 -0.031394323  0.0149935618  0.001875482
## perimeter_mean     -0.037715592  0.028394008 -0.0435888242 -0.106272097
## area_mean          -0.010562229  0.006113155 -0.0289256668 -0.047414568
## smoothness_mean     0.365750055 -0.262508993 -0.1403403617 -0.123541189
## compactness_mean   -0.011786637 -0.004903894 -0.0453031106  0.043145968
## concavity_mean     -0.086512506 -0.002356338 -0.0325530646 -0.102436021
## points_mean         0.043667412 -0.034509273 -0.0814216298 -0.136923237
## symmetry_mean       0.305378893  0.335082168  0.1182592361 -0.098874531
## dimension_mean      0.044767906 -0.112784169 -0.0410588768  0.306499872
## radius_se           0.154254367 -0.023261199  0.0167882718  0.307415709
## texture_se          0.190001500  0.022856912 -0.1902676469 -0.052632477
## perimeter_se        0.120703357  0.003820151  0.0195081762  0.311265679
## area_se             0.127765023 -0.051958835  0.0565606078  0.334287959
## smoothness_se       0.232745603 -0.330867850 -0.0678348099 -0.260833914
## compactness_se     -0.280298048  0.066788120  0.0222220211  0.021001944
## concavity_se       -0.354164595  0.049699104  0.0336810725 -0.219193299
## points_se          -0.195758558 -0.023197526 -0.0378517870 -0.370217167
## symmetry_se         0.251331178  0.477530515  0.1184032606 -0.084854768
## dimension_se       -0.263395188 -0.048462373 -0.0157602244  0.194418818
## radius_worst        0.004280034  0.004521737 -0.0166458140 -0.007508307
## texture_worst       0.092551860 -0.045174516 -0.0094601240  0.006617640
## perimeter_worst    -0.007599144  0.012921166 -0.0145260986  0.002162488
## area_worst          0.027413595 -0.024033338 -0.0007372602  0.066173186
## smoothness_worst    0.325860028 -0.365048687 -0.0670682168 -0.116496117
## compactness_worst  -0.121503371  0.034042714  0.0507556727  0.136509363
## concavity_worst    -0.188280510  0.017962040  0.0352007117 -0.067085744
## points_worst       -0.043123573 -0.029549100 -0.0207238959 -0.166500918
## symmetry_worst      0.244245936  0.451404312  0.2340143294 -0.041439633
## dimension_worst    -0.093699078 -0.092479698  0.0347167538  0.372034479
```

```
##                              PC9        PC10        PC11         PC12
## id                   0.149115642 -0.16926751  0.058188997 -0.006721252
## radius_mean         -0.046270835 -0.22402704 -0.079466081 -0.042213788
## texture_mean        -0.088727168  0.11945674 -0.253258091  0.304032359
## perimeter_mean      -0.036230738 -0.22634517 -0.069865929 -0.017573055
## area_mean           -0.080649856 -0.18600385 -0.062795372 -0.110760120
## smoothness_mean      0.278996404 -0.06133822  0.084661549  0.135321954
## compactness_mean     0.099214048 -0.19518602  0.005172841  0.307036205
## concavity_mean       0.075750464  0.03395563  0.134664686 -0.124553100
## points_mean          0.116569072 -0.14261678  0.006124860  0.071564686
## symmetry_mean        0.315150303  0.13561452 -0.574417320 -0.161058144
## dimension_mean       0.130639482 -0.15848117 -0.066456112  0.037318709
## radius_se            0.026200456  0.26504403  0.025847282  0.027030250
## texture_se           0.372989606 -0.31521084  0.323158815 -0.348396233
## perimeter_se         0.052860114  0.23789288  0.094867442  0.168501485
## area_se             -0.030627892  0.24966405  0.071991560 -0.050731496
## smoothness_se       -0.580789293 -0.01015980 -0.179568831 -0.081753374
## compactness_se      -0.148593714 -0.11518343 -0.038615749  0.206959272
## concavity_se         0.034715098  0.36592141  0.113536362 -0.348342358
## points_se            0.189022962  0.21518752 -0.094066850  0.342855186
## symmetry_se         -0.292785738 -0.22049558  0.328314881  0.185998712
## dimension_se        -0.060203202 -0.22637997 -0.353844543 -0.250428852
## radius_worst        -0.070224590 -0.09981025 -0.073013014 -0.105030701
## texture_worst       -0.008571809  0.10669296 -0.038561250 -0.012490348
## perimeter_worst     -0.058854223 -0.09821693 -0.045750979 -0.051125158
## area_worst          -0.097034650 -0.06179787 -0.068822329 -0.184460981
## smoothness_worst    -0.173257498  0.16912753  0.109278029 -0.142996001
## compactness_worst   -0.111218083 -0.06445290  0.175401648  0.196805544
## concavity_worst     -0.035467377  0.19661986  0.295581609 -0.184959562
## points_worst         0.052322473  0.05121611  0.075496752  0.117518361
## symmetry_worst      -0.188266324  0.10308901  0.019223451 -0.157210098
## dimension_worst     -0.087222442 -0.11291399 -0.007071634 -0.118625115
##                             PC13         PC14         PC15         PC16
## id                  -0.004841084 -0.006500099  0.006885943 -0.002753492
## radius_mean          0.050603927 -0.012496988 -0.059054553  0.050789156
## texture_mean         0.256273666 -0.201876125  0.020701124  0.108089530
## perimeter_mean       0.038470392 -0.044684430 -0.048019221  0.039590476
## area_mean            0.065047550 -0.067879244 -0.010152279 -0.014636050
## smoothness_mean      0.315872261 -0.046461624 -0.444044654  0.117493291
## compactness_mean    -0.104264618 -0.230005458 -0.007661166 -0.230759682
## concavity_mean       0.065723393 -0.387349680  0.189733740  0.128386008
## points_mean          0.042253113 -0.132637847  0.245219266  0.217299938
## symmetry_mean       -0.288054252 -0.189570545 -0.030903840  0.073950596
## dimension_mean       0.236120382 -0.106390748  0.377436108 -0.518333769
## radius_se           -0.015625578  0.069635807 -0.011959877  0.111103952
## texture_se          -0.308499115  0.165408488  0.012614192 -0.033389049
## perimeter_se        -0.100597125  0.038865462  0.044358477  0.008991734
## area_se             -0.017226446 -0.055687709 -0.083203050  0.045171638
## smoothness_se       -0.293287983 -0.149148603  0.200139961 -0.018414232
## compactness_se      -0.263398426 -0.010320713 -0.491903153 -0.167886977
## concavity_se         0.251864823 -0.157777595 -0.135322845 -0.250292522
## points_se           -0.006430584  0.494527095  0.199547389 -0.062548716
## symmetry_se          0.319874237 -0.010836031  0.047340593  0.113219397
## dimension_se         0.275943072  0.240767973 -0.145958050  0.353782637
## radius_worst         0.039582217  0.138036550 -0.023526025 -0.166213790
## texture_worst        0.080142089  0.080737140 -0.053897961 -0.100862417
## perimeter_worst     -0.009084762  0.097004376 -0.012559001 -0.182407021
## area_worst           0.047986766  0.101235629  0.006646192 -0.315142865
## smoothness_worst     0.056931408  0.206026671 -0.163389545 -0.045226715
## compactness_worst   -0.371991007 -0.013117334 -0.165941776  0.049613607
## concavity_worst     -0.086870368 -0.218055908  0.066854662  0.204743734
## points_worst        -0.068367254  0.254345228  0.276401728  0.169597618
## symmetry_worst       0.043937722  0.256766084 -0.005448734 -0.139913723
## dimension_worst     -0.035134642  0.172524501  0.212520491  0.255448214
##                             PC17         PC18         PC19         PC20
## id                  -0.007779983 -0.019707372  0.005442248  0.020454908
## radius_mean          0.150008977  0.209908003 -0.156773206  0.211821385
## texture_mean         0.159152972 -0.034161758  0.040048687  0.029931705
## perimeter_mean       0.113792993  0.201233658 -0.168413120  0.227079273
## area_mean            0.130173978  0.251460456 -0.269145594 -0.045499625
## smoothness_mean      0.203117911  0.168171613  0.354463321 -0.160358262
## compactness_mean    -0.170379447 -0.016302860 -0.014259132  0.292092522
## concavity_mean      -0.270010606 -0.005071590  0.027973937  0.007197446
```

```
##                        -_
## points_mean         -0.381111880  0.028741889  0.087065594 -0.153991624
## symmetry_mean        0.165691481 -0.194702559 -0.169168737 -0.058503329
## dimension_mean       0.039119713  0.046298986 -0.086779501 -0.062879947
## radius_se           -0.055118880 -0.124562479  0.231233991  0.181436577
## texture_se           0.032768777  0.041652813  0.009177450  0.038681291
## perimeter_se        -0.023929011 -0.009084130  0.014508488  0.364045783
## area_se             -0.045538238  0.313148246 -0.296273515 -0.433949999
## smoothness_se        0.058326686  0.145306166  0.228819703 -0.013932678
## compactness_se      -0.190065826 -0.015610691 -0.094108380 -0.250216687
## concavity_se         0.126034946  0.092345618 -0.005794297  0.119490304
## points_se            0.197671940  0.106747906 -0.046944796 -0.015851066
## symmetry_se          0.158541381 -0.279918359 -0.180195394 -0.084242460
## dimension_se        -0.267180143 -0.122002438  0.059970839  0.097082660
## radius_worst         0.083459877 -0.235215809  0.218781792  0.027741137
## texture_worst       -0.185972310  0.065992656 -0.057250572 -0.080880841
## perimeter_worst      0.056649279 -0.228493742  0.189279122  0.105666112
## area_worst           0.090325036 -0.286471546  0.158722686 -0.393681440
## smoothness_worst    -0.142781922 -0.276751162 -0.504565504  0.228506719
## compactness_worst    0.153347954 -0.003683424  0.073627229  0.025544372
## concavity_worst      0.216302398 -0.190307542  0.107894455 -0.035839305
## points_worst        -0.178353485 -0.085180057 -0.067182996 -0.261323873
## symmetry_worst      -0.260033510  0.436706158  0.269313654  0.111738683
## dimension_worst      0.404957673  0.162920272 -0.026674889 -0.022516600
##                              PC21         PC22         PC23         PC24
## id                    0.009870917  0.006195707  0.003190337 -0.010289027
## radius_mean           0.046009507  0.070394387 -0.073021974 -0.098704322
## texture_mean          0.264801220 -0.436269565 -0.095890704  0.001311285
## perimeter_mean        0.015122205  0.070963404 -0.074821704 -0.040500943
## area_mean             0.087345298  0.021672998 -0.097428804  0.009396470
## smoothness_mean      -0.023842011  0.117945821 -0.063741313 -0.020088204
## compactness_mean     -0.476395571 -0.213187888  0.094254664  0.058295270
## concavity_mean        0.037771062 -0.001270114  0.188862925  0.321062737
## points_mean           0.231546040  0.017493297  0.313280824 -0.057974684
## symmetry_mean        -0.030776761  0.085067786  0.018331111 -0.052004767
## dimension_mean        0.172565576  0.085104005 -0.286892578 -0.084701081
## radius_se             0.090564458 -0.085660592  0.147793165 -0.263799753
## texture_se            0.083589382 -0.212168357 -0.048761201 -0.001150858
## perimeter_se          0.169586632  0.317246026 -0.153859020  0.081384223
## area_se              -0.270679518 -0.207916141 -0.068745790  0.110258620
## smoothness_se        -0.095370809  0.066602974 -0.051852247 -0.057154068
## compactness_se        0.451033960  0.159332265  0.048970757  0.003993806
## concavity_se         -0.070203251 -0.071023842  0.200850815 -0.388573085
## points_se            -0.064848884 -0.035557778  0.074494143  0.354040783
## symmetry_se          -0.112133933  0.092193625  0.084324570 -0.043455477
## dimension_se         -0.214213177 -0.069171668 -0.245408452  0.089594196
## radius_worst          0.006481267 -0.007068180  0.096292694 -0.057768458
## texture_worst        -0.330244412  0.578095532  0.111968438 -0.009473435
## perimeter_worst      -0.010544107  0.094457678 -0.014952244  0.058698441
## area_worst           -0.053510824 -0.149328216  0.096798702  0.193293235
## smoothness_worst      0.140127867 -0.156936236  0.069660581  0.091134610
## compactness_worst    -0.220884131 -0.191897773 -0.033373706 -0.145389941
## concavity_worst       0.047166544  0.139729448 -0.456817799  0.290302924
## points_worst         -0.039740929 -0.006870640 -0.305694162 -0.563297713
## symmetry_worst        0.125617213 -0.155827542 -0.096426675  0.122996111
## dimension_worst       0.095366679  0.092769737  0.470358007  0.002775112
##                              PC25        PC26         PC27         PC28
## id                   -0.004233388 -0.00132610 -0.002571324 -0.001623875
## radius_mean          -0.183664583  0.01859418  0.128713229  0.131697326
## texture_mean          0.099441545 -0.08442059  0.024821224  0.017622634
## perimeter_mean       -0.117262178 -0.02743488  0.124670225  0.115650274
## area_mean             0.070557041  0.21057100 -0.361014547 -0.467489167
## smoothness_mean       0.068940049 -0.02876100  0.037372832 -0.069482805
## compactness_mean     -0.102198309 -0.39651346 -0.262695425 -0.098624638
## concavity_mean        0.045550527  0.09717977  0.550227716 -0.363040016
## points_mean           0.082349955  0.18630114 -0.389316679  0.453345398
## symmetry_mean         0.018841491  0.02451053  0.015910368  0.015157593
## dimension_mean       -0.134601525  0.20670502  0.096796804  0.101343150
## radius_se            -0.561133900  0.17339784 -0.050411953 -0.213735821
## texture_se            0.023938591 -0.05709165  0.010893175  0.009925699
## perimeter_se          0.516048248 -0.07217201 -0.103485879 -0.041989200
## area_se              -0.018546693 -0.13093723  0.155929011  0.314758068
## smoothness_se         0.016193934 -0.03100551  0.008066566  0.009312365
## compactness_se       -0.122457873 -0.17364984  0.049404535 -0.046651501
```

```
## compactness_se     -0.122457875 -0.17364964  0.049404535 -0.046651501
## concavity_se         0.186159613 -0.01600952 -0.091931364  0.083824645
## points_se           -0.107166573  0.12999049  0.018674110  0.011675700
## symmetry_se          0.002613811  0.01936313  0.016991197  0.019891112
## dimension_se         0.076177800  0.08458109 -0.035156906  0.012141785
## radius_worst        -0.158114412 -0.07144112  0.195812320  0.178796461
## texture_worst       -0.118609952  0.11802219 -0.036347107 -0.021473842
## perimeter_worst      0.236463109 -0.11790535  0.243266456  0.241658719
## area_worst           0.146339946  0.03921251 -0.229813188 -0.237323945
## smoothness_worst    -0.011224935  0.04787154 -0.012860335  0.040730207
## compactness_worst    0.185437121  0.62471727  0.100772153  0.071087434
## concavity_worst     -0.286701322 -0.11586768 -0.267236886  0.142148446
## points_worst         0.105286798 -0.26352782  0.133749940 -0.230794105
## symmetry_worst      -0.013193455 -0.04505357 -0.027824916 -0.022695808
## dimension_worst      0.037882167 -0.28015574 -0.004500884 -0.060081371
##                              PC29            PC30          PC31
## id                  -1.891724e-05 -0.0006852263 -7.122581e-05
## radius_mean          2.111968e-01 -0.2114371011 -7.024325e-01
## texture_mean        -6.362507e-05  0.0106165839 -2.644366e-04
## perimeter_mean       8.434280e-02 -0.3838889617  6.898676e-01
## area_mean           -2.725167e-01  0.4227208085  3.297173e-02
## smoothness_mean      1.480038e-03  0.0034638648  4.850746e-03
## compactness_mean    -5.466656e-03  0.0409079834 -4.468229e-02
## concavity_mean       4.554138e-02  0.0101122808 -2.512860e-02
## points_mean         -8.885707e-03  0.0041142627  1.067984e-03
## symmetry_mean        1.432581e-03  0.0075571475  1.279594e-03
## dimension_mean      -6.312291e-03 -0.0073311823  4.751885e-03
## radius_se           -1.922290e-01 -0.1186768422  8.679321e-03
## texture_se          -5.624974e-03  0.0086942153  1.063104e-03
## perimeter_se         2.631905e-01  0.0060612569 -1.373310e-02
## area_se             -4.205668e-02  0.0863645419 -1.054698e-03
## smoothness_se        9.795835e-03 -0.0016737982  1.618711e-03
## compactness_se      -1.539757e-02 -0.0032295613 -1.923037e-03
## concavity_se         5.819985e-03 -0.0161202167  8.921294e-03
## points_se           -2.900497e-02  0.0241014722  2.178643e-03
## symmetry_se         -7.637856e-03  0.0051771158 -3.338380e-04
## dimension_se         1.975791e-02  0.0083971145 -1.792802e-03
## radius_worst         4.126296e-01  0.6356796555  1.356846e-01
## texture_worst       -3.896988e-04 -0.0172219636 -1.020237e-03
## perimeter_worst     -7.286790e-01 -0.0228830657 -7.974244e-02
## area_worst           2.389679e-01 -0.4448733182 -3.976788e-02
## smoothness_worst    -1.535941e-03 -0.0074142082 -4.586820e-03
## compactness_worst    4.869512e-02  0.0001075081  1.285262e-02
## concavity_worst     -1.764174e-02  0.0126547542 -4.031809e-04
## points_worst         2.247340e-02 -0.0353341030  2.276561e-03
## symmetry_worst       4.922100e-03 -0.0133523613 -3.910451e-04
## dimension_worst     -2.356283e-02 -0.0115053741 -1.897779e-03
```

```
# Sample scores stored in cancer_pca$x
head(cancer_pca$x)
```

```
##             PC1          PC2        PC3        PC4         PC5        PC6
## [1,] 2.501946 -0.09694805 -0.4489597  2.3341176  0.69771548 -0.2430058
## [2,] 1.467439 -1.68630059  1.1542039  0.3362109  0.45962538  1.2308248
## [3,] 2.929028 -0.38319924 -0.8955891 -0.1164828  0.98441377 -0.2587872
## [4,] 1.995342 -1.33046592  1.1172876  2.0502761  0.25303846 -1.5539634
## [5,] 2.500252  2.01035097 -0.7584035  1.9862169 -1.13537096  0.5940361
## [6,] 2.018308 -0.78242095  0.1125197 -0.6532280  0.01841577  0.6914453
##             PC7         PC8        PC9       PC10       PC11        PC12
## [1,]  0.5092015 -1.11423307  0.2840243  0.32463197 -0.3245353  0.04981306
## [2,]  0.2937434  0.10000461 -0.0668399  0.42612180  0.4564029  1.19357566
## [3,] -0.3303385  0.03599041  0.8734350  0.02222192  0.4208602 -0.06687286
## [4,] -0.9692185 -1.31852134  0.6254396  0.05666470 -0.0691646  0.97082409
## [5,]  0.1198201 -0.48279704 -0.2727816 -0.29439485 -0.3577533  0.03266208
## [6,]  0.1454026  0.06214539  0.2342454  0.73681239 -0.3671239 -0.77029743
##             PC13       PC14         PC15        PC16        PC17
## [1,] -0.19760220  0.1134403 -0.059302558  0.16637723 -0.04286656
## [2,]  0.01807424 -0.2824292 -0.204858888 -0.07067959  0.03088787
## [3,]  0.37435458  0.2585457 -0.330274216 -0.13000189 -0.24616091
## [4,] -0.90968379  0.2179117 -0.665825669  0.10213387 -0.10289446
## [5,] -0.35547138 -0.1480140 -0.005540503 -0.06495881  0.22273309
## [6,] -0.49542291 -0.2992431  0.049952835 -0.20161083  0.14920422
##              PC18        PC19        PC20        PC21        PC22
## [1,] -0.104542766 -0.03484189 -0.09691187 -0.02846306 -0.00673628
## [2,] -0.405534243 -0.02886103 -0.05262226 -0.05987170  0.05868642
## [3,]  0.327711259  0.15937793 -0.13804895 -0.13489743  0.10080029
## [4,]  0.197085181  0.36251771 -0.40018239 -0.10302093 -0.28821708
## [5,] -0.129129156 -0.35877054  0.08515543 -0.08500541 -0.06332008
## [6,] -0.002229379 -0.08178568  0.18970936 -0.06872875  0.09669594
##              PC23         PC24         PC25        PC26         PC27
## [1,] -0.038971937  0.062212075  0.088438866  0.04872948 -0.007000724
## [2,]  0.070978613 -0.030822339 -0.016741580  0.04173030 -0.059332996
## [3,]  0.053909008  0.085484364  0.038277664 -0.04151896 -0.035546410
## [4,]  0.182045907  0.222848059 -0.115720065 -0.03676948 -0.148171674
## [5,]  0.043591030  0.008165322  0.002738052  0.05983731  0.046167735
## [6,] -0.001458054 -0.031338348  0.042784223 -0.08646068 -0.030944690
##              PC28        PC29         PC30         PC31
## [1,]  0.05356131  0.015184882  0.015985406  0.001396101
## [2,] -0.18696553  0.027011311 -0.000803330  0.008096490
## [3,] -0.07653067 -0.014640388  0.010307894  0.009074601
## [4,] -0.01711665 -0.047828494  0.023862995  0.000265075
## [5,]  0.03835364  0.032450800 -0.002312178 -0.002563269
## [6,]  0.00955434 -0.004403431  0.003869919 -0.002931194
```

```
# Identifying the scores by their diagnosis
diag_pca <- cbind(data.frame(diagnosis),cancer_pca$x)
head(diag_pca)
```

```
##   diagnosis      PC1         PC2        PC3        PC4         PC5
## 1         B 2.501946 -0.09694805 -0.4489597  2.3341176  0.69771548
## 2         B 1.467439 -1.68630059  1.1542039  0.3362109  0.45962538
## 3         B 2.929028 -0.38319924 -0.8955891 -0.1164828  0.98441377
## 4         B 1.995342 -1.33046592  1.1172876  2.0502761  0.25303846
## 5         B 2.500252  2.01035097 -0.7584035  1.9862169 -1.13537096
## 6         B 2.018308 -0.78242095  0.1125197 -0.6532280  0.01841577
##         PC6        PC7         PC8        PC9        PC10        PC11
## 1 -0.2430058  0.5092015 -1.11423307  0.2840243  0.32463197 -0.3245353
## 2  1.2308248  0.2937434  0.10000461 -0.0668399  0.42612180  0.4564029
## 3 -0.2587872 -0.3303385  0.03599041  0.8734350  0.02222192  0.4208602
## 4 -1.5539634 -0.9692185 -1.31852134  0.6254396  0.05666470 -0.0691646
## 5  0.5940361  0.1198201 -0.48279704 -0.2727816 -0.29439485 -0.3577533
## 6  0.6914453  0.1454026  0.06214539  0.2342454  0.73681239 -0.3671239
##         PC12        PC13       PC14         PC15        PC16        PC17
## 1  0.04981306 -0.19760220  0.1134403 -0.059302558  0.16637723 -0.04286656
## 2  1.19357566  0.01807424 -0.2824292 -0.204858888 -0.07067959  0.03088787
## 3 -0.06687286  0.37435458  0.2585457 -0.330274216 -0.13000189 -0.24616091
## 4  0.97082409 -0.90968379  0.2179117 -0.665825669  0.10213387 -0.10289446
## 5  0.03266208 -0.35547138 -0.1480140 -0.005540503 -0.06495881  0.22273309
## 6 -0.77029743 -0.49542291 -0.2992431  0.049952835 -0.20161083  0.14920422
##          PC18        PC19        PC20        PC21        PC22
## 1 -0.104542766 -0.03484189 -0.09691187 -0.02846306 -0.00673628
## 2 -0.405534243 -0.02886103 -0.05262226 -0.05987170  0.05868642
## 3  0.327711259  0.15937793 -0.13804895 -0.13489743  0.10080029
## 4  0.197085181  0.36251771 -0.40018239 -0.10302093 -0.28821708
## 5 -0.129129156 -0.35877054  0.08515543 -0.08500541 -0.06332008
## 6 -0.002229379 -0.08178568  0.18970936 -0.06872875  0.09669594
##          PC23        PC24        PC25        PC26         PC27
## 1 -0.038971937  0.062212075  0.088438866  0.04872948 -0.007000724
## 2  0.070978613 -0.030822339 -0.016741580  0.04173030 -0.059332996
## 3  0.053909008  0.085484364  0.038277664 -0.04151896 -0.035546410
## 4  0.182045907  0.222848059 -0.115720065 -0.03676948 -0.148171674
## 5  0.043591030  0.008165322  0.002738052  0.05983731  0.046167735
## 6 -0.001458054 -0.031338348  0.042784223 -0.08646068 -0.030944690
##         PC28        PC29         PC30         PC31
## 1  0.05356131  0.015184882  0.015985406  0.001396101
## 2 -0.18696553  0.027011311 -0.000803330  0.008096490
## 3 -0.07653067 -0.014640388  0.010307894  0.009074601
## 4 -0.01711665 -0.047828494  0.023862995  0.000265075
## 5  0.03835364  0.032450800 -0.002312178 -0.002563269
## 6  0.00955434 -0.004403431  0.003869919 -0.002931194
```

```
# Means of scores for all the PC's classified by diagnosis status
tabmeansPC <- aggregate(diag_pca[,2:31],by=list(diagnosis=cancer$diagnosis),mean)
tabmeansPC
```

```
##   diagnosis       PC1        PC2        PC3        PC4         PC5
## 1         B  2.204253 -0.3436398  0.2160542  0.1384470 -0.09800974
## 2         M -3.711879  0.5786765 -0.3638272 -0.2331395  0.16504470
##          PC6         PC7         PC8         PC9        PC10
## 1  0.004373132  0.01691799  0.04905754  0.03377092 -0.01002704
## 2 -0.007364189 -0.02848926 -0.08261104 -0.05686895  0.01688516
##           PC11         PC12         PC13        PC14        PC15
## 1 -0.0007888591  0.006017621  0.003305282 -0.03736471 -0.02453152
## 2  0.0013284090 -0.010133446 -0.005565970  0.06292076  0.04131016
##          PC16         PC17         PC18        PC19         PC20
## 1 -0.02516699  0.0001112917  0.006103777 -0.01307695 -0.009733891
## 2  0.04238026 -0.0001874111 -0.010278530  0.02202108  0.016391505
##          PC21         PC22         PC23         PC24         PC25
## 1 -0.008359794 -0.006225063 -0.003024993  0.002609428  0.007813479
## 2  0.014077577  0.010482771  0.005093974 -0.004394179 -0.013157604
##          PC26         PC27         PC28          PC29          PC30
## 1 -0.000879209 -0.003967725 -0.001909259 -0.0003418423 -0.0009838392
## 2  0.001480555  0.006681499  0.003215121  0.0005756496  0.0016567480
```

```
tabmeansPC <- tabmeansPC[rev(order(tabmeansPC$diagnosis)),]
tabmeansPC
```

```
##   diagnosis       PC1        PC2        PC3        PC4         PC5
## 2         M -3.711879  0.5786765 -0.3638272 -0.2331395  0.16504470
## 1         B  2.204253 -0.3436398  0.2160542  0.1384470 -0.09800974
##            PC6         PC7        PC8         PC9        PC10
## 2 -0.007364189 -0.02848926 -0.08261104 -0.05686895  0.01688516
## 1  0.004373132  0.01691799  0.04905754  0.03377092 -0.01002704
##            PC11         PC12         PC13        PC14        PC15
## 2  0.0013284090 -0.010133446 -0.005565970  0.06292076  0.04131016
## 1 -0.0007888591  0.006017621  0.003305282 -0.03736471 -0.02453152
##          PC16         PC17         PC18        PC19         PC20
## 2  0.04238026 -0.0001874111 -0.010278530  0.02202108  0.016391505
## 1 -0.02516699  0.0001112917  0.006103777 -0.01307695 -0.009733891
##          PC21         PC22         PC23         PC24         PC25
## 2  0.014077577  0.010482771  0.005093974 -0.004394179 -0.013157604
## 1 -0.008359794 -0.006225063 -0.003024993  0.002609428  0.007813479
##            PC26         PC27         PC28          PC29          PC30
## 2  0.001480555  0.006681499  0.003215121  0.0005756496  0.0016567480
## 1 -0.000879209 -0.003967725 -0.001909259 -0.0003418423 -0.0009838392
```

```
tabfmeans <- t(tabmeansPC[,-1])
tabfmeans
```

```
##                  2            1
## PC1  -3.7118786952  2.2042528946
## PC2   0.5786764540 -0.3436397990
## PC3  -0.3638271826  0.2160542373
## PC4  -0.2331394896  0.1384469798
## PC5   0.1650447018 -0.0980097389
## PC6  -0.0073641886  0.0043731316
## PC7  -0.0284892608  0.0169179924
## PC8  -0.0826110415  0.0490575373
## PC9  -0.0568689505  0.0337709174
## PC10  0.0168851623 -0.0100270432
## PC11  0.0013284090 -0.0007888591
## PC12 -0.0101334459  0.0060176205
## PC13 -0.0055659702  0.0033052820
## PC14  0.0629207582 -0.0373647080
## PC15  0.0413101623 -0.0245315249
## PC16  0.0423802589 -0.0251669885
## PC17 -0.0001874111  0.0001112917
## PC18 -0.0102785304  0.0061037771
## PC19  0.0220210837 -0.0130769461
## PC20  0.0163915046 -0.0097338907
## PC21  0.0140775772 -0.0083597937
## PC22  0.0104827709 -0.0062250628
## PC23  0.0050939739 -0.0030249929
## PC24 -0.0043941787  0.0026094282
## PC25 -0.0131576035  0.0078134789
## PC26  0.0014805547 -0.0008792090
## PC27  0.0066814986 -0.0039677247
## PC28  0.0032151208 -0.0019092594
## PC29  0.0005756496 -0.0003418423
## PC30  0.0016567480 -0.0009838392
```

```
colnames(tabfmeans) <- t(as.vector(tabmeansPC[1]))
tabfmeans
```

```
##                 M            B
## PC1  -3.7118786952  2.2042528946
## PC2   0.5786764540 -0.3436397990
## PC3  -0.3638271826  0.2160542373
## PC4  -0.2331394896  0.1384469798
## PC5   0.1650447018 -0.0980097389
## PC6  -0.0073641886  0.0043731316
## PC7  -0.0284892608  0.0169179924
## PC8  -0.0826110415  0.0490575373
## PC9  -0.0568689505  0.0337709174
## PC10  0.0168851623 -0.0100270432
## PC11  0.0013284090 -0.0007888591
## PC12 -0.0101334459  0.0060176205
## PC13 -0.0055659702  0.0033052820
## PC14  0.0629207582 -0.0373647080
## PC15  0.0413101623 -0.0245315249
## PC16  0.0423802589 -0.0251669885
## PC17 -0.0001874111  0.0001112917
## PC18 -0.0102785304  0.0061037771
## PC19  0.0220210837 -0.0130769461
## PC20  0.0163915046 -0.0097338907
## PC21  0.0140775772 -0.0083597937
## PC22  0.0104827709 -0.0062250628
## PC23  0.0050939739 -0.0030249929
## PC24 -0.0043941787  0.0026094282
## PC25 -0.0131576035  0.0078134789
## PC26  0.0014805547 -0.0008792090
## PC27  0.0066814986 -0.0039677247
## PC28  0.0032151208 -0.0019092594
## PC29  0.0005756496 -0.0003418423
## PC30  0.0016567480 -0.0009838392
```

```r
# Standard deviations of scores for all the PC's classified by diagnosis status
tabsdsPC <- aggregate(diag_pca[,2:31],by=list(cancer$diagnosis),sd)
tabfsds <- t(tabsdsPC[,-1])
colnames(tabfsds) <- t(as.vector(tabsdsPC[1]))
tabfsds
```

```
##               B          M
## PC1  1.63956487 3.02839244
## PC2  2.08691418 2.72966952
## PC3  1.36038677 2.07323861
## PC4  1.39613539 1.39927526
## PC5  1.39777817 1.04807636
## PC6  0.95340249 1.33789147
## PC7  0.95140466 1.05116532
## PC8  0.64932787 1.04212370
## PC9  0.65881989 0.70917409
## PC10 0.57998076 0.71917808
## PC11 0.60269891 0.57186757
## PC12 0.54006502 0.54668527
## PC13 0.51222488 0.51016086
## PC14 0.37926601 0.63294179
## PC15 0.38070917 0.41867516
## PC16 0.26760334 0.36012377
## PC17 0.26627925 0.30856638
## PC18 0.17881651 0.32377631
## PC19 0.17193548 0.30152802
## PC20 0.17202337 0.28613872
## PC21 0.15015083 0.21280261
## PC22 0.15982321 0.19320204
## PC23 0.14579937 0.19476702
## PC24 0.12247334 0.19984615
## PC25 0.11050781 0.16637188
## PC26 0.09806381 0.15950557
## PC27 0.07202620 0.11477556
## PC28 0.06617618 0.10565982
## PC29 0.02588741 0.05609976
## PC30 0.01834069 0.03798219
```

```
t.test(PC1~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC1 by cancer$diagnosis
## t = 26.251, df = 285.72, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  5.472542 6.359721
## sample estimates:
## mean in group B mean in group M
##        2.204253       -3.711879
```

```
t.test(PC2~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC2 by cancer$diagnosis
## t = -4.2387, df = 357.38, p-value = 2.865e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.3502373 -0.4943952
## sample estimates:
## mean in group B mean in group M
##      -0.3436398       0.5786765
```

```
t.test(PC3~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC3 by cancer$diagnosis
## t = 3.6343, df = 320.28, p-value = 0.0003246
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.2659658 0.8937970
## sample estimates:
## mean in group B mean in group M
##       0.2160542      -0.3638272
```

```
t.test(PC4~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC4 by cancer$diagnosis
## t = 3.0652, df = 442.55, p-value = 0.002308
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.1333371 0.6098358
## sample estimates:
## mean in group B mean in group M
##       0.1384470      -0.2331395
```

```
t.test(PC5~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC5 by cancer$diagnosis
## t = -2.5485, df = 537.03, p-value = 0.0111
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.46581747 -0.06029141
## sample estimates:
## mean in group B mean in group M
##     -0.09800974      0.16504470
```

```
t.test(PC6~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC6 by cancer$diagnosis
## t = 0.11197, df = 339.17, p-value = 0.9109
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1944615  0.2179362
## sample estimates:
## mean in group B mean in group M
##     0.004373132     -0.007364189
```

```
t.test(PC7~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC7 by cancer$diagnosis
## t = 0.51587, df = 408.87, p-value = 0.6062
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1276209  0.2184354
## sample estimates:
## mean in group B mean in group M
##     0.01691799     -0.02848926
```

```
t.test(PC8~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC8 by cancer$diagnosis
## t = 1.6584, df = 309.75, p-value = 0.09825
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02455572  0.28789287
## sample estimates:
## mean in group B mean in group M
##     0.04905754     -0.08261104
```

```
t.test(PC9~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC9 by cancer$diagnosis
## t = 1.5132, df = 417.67, p-value = 0.131
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.0271048  0.2083845
## sample estimates:
## mean in group B mean in group M
##      0.03377092     -0.05686895
```

```
t.test(PC10~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC10 by cancer$diagnosis
## t = -0.46277, df = 372.52, p-value = 0.6438
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.14126432  0.08743991
## sample estimates:
## mean in group B mean in group M
##     -0.01002704      0.01688516
```

```
t.test(PC11~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC11 by cancer$diagnosis
## t = -0.041845, df = 462.01, p-value = 0.9666
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.10154692  0.09731238
## sample estimates:
## mean in group B mean in group M
##   -0.0007888591    0.0013284090
```

```
t.test(PC12~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC12 by cancer$diagnosis
## t = 0.34227, df = 439.04, p-value = 0.7323
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.07659212  0.10889425
## sample estimates:
## mean in group B mean in group M
##      0.006017621     -0.010133446
```

```
t.test(PC13~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC13 by cancer$diagnosis
## t = 0.20025, df = 444.77, p-value = 0.8414
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.07819457  0.09593708
## sample estimates:
## mean in group B mean in group M
##     0.003305282    -0.005565970
```

```
t.test(PC14~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC14 by cancer$diagnosis
## t = -2.0945, df = 302.42, p-value = 0.03705
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.194508096 -0.006062836
## sample estimates:
## mean in group B mean in group M
##     -0.03736471      0.06292076
```

```
t.test(PC15~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC15 by cancer$diagnosis
## t = -1.8752, df = 410.43, p-value = 0.06147
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.134862771  0.003179396
## sample estimates:
## mean in group B mean in group M
##     -0.02453152      0.04131016
```

```
t.test(PC16~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC16 by cancer$diagnosis
## t = -2.37, df = 349.77, p-value = 0.01833
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.12360307 -0.01149143
## sample estimates:
## mean in group B mean in group M
##     -0.02516699      0.04238026
```

```
t.test(PC17~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC17 by cancer$diagnosis
## t = 0.011737, df = 393.3, p-value = 0.9906
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.04973747  0.05033487
## sample estimates:
## mean in group B mean in group M
##    0.0001112917   -0.0001874111
```

```
t.test(PC18~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC18 by cancer$diagnosis
## t = 0.67787, df = 288.75, p-value = 0.4984
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.03118389  0.06394850
## sample estimates:
## mean in group B mean in group M
##    0.006103777   -0.010278530
```

```
t.test(PC19~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC19 by cancer$diagnosis
## t = -1.5516, df = 293.85, p-value = 0.1218
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.079616015  0.009419955
## sample estimates:
## mean in group B mean in group M
##    -0.01307695    0.02202108
```

```
t.test(PC20~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC20 by cancer$diagnosis
## t = -1.2062, df = 303.02, p-value = 0.2287
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.06874572  0.01649493
## sample estimates:
## mean in group B mean in group M
##    -0.009733891    0.016391505
```

```
t.test(PC21~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC21 by cancer$diagnosis
## t = -1.3487, df = 336.76, p-value = 0.1783
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.05516116  0.01028642
## sample estimates:
## mean in group B mean in group M
##    -0.008359794     0.014077577
```

```
t.test(PC22~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC22 by cancer$diagnosis
## t = -1.0618, df = 380.13, p-value = 0.289
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.04764831  0.01423264
## sample estimates:
## mean in group B mean in group M
##    -0.006225063     0.010482771
```

```
t.test(PC23~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC23 by cancer$diagnosis
## t = -0.52575, df = 351.71, p-value = 0.5994
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.03849078  0.02225285
## sample estimates:
## mean in group B mean in group M
##    -0.003024993     0.005093974
```

```
t.test(PC24~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC24 by cancer$diagnosis
## t = 0.4614, df = 306.57, p-value = 0.6448
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02286480  0.03687201
## sample estimates:
## mean in group B mean in group M
##     0.002609428    -0.004394179
```

```
t.test(PC25~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC25 by cancer$diagnosis
## t = 1.6337, df = 322.91, p-value = 0.1033
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.004282315  0.046224480
## sample estimates:
## mean in group B mean in group M
##     0.007813479     -0.013157604
```

```
t.test(PC26~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC26 by cancer$diagnosis
## t = -0.19467, df = 307.18, p-value = 0.8458
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02621273  0.02149320
## sample estimates:
## mean in group B mean in group M
##    -0.000879209      0.001480555
```

```
t.test(PC27~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC27 by cancer$diagnosis
## t = -1.2162, df = 311.14, p-value = 0.2248
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.027878004  0.006579557
## sample estimates:
## mean in group B mean in group M
##    -0.003967725      0.006681499
```

```
t.test(PC28~cancer$diagnosis,data=diag_pca)
```

```
##
##  Welch Two Sample t-test
##
## data:  PC28 by cancer$diagnosis
## t = -0.63596, df = 310.76, p-value = 0.5253
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02097902  0.01073026
## sample estimates:
## mean in group B mean in group M
##    -0.001909259      0.003215121
```

```
t.test(PC29~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC29 by cancer$diagnosis
## t = -0.22436, df = 265.22, p-value = 0.8226
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.008969119  0.007134135
## sample estimates:
## mean in group B mean in group M
##   -0.0003418423     0.0005756496
```

```
t.test(PC30~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC30 by cancer$diagnosis
## t = -0.9487, df = 270.4, p-value = 0.3436
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.008120430  0.002839256
## sample estimates:
## mean in group B mean in group M
##   -0.0009838392     0.0016567480
```

```
t.test(PC31~cancer$diagnosis,data=diag_pca)
```

```
## 
##   Welch Two Sample t-test
## 
## data:  PC31 by cancer$diagnosis
## t = -0.54256, df = 278.74, p-value = 0.5879
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.002917016  0.001656473
## sample estimates:
## mean in group B mean in group M
##   -0.0002348289     0.0003954429
```

```
# F ratio tests
var.test(PC1~cancer$diagnosis,data=diag_pca)
```

```
## 
##   F test to compare two variances
## 
## data:  PC1 by cancer$diagnosis
## F = 0.29311, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2293890 0.3717204
## sample estimates:
## ratio of variances
##          0.2931115
```

```
var.test(PC2~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC2 by cancer$diagnosis
## F = 0.58451, num df = 356, denom df = 211, p-value = 8.474e-06
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4574343 0.7412633
## sample estimates:
## ratio of variances
##          0.5845061
```

```
var.test(PC3~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC3 by cancer$diagnosis
## F = 0.43055, num df = 356, denom df = 211, p-value = 2.327e-12
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3369504 0.5460214
## sample estimates:
## ratio of variances
##          0.4305526
```

```
var.test(PC4~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC4 by cancer$diagnosis
## F = 0.99552, num df = 356, denom df = 211, p-value = 0.9625
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7790915 1.2625024
## sample estimates:
## ratio of variances
##          0.9955172
```

```
var.test(PC5~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC5 by cancer$diagnosis
## F = 1.7787, num df = 356, denom df = 211, p-value = 5.82e-06
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  1.391972 2.255662
## sample estimates:
## ratio of variances
##          1.778651
```

```
var.test(PC6~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC6 by cancer$diagnosis
## F = 0.50782, num df = 356, denom df = 211, p-value = 1.795e-08
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3974207 0.6440124
## sample estimates:
## ratio of variances
##           0.5078212
```

```
var.test(PC7~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC7 by cancer$diagnosis
## F = 0.8192, num df = 356, denom df = 211, p-value = 0.1
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6411036 1.0388957
## sample estimates:
## ratio of variances
##           0.8191973
```

```
var.test(PC8~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC8 by cancer$diagnosis
## F = 0.38823, num df = 356, denom df = 211, p-value = 3.319e-15
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3038290 0.4923489
## sample estimates:
## ratio of variances
##           0.3882304
```

```
var.test(PC9~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC9 by cancer$diagnosis
## F = 0.86303, num df = 356, denom df = 211, p-value = 0.2243
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6754099 1.0944883
## sample estimates:
## ratio of variances
##           0.8630336
```

```
var.test(PC10~cancer$diagnosis,data=diag_pca)
```

```
## 
##   F test to compare two variances
## 
## data:  PC10 by cancer$diagnosis
## F = 0.65036, num df = 356, denom df = 211, p-value = 0.0003698
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.5089722 0.8247793
## sample estimates:
## ratio of variances
##           0.6503607
```

```
var.test(PC11~cancer$diagnosis,data=diag_pca)
```

```
## 
##   F test to compare two variances
## 
## data:  PC11 by cancer$diagnosis
## F = 1.1107, num df = 356, denom df = 211, p-value = 0.4012
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.8692598 1.4086183
## sample estimates:
## ratio of variances
##           1.110734
```

```
var.test(PC12~cancer$diagnosis,data=diag_pca)
```

```
## 
##   F test to compare two variances
## 
## data:  PC12 by cancer$diagnosis
## F = 0.97593, num df = 356, denom df = 211, p-value = 0.8346
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7637603 1.2376584
## sample estimates:
## ratio of variances
##           0.975927
```

```
var.test(PC13~cancer$diagnosis,data=diag_pca)
```

```
## 
##   F test to compare two variances
## 
## data:  PC13 by cancer$diagnosis
## F = 1.0081, num df = 356, denom df = 211, p-value = 0.956
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.7889451 1.2784699
## sample estimates:
## ratio of variances
##           1.008108
```

```
var.test(PC14~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC14 by cancer$diagnosis
## F = 0.35905, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2809959 0.4553483
## sample estimates:
## ratio of variances
##           0.3590544
```

```
var.test(PC15~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC15 by cancer$diagnosis
## F = 0.82686, num df = 356, denom df = 211, p-value = 0.1169
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.6471009 1.0486142
## sample estimates:
## ratio of variances
##           0.8268605
```

```
var.test(PC16~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC16 by cancer$diagnosis
## F = 0.55218, num df = 356, denom df = 211, p-value = 8.26e-07
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4321348 0.7002658
## sample estimates:
## ratio of variances
##           0.5521785
```

```
var.test(PC17~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC17 by cancer$diagnosis
## F = 0.74469, num df = 356, denom df = 211, p-value = 0.01494
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.5827968 0.9444106
## sample estimates:
## ratio of variances
##           0.7446933
```

```
var.test(PC18~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC18 by cancer$diagnosis
## F = 0.30502, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2387068 0.3868197
## sample estimates:
## ratio of variances
##           0.3050177
```

```
var.test(PC19~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC19 by cancer$diagnosis
## F = 0.32514, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2544576 0.4123434
## sample estimates:
## ratio of variances
##           0.3251439
```

```
var.test(PC20~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC20 by cancer$diagnosis
## F = 0.36143, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2828534 0.4583583
## sample estimates:
## ratio of variances
##           0.3614279
```

```
var.test(PC21~cancer$diagnosis,data=diag_pca)
```

```
##
##  F test to compare two variances
##
## data:  PC21 by cancer$diagnosis
## F = 0.49785, num df = 356, denom df = 211, p-value = 6.758e-09
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3896201 0.6313716
## sample estimates:
## ratio of variances
##           0.4978535
```

```
var.test(PC22~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC22 by cancer$diagnosis
## F = 0.68432, num df = 356, denom df = 211, p-value = 0.001709
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.5355451 0.8678402
## sample estimates:
## ratio of variances
##           0.6843154
```

```
var.test(PC23~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC23 by cancer$diagnosis
## F = 0.56038, num df = 356, denom df = 211, p-value = 1.542e-06
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.4385511 0.7106634
## sample estimates:
## ratio of variances
##           0.5603772
```

```
var.test(PC24~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC24 by cancer$diagnosis
## F = 0.37557, num df = 356, denom df = 211, p-value = 3.495e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2939215 0.4762939
## sample estimates:
## ratio of variances
##           0.3755706
```

```
var.test(PC25~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC25 by cancer$diagnosis
## F = 0.44119, num df = 356, denom df = 211, p-value = 9.824e-12
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3452756 0.5595122
## sample estimates:
## ratio of variances
##           0.4411905
```

```
var.test(PC26~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC26 by cancer$diagnosis
## F = 0.37798, num df = 356, denom df = 211, p-value = 5.423e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2958050 0.4793461
## sample estimates:
## ratio of variances
##           0.3779774
```

```
var.test(PC27~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC27 by cancer$diagnosis
## F = 0.39381, num df = 356, denom df = 211, p-value = 8.544e-15
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3081924 0.4994196
## sample estimates:
## ratio of variances
##           0.3938058
```

```
var.test(PC28~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC28 by cancer$diagnosis
## F = 0.39227, num df = 356, denom df = 211, p-value = 6.601e-15
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3069894 0.4974701
## sample estimates:
## ratio of variances
##           0.3922686
```

```
var.test(PC29~cancer$diagnosis,data=diag_pca)
```

```
## 
##  F test to compare two variances
## 
## data:  PC29 by cancer$diagnosis
## F = 0.21294, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1666460 0.2700465
## sample estimates:
## ratio of variances
##           0.2129389
```

```
var.test(PC30~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC30 by cancer$diagnosis
## F = 0.23317, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.1824782 0.2957024
## sample estimates:
## ratio of variances
##          0.2331693
```

```
var.test(PC31~cancer$diagnosis,data=diag_pca)
```

```
##
##   F test to compare two variances
##
## data:  PC31 by cancer$diagnosis
## F = 0.26577, num df = 356, denom df = 211, p-value < 2.2e-16
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.2079951 0.3370519
## sample estimates:
## ratio of variances
##          0.2657746
```

```
# Levene's tests (one-sided)
library(car)
(LTPC1 <- leveneTest(PC1~cancer$diagnosis,data=diag_pca))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  62.132 1.654e-14 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(p_PC1_1sided <- LTPC1[[3]][[1]]/2)
```

```
## [1] 8.268824e-15
```

```
(LTPC2 <- leveneTest(PC2~cancer$diagnosis,data=diag_pca))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1  18.786 1.73e-05 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(p_PC2_1sided=LTPC2[[3]][[1]]/2)
```

```
## [1] 8.651441e-06
```

```
(LTPC3 <- leveneTest(PC3~cancer$diagnosis,data=diag_pca))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value    Pr(>F)
## group   1   27.65 2.063e-07 ***
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(p_PC3_1sided <- LTPC3[[3]][1]/2)
```

```
## [1] 1.031266e-07
```

```
(LTPC4 <- leveneTest(PC4~cancer$diagnosis,data=diag_pca))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value Pr(>F)
## group   1   2e-04  0.989
##       567
```

```
(p_PC4_1sided <- LTPC4[[3]][1]/2)
```

```
## [1] 0.4944984
```

```
(LTPC5 <- leveneTest(PC5~cancer$diagnosis,data=diag_pca))
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##        Df F value   Pr(>F)
## group   1  6.8535 0.009083 **
##       567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(p_PC5_1sided <- LTPC5[[3]][1]/2)
```

```
## [1] 0.004541533
```

```
# Plotting the scores for the first and second components
plot(diag_pca$PC1, diag_pca$PC2,pch=ifelse(diag_pca$diagnosis == "S",1,16),xlab="PC1", ylab="PC2", main="569
entries against values for PC1 & PC2")
abline(h=0)
abline(v=0)
legend("bottomleft", legend=c("Benign","Malignant"), pch=c(1,16))
```


569 entries against values for PC1 & PC2
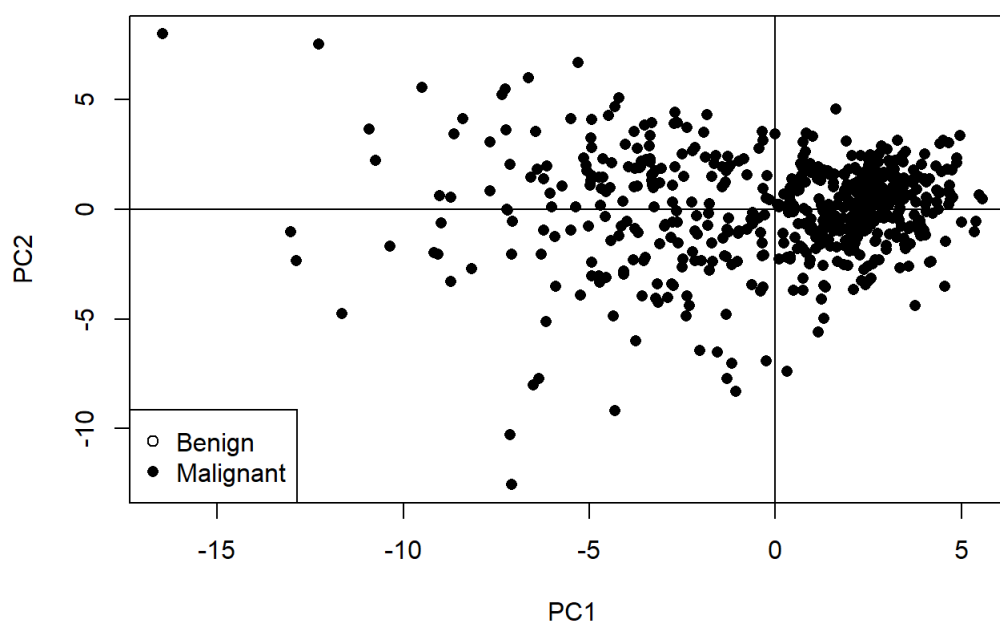
```
plot(eigen_cancer, xlab = "Component number", ylab = "Component variance", type = "l", main = "Scree diagram
")
```

Scree diagram
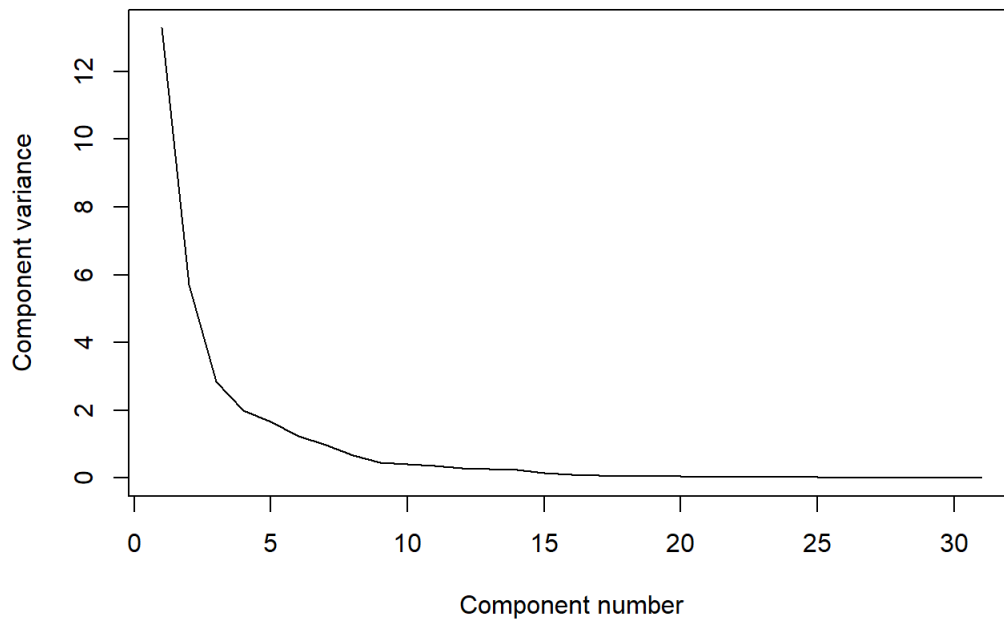

```
plot(log(eigen_cancer), xlab = "Component number",ylab = "log(Component variance)", type="l",main = "Log(eig
envalue) diagram")
```

Log(eigenvalue) diagram


```
print(summary(cancer_pca))
```

```
## Importance of components:
##                            PC1     PC2     PC3     PC4     PC5     PC6
## Standard deviation      3.6453  2.3868 1.68386 1.40761 1.28406 1.11116
## Proportion of Variance  0.4286  0.1838 0.09146 0.06391 0.05319 0.03983
## Cumulative Proportion   0.4286  0.6124 0.70388 0.76779 0.82098 0.86081
##                            PC7     PC8     PC9    PC10    PC11    PC12
## Standard deviation      0.98908 0.81961 0.67882 0.6349 0.59089 0.54212
## Proportion of Variance  0.03156 0.02167 0.01486 0.0130 0.01126 0.00948
## Cumulative Proportion   0.89237 0.91404 0.92890 0.9419 0.95317 0.96265
##                           PC13    PC14    PC15    PC16    PC17    PC18
## Standard deviation      0.51103 0.49125 0.39620 0.30680 0.28251 0.2430
## Proportion of Variance  0.00842 0.00778 0.00506 0.00304 0.00257 0.0019
## Cumulative Proportion   0.97107 0.97886 0.98392 0.98696 0.98953 0.9914
##                           PC19    PC20    PC21    PC22    PC23    PC24
## Standard deviation      0.2293  0.22163 0.1763  0.17304 0.16562 0.15572
## Proportion of Variance  0.0017  0.00158 0.0010  0.00097 0.00088 0.00078
## Cumulative Proportion   0.9931  0.99472 0.9957  0.99669 0.99757 0.99835
##                           PC25    PC26    PC27    PC28    PC29    PC30
## Standard deviation      0.13431 0.1244  0.09040 0.08305 0.03987 0.02736
## Proportion of Variance  0.00058 0.0005  0.00026 0.00022 0.00005 0.00002
## Cumulative Proportion   0.99893 0.9994  0.99970 0.99992 0.99997 1.00000
##                           PC31
## Standard deviation      0.01153
## Proportion of Variance 0.00000
## Cumulative Proportion  1.00000
```
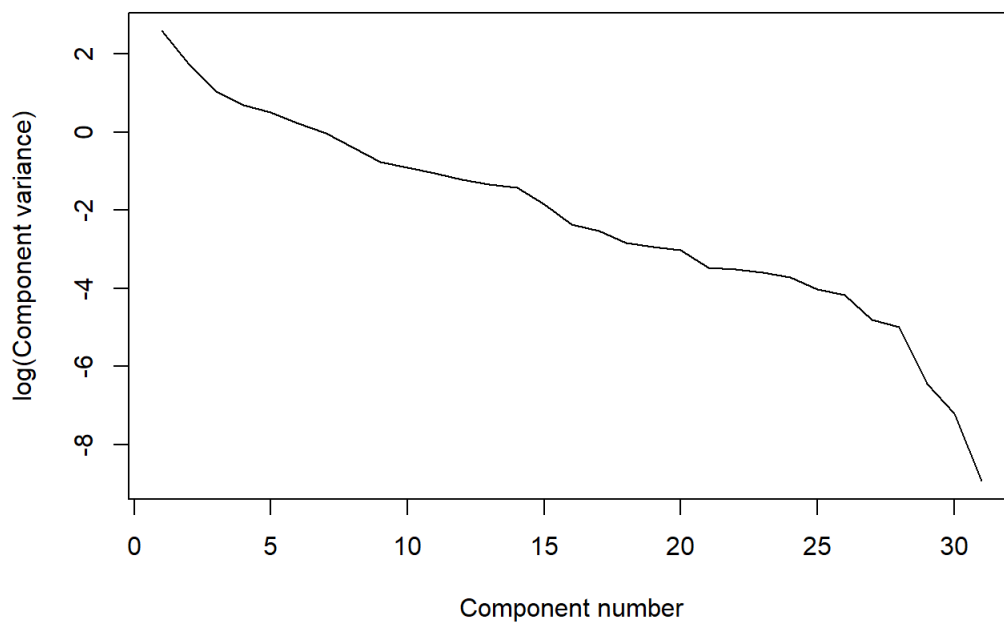
```
#View(cancer_pca)
diag(cov(cancer_pca$x))
```

```
##          PC1          PC2          PC3          PC4          PC5
## 1.328806e+01 5.696805e+00 2.835395e+00 1.981357e+00 1.648815e+00
##          PC6          PC7          PC8          PC9         PC10
## 1.234673e+00 9.782732e-01 6.717530e-01 4.607924e-01 4.031331e-01
##         PC11         PC12         PC13         PC14         PC15
## 3.491550e-01 2.938904e-01 2.611469e-01 2.413302e-01 1.569736e-01
##         PC16         PC17         PC18         PC19         PC20
## 9.412853e-02 7.980995e-02 5.904627e-02 5.259119e-02 4.912193e-02
##         PC21         PC22         PC23         PC24         PC25
## 3.107078e-02 2.994121e-02 2.743052e-02 2.424902e-02 1.803936e-02
##         PC26         PC27         PC28         PC29         PC30
## 1.547973e-02 8.171699e-03 6.898103e-03 1.589338e-03 7.483761e-04
##         PC31
## 1.330402e-04
```

```
xlim <- range(cancer_pca$x[,1])
head(cancer_pca$x[,1])
```

```
## [1] 2.501946 1.467439 2.929028 1.995342 2.500252 2.018308
```

```
head(cancer_pca$x)
```

```
##             PC1         PC2        PC3        PC4         PC5        PC6
## [1,] 2.501946 -0.09694805 -0.4489597  2.3341176  0.69771548 -0.2430058
## [2,] 1.467439 -1.68630059  1.1542039  0.3362109  0.45962538  1.2308248
## [3,] 2.929028 -0.38319924 -0.8955891 -0.1164828  0.98441377 -0.2587872
## [4,] 1.995342 -1.33046592  1.1172876  2.0502761  0.25303846 -1.5539634
## [5,] 2.500252  2.01035097 -0.7584035  1.9862169 -1.13537096  0.5940361
## [6,] 2.018308 -0.78242095  0.1125197 -0.6532280  0.01841577  0.6914453
##             PC7         PC8        PC9       PC10       PC11        PC12
## [1,]  0.5092015 -1.11423307  0.2840243  0.32463197 -0.3245353  0.04981306
## [2,]  0.2937434  0.10000461 -0.0668399  0.42612180  0.4564029  1.19357566
## [3,] -0.3303385  0.03599041  0.8734350  0.02222192  0.4208602 -0.06687286
## [4,] -0.9692185 -1.31852134  0.6254396  0.05666470 -0.0691646  0.97082409
## [5,]  0.1198201 -0.48279704 -0.2727816 -0.29439485 -0.3577533  0.03266208
## [6,]  0.1454026  0.06214539  0.2342454  0.73681239 -0.3671239 -0.77029743
##             PC13       PC14         PC15        PC16        PC17
## [1,] -0.19760220  0.1134403 -0.059302558  0.16637723 -0.04286656
## [2,]  0.01807424 -0.2824292 -0.204858888 -0.07067959  0.03088787
## [3,]  0.37435458  0.2585457 -0.330274216 -0.13000189 -0.24616091
## [4,] -0.90968379  0.2179117 -0.665825669  0.10213387 -0.10289446
## [5,] -0.35547138 -0.1480140 -0.005540503 -0.06495881  0.22273309
## [6,] -0.49542291 -0.2992431  0.049952835 -0.20161083  0.14920422
##             PC18         PC19        PC20        PC21        PC22
## [1,] -0.104542766 -0.03484189 -0.09691187 -0.02846306 -0.00673628
## [2,] -0.405534243 -0.02886103 -0.05262226 -0.05987170  0.05868642
## [3,]  0.327711259  0.15937793 -0.13804895 -0.13489743  0.10080029
## [4,]  0.197085181  0.36251771 -0.40018239 -0.10302093 -0.28821708
## [5,] -0.129129156 -0.35877054  0.08515543 -0.08500541 -0.06332008
## [6,] -0.002229379 -0.08178568  0.18970936 -0.06872875  0.09669594
##             PC23         PC24        PC25        PC26         PC27
## [1,] -0.038971937  0.062212075  0.088438866  0.04872948 -0.007000724
## [2,]  0.070978613 -0.030822339 -0.016741580  0.04173030 -0.059332996
## [3,]  0.053909008  0.085484364  0.038277664 -0.04151896 -0.035546410
## [4,]  0.182045907  0.222848059 -0.115720065 -0.03676948 -0.148171674
## [5,]  0.043591030  0.008165322  0.002738052  0.05983731  0.046167735
## [6,] -0.001458054 -0.031338348  0.042784223 -0.08646068 -0.030944690
##             PC28        PC29         PC30         PC31
## [1,]  0.05356131  0.015184882  0.015985406  0.001396101
## [2,] -0.18696553  0.027011311 -0.000803330  0.008096490
## [3,] -0.07653067 -0.014640388  0.010307894  0.009074601
## [4,] -0.01711665 -0.047828494  0.023862995  0.000265075
## [5,]  0.03835364  0.032450800 -0.002312178 -0.002563269
## [6,]  0.00955434 -0.004403431  0.003869919 -0.002931194
```

```
plot(cancer_pca$x,xlim=xlim,ylim=xlim)
```
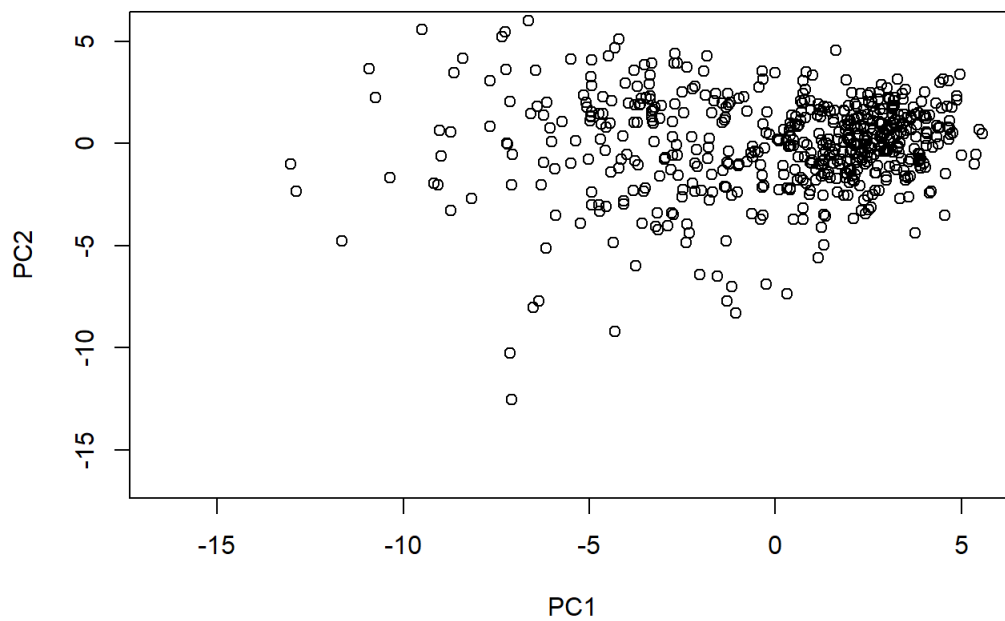
```
#Factor Analysis
#install.packages("psych", lib="/Library/Frameworks/R.framework/Versions/3.5/Resources/library")
library(psych)
```

```
##
## Attaching package: 'psych'
```

```
## The following object is masked from 'package:car':
##
##     logit
```

```
## The following objects are masked from 'package:ggplot2':
##
##     %+%, alpha
```

```
fit.pc <- principal(cancer[-2], nfactors=4, rotate="varimax")
fit.pc
```

```
## Principal Components Analysis
## Call: principal(r = cancer[-2], nfactors = 4, rotate = "varimax")
## Standardized loadings (pattern matrix) based upon correlation matrix
##                    RC1   RC2   RC3   RC4    h2    u2 com
## id                0.13 -0.10  0.10  0.07 0.042 0.958 3.3
## radius_mean       0.95  0.13 -0.14  0.10 0.951 0.049 1.1
## texture_mean      0.25  0.06  0.05  0.91 0.897 0.103 1.2
## perimeter_mean    0.95  0.17 -0.11  0.10 0.954 0.046 1.1
## area_mean         0.97  0.10 -0.08  0.09 0.960 0.040 1.1
## smoothness_mean   0.16  0.65  0.26 -0.19 0.547 0.453 1.6
## compactness_mean  0.46  0.77  0.32  0.05 0.910 0.090 2.0
## concavity_mean    0.66  0.61  0.31  0.10 0.908 0.092 2.5
## points_mean       0.80  0.51  0.15  0.05 0.921 0.079 1.8
## symmetry_mean     0.14  0.58  0.33 -0.06 0.474 0.526 1.7
## dimension_mean   -0.31  0.66  0.53 -0.10 0.826 0.174 2.4
## radius_se         0.83  0.00  0.40  0.03 0.850 0.150 1.4
## texture_se       -0.05 -0.21  0.60  0.54 0.693 0.307 2.3
## perimeter_se      0.82  0.04  0.42  0.04 0.855 0.145 1.5
## area_se           0.88 -0.02  0.26  0.01 0.836 0.164 1.2
## smoothness_se    -0.14  0.00  0.70 -0.05 0.518 0.482 1.1
## compactness_se    0.20  0.51  0.67  0.11 0.762 0.238 2.2
## concavity_se      0.22  0.41  0.63  0.07 0.622 0.378 2.0
## points_se         0.43  0.33  0.64  0.00 0.697 0.303 2.3
## symmetry_se      -0.04  0.06  0.67 -0.03 0.451 0.549 1.0
## dimension_se     -0.03  0.38  0.75  0.01 0.713 0.287 1.5
## radius_worst      0.94  0.21 -0.16  0.13 0.972 0.028 1.2
## texture_worst     0.20  0.19 -0.08  0.93 0.956 0.044 1.2
## perimeter_worst   0.94  0.25 -0.13  0.13 0.978 0.022 1.2
## area_worst        0.94  0.16 -0.12  0.12 0.947 0.053 1.1
## smoothness_worst  0.06  0.75  0.01 -0.01 0.572 0.428 1.0
## compactness_worst 0.31  0.86  0.06  0.19 0.877 0.123 1.4
## concavity_worst   0.45  0.77  0.10  0.19 0.845 0.155 1.8
## points_worst      0.68  0.67 -0.02  0.11 0.918 0.082 2.1
## symmetry_worst    0.07  0.72 -0.06  0.06 0.526 0.474 1.0
## dimension_worst  -0.09  0.88  0.18  0.10 0.825 0.175 1.1
##
##                        RC1  RC2  RC3  RC4
## SS loadings          10.15 7.04 4.36 2.25
## Proportion Var        0.33 0.23 0.14 0.07
## Cumulative Var        0.33 0.55 0.70 0.77
## Proportion Explained  0.43 0.30 0.18 0.09
## Cumulative Proportion 0.43 0.72 0.91 1.00
##
## Mean item complexity =  1.6
## Test of the hypothesis that 4 components are sufficient.
##
## The root mean square of the residuals (RMSR) is  0.06
##  with the empirical chi square  1923.24  with prob <  3.8e-216
##
## Fit based upon off diagonal values = 0.98
```

```
round(fit.pc$values, 3)
```

```
## [1] 13.288  5.697  2.835  1.981  1.649  1.235  0.978  0.672  0.461  0.403
## [11]  0.349  0.294  0.261  0.241  0.157  0.094  0.080  0.059  0.053  0.049
## [21]  0.031  0.030  0.027  0.024  0.018  0.015  0.008  0.007  0.002  0.001
## [31]  0.000
```

```
fit.pc$loadings
```

```
## 
## Loadings:
##                  RC1    RC2    RC3    RC4
## id               0.133
## radius_mean      0.951  0.131 -0.139
## texture_mean     0.252                0.909
## perimeter_mean   0.950  0.175 -0.107
## area_mean        0.967  0.101
## smoothness_mean  0.159  0.649  0.255 -0.187
## compactness_mean 0.459  0.771  0.320
## concavity_mean   0.659  0.606  0.311  0.102
## points_mean      0.798  0.508  0.149
## symmetry_mean    0.137  0.585  0.332
## dimension_mean  -0.314  0.660  0.532
## radius_se        0.832         0.395
## texture_se             -0.209  0.597  0.538
## perimeter_se     0.823         0.418
## area_se          0.876         0.262
## smoothness_se   -0.138         0.705
## compactness_se   0.204  0.514  0.667  0.111
## concavity_se     0.218  0.408  0.635
## points_se        0.426  0.328  0.638
## symmetry_se                    0.667
## dimension_se            0.384  0.751
## radius_worst     0.941  0.207 -0.164  0.131
## texture_worst    0.196  0.193                0.935
## perimeter_worst  0.937  0.253 -0.131  0.134
## area_worst       0.944  0.165 -0.118  0.120
## smoothness_worst        0.754
## compactness_worst 0.312 0.861                0.186
## concavity_worst  0.450  0.773  0.100  0.187
## points_worst     0.678  0.668         0.106
## symmetry_worst          0.717
## dimension_worst         0.880  0.181  0.104
## 
##                   RC1    RC2    RC3    RC4
## SS loadings     10.151  7.037  4.361  2.252
## Proportion Var   0.327  0.227  0.141  0.073
## Cumulative Var   0.327  0.554  0.695  0.768
```

```r
# Loadings with more digits
for (i in c(1,3,2,4)) { print(fit.pc$loadings[[1,i]])}
```

```
## [1] 0.1330256
## [1] 0.0991346
## [1] -0.09752479
## [1] 0.06781887
```

```r
# Communalities
fit.pc$communality
```

```
##               id       radius_mean      texture_mean    perimeter_mean 
##       0.04163396        0.95069170        0.89684853        0.95431848 
##        area_mean   smoothness_mean  compactness_mean    concavity_mean 
##       0.96014950        0.54720158        0.90971908        0.90807129 
##      points_mean     symmetry_mean    dimension_mean         radius_se 
##       0.92076209        0.47390203        0.82580280        0.84993832 
##        texture_se       perimeter_se           area_se      smoothness_se 
##       0.69271471        0.85520824        0.83634402        0.51759585 
##    compactness_se      concavity_se         points_se       symmetry_se 
##       0.76240129        0.62241576        0.69650774        0.45095156 
##      dimension_se      radius_worst     texture_worst    perimeter_worst 
##       0.71272740        0.97219376        0.95565236        0.97796884 
##       area_worst  smoothness_worst compactness_worst   concavity_worst 
##       0.94731995        0.57201913        0.87681767        0.84471615 
##     points_worst    symmetry_worst   dimension_worst 
##       0.91825491        0.52608733        0.82467896 
```

```
# Rotated factor scores, Notice the columns ordering: RC1, RC3, RC2 and RC4
head(fit.pc$scores)
```

```
##            RC1          RC2          RC3          RC4
## [1,] -0.3200066 -0.20898001 -0.25160464 -1.75616620
## [2,] -0.5649931 -0.22081178  0.85830109 -0.28887483
## [3,] -0.8242652 -0.03734588 -0.52158508 -0.09098986
## [4,] -0.3869942 -0.38180634  0.79329588 -1.49911551
## [5,]  0.1145874 -0.61206123 -0.91421184 -1.46638605
## [6,] -0.6900800 -0.15424020  0.07996063  0.35700314
```

```
# Play with FA utilities

fa.parallel(cancer[-2]) # See factor recommendation
```

```
## Warning in fa.stats(r = r, f = f, phi = phi, n.obs = n.obs, np.obs
## = np.obs, : The estimated weights for the factor scores are probably
## incorrect. Try a different factor extraction method.
```
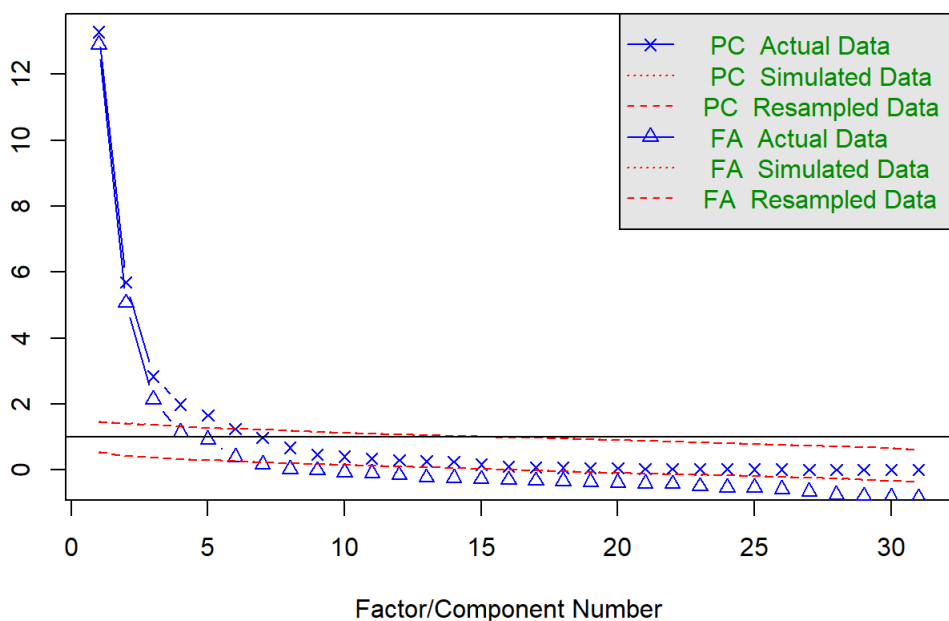


```
## Parallel analysis suggests that the number of factors =  6  and the number of components =  5
```

```
fa.plot(fit.pc) # See Correlations within Factors
```

Principal Component Analysis
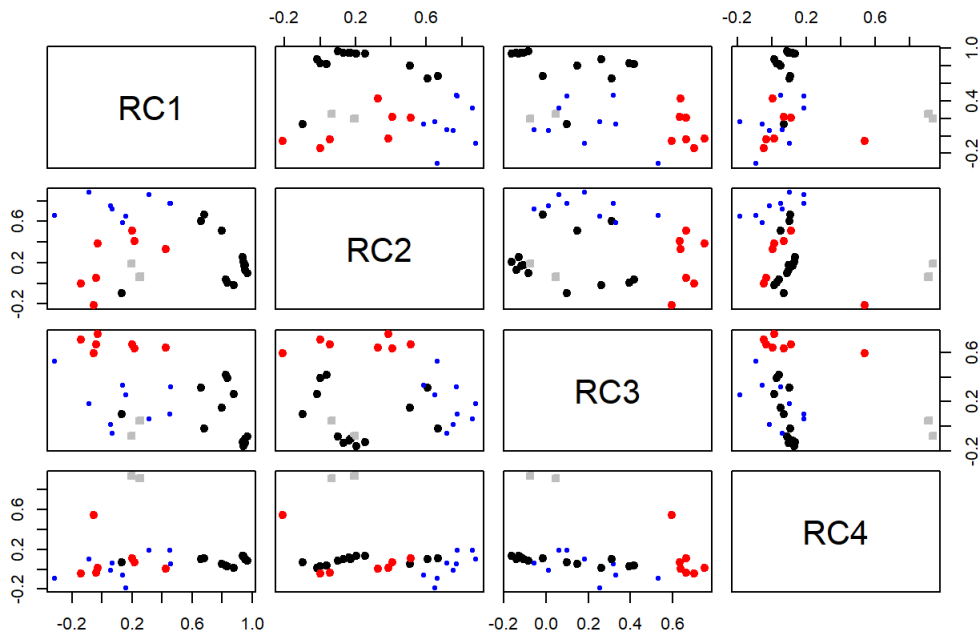

```
fa.diagram(fit.pc) # Visualize the relationship
```

Components Analysis
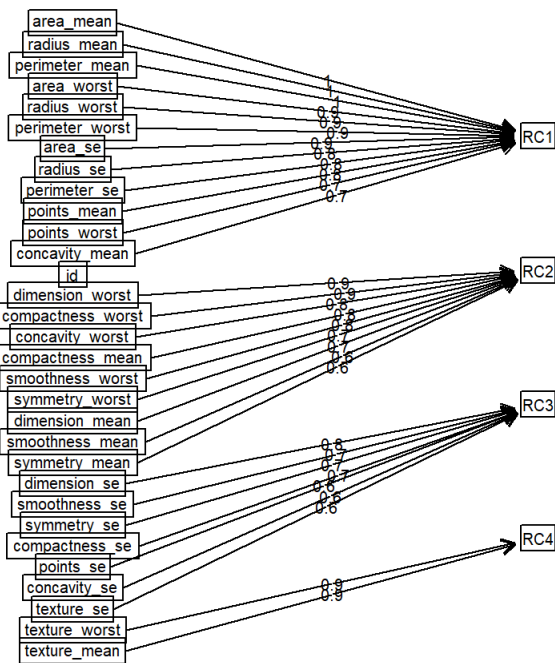

```
#Multiple Regression
# Performing multiple regression on mtcars dataset
fit <- lm(radius_mean~texture_mean+perimeter_mean+area_mean+smoothness_mean+compactness_mean+concavity_mean+
points_mean+symmetry_mean+dimension_mean, data=cancer)
#show the results
summary(fit)
```

```
##
## Call:
## lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean + points_mean +
##     symmetry_mean + dimension_mean, data = cancer)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.60730 -0.03619 -0.00712  0.02849  0.45917
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       9.941e-02  1.342e-01   0.741  0.45915
## texture_mean      2.343e-04  9.418e-04   0.249  0.80360
## perimeter_mean    1.569e-01  1.337e-03 117.301  < 2e-16 ***
## area_mean        -2.857e-04  7.834e-05  -3.647  0.00029 ***
## smoothness_mean   1.274e+00  4.514e-01   2.822  0.00495 **
## compactness_mean -4.827e+00  2.654e-01 -18.189  < 2e-16 ***
## concavity_mean   -7.596e-01  1.564e-01  -4.857 1.55e-06 ***
## points_mean      -2.975e-01  4.463e-01  -0.667  0.50529
## symmetry_mean     2.351e-01  1.806e-01   1.302  0.19362
## dimension_mean    3.252e+00  1.333e+00   2.440  0.01501 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08862 on 559 degrees of freedom
## Multiple R-squared:  0.9994, Adjusted R-squared:  0.9994
## F-statistic: 9.974e+04 on 9 and 559 DF,  p-value: < 2.2e-16
```

```
#Summary has three sections. Section1: How well does the model fit the data (before Coefficients). Section2:
Is the hypothesis supported? (until sifnif codes). Section3: How well does data fit the model (again).
# Useful Helper Functions
coefficients(fit)
```

```
##       (Intercept)      texture_mean    perimeter_mean          area_mean
##      0.0994138030      0.0002343378      0.1568643174     -0.0002857232
##   smoothness_mean  compactness_mean    concavity_mean        points_mean
##      1.2738109479     -4.8274442661     -0.7595883764     -0.2975420252
##     symmetry_mean    dimension_mean
##      0.2350661382      3.2515869536
```

```
library(GGally)
#install.packages("GGally", lib="/Library/Frameworks/R.framework/Versions/3.5/Resources/library")
library(GGally)
confint(fit,level=0.95)
```

```
##                         2.5 %        97.5 %
## (Intercept)      -0.164195263  0.3630228692
## texture_mean     -0.001615646  0.0020843216
## perimeter_mean    0.154237605  0.1594910294
## area_mean        -0.000439607 -0.0001318393
## smoothness_mean   0.387080716  2.1605411796
## compactness_mean -5.348753593 -4.3061349387
## concavity_mean   -1.066756343 -0.4524204101
## points_mean      -1.174254709  0.5791706582
## symmetry_mean    -0.119690675  0.5898229511
## dimension_mean    0.633618180  5.8695557271
```

```
# Predicted Values
fitted(fit)
```

```
##         1         2         3         4         5         6         7
## 12.330796 10.642003 11.097924 11.233164 15.170675 11.567838 11.453923
##         8         9        10        11        12        13        14
## 13.760271 10.531795 11.118149 20.733918 12.250051 13.162461 13.051487
##        15        16        17        18        19        20        21
## 19.513196 14.647787 15.705885 12.673868 20.212847 12.278214 11.721279
##        22        23        24        25        26        27        28
```

```
## 11.620070 11.011240 14.950736 10.529627 13.810144 13.451282 15.381638
##        29        30        31        32        33        34        35
##  9.563629 13.383655 13.058871 12.806841 17.729902 12.261681 14.548721
##        36        37        38        39        40        41        42
## 13.718672 18.897047 12.017636 16.806422 16.293030 20.267835 19.614021
##        43        44        45        46        47        48        49
## 11.137628 13.023973 13.920216 18.018794 11.188343 25.792861 13.504247
##        50        51        52        53        54        55        56
## 12.388114 13.787234 14.947070 11.813153 14.182581 23.627714 13.078543
##        57        58        59        60        61        62        63
## 11.784277 10.140061 24.374095 19.250052 19.044811 17.443693 17.444516
##        64        65        66        67        68        69        70
## 13.468937 15.187222 12.343554 13.262009 14.571310 13.839425 11.671497
##        71        72        73        74        75        76        77
## 13.487120 10.118895  8.806259 17.748382 16.769998 12.338536 18.246198
##        78        79        80        81        82        83        84
## 11.315963 12.794134 17.928671 14.940325 12.272111 13.316477 14.596785
##        85        86        87        88        89        90        91
## 11.285241 12.901529 12.359722 13.447163 20.956363 13.679625 12.860670
##        92        93        94        95        96        97        98
## 12.529420 15.575301 12.978901 13.837036 16.055512 13.070238 11.866384
##        99       100       101       102       103       104       105
## 10.204178 25.274779 10.612917  9.771597 11.292373 14.706011 13.201215
##       106       107       108       109       110       111       112
## 11.538973 12.571711 12.229696 10.831818 11.194120 11.622124  8.106041
##       113       114       115       116       117       118       119
## 18.554052 13.772018 11.784096 17.144074 14.434849 15.441815 19.695601
##       120       121       122       123       124       125       126
## 12.982999 13.839291 20.382521 11.668319 21.560908 11.492851 11.479781
##       127       128       129       130       131       132       133
## 13.067226 14.580673 18.975461 14.319441 15.013201 13.691013 13.239078
##       134       135       136       137       138       139       140
## 21.535518 11.072082 16.650069  8.757531 12.101903 17.105958 11.954320
##       141       142       143       144       145       146       147
## 18.639370 17.930570 20.034337 14.304244 14.576573 11.853722 15.777377
##       148       149       150       151       152       153       154
## 16.458655 12.426253 12.352359 12.518888  9.745966 12.942271 10.370930
##       155       156       157       158       159       160       161
## 14.435225  9.485643 13.571299 11.017004 10.601156 13.499586 13.260433
##       162       163       164       165       166       167       168
## 11.264164 13.872597  9.072477 23.042581 27.198008 14.357770 17.410391
##       169       170       171       172       173       174       175
## 13.204129 13.742966 13.146899 13.961528 13.650624 13.510821 13.386639
##       176       177       178       179       180       181       182
## 12.873179 19.095214 11.107772 18.587852 12.195465 12.222128 16.033680
##       183       184       185       186       187       188       189
## 13.782232 15.206463 11.320783 10.941291 17.101286 18.421949 20.093960
##       190       191       192       193       194       195       196
##  9.797758 16.090201 11.971754 14.898998 14.604071 15.610233 19.405955
##       197       198       199       200       201       202       203
## 15.067836 14.647200 13.454749 12.233419 14.953264 10.837405 14.993348
##       204       205       206       207       208       209       210
## 12.568171 11.766150 15.519792 11.595947 11.798423 13.503961 20.957234
##       211       212       213       214       215       216       217
## 12.913620 14.536059 17.110585 13.270607 10.880093 10.173402 12.735993
##       218       219       220       221       222       223       224
## 14.185480 12.413859 23.130126 12.729717 12.696396 19.480556 11.485750
##       225       226       227       228       229       230       231
## 10.733768  8.670037  9.427180 20.198664 17.536010 11.316807 11.619784
##       232       233       234       235       236       237       238
## 12.340120 14.333302 16.265109 12.822970 11.731134 14.941807  8.603776
##       239       240       241       242       243       244       245
## 10.675824 10.526020 13.949781  8.796888  9.428327 17.235765 19.550249
##       246       247       248       249       250       251       252
##  9.683485 10.087674 14.627653  8.218990 12.018023 15.046638 15.848232
##       253       254       255       256       257       258       259
## 11.264181 18.250523 13.947197  9.454737 14.576008 11.419258 12.781230
##       260       261       262       263       264       265       266
## 13.559422 12.082122 10.243628 15.490241 13.885013 17.013639 13.037594
##       267       268       269       270       271       272       273
## 10.237655  8.903503 12.302196 19.464311 12.814601 19.610526 14.047615
##       274       275       276       277       278       279       280
## 12.378348 19.312631 28.300059 14.861959 16.598054 10.871268  7.729156
```

```
##        281       282       283       284       285       286       287
## 17.878059 11.312171 12.053927 13.623029 17.172147 14.637487 14.146359
##        288       289       290       291       292       293       294
## 19.836114 20.855280 12.614561  9.425671 13.717608 13.836310 12.220737
##        295       296       297       298       299       300       301
## 21.975570 24.700739 20.695773 19.838411 12.106094 16.378705 19.213069
##        302       303       304       305       306       307       308
## 14.260896 10.905228 13.435188 15.674339 20.482838 15.308358 12.915666
##        309       310       311       312       313       314       315
## 14.967491 13.575471 20.426746 17.293851 13.644130 11.911396 13.258970
##        316       317       318       319       320       321       322
## 13.493917 20.463621 23.081491 11.154481 14.713486 12.510447 16.712445
##        323       324       325       326       327       328       329
## 20.090099 11.939316 12.447205 18.528669 14.005747 15.860510 13.059781
##        330       331       332       333       334       335       336
## 23.456415  9.799514 12.892559 10.848668 12.245084 14.726324 15.255470
##        337       338       339       340       341       342       343
## 12.590043  8.768101 18.655429 15.656495 16.122398 18.560830 16.356188
##        344       345       346       347       348       349       350
## 11.243513 16.187029  9.779642  8.886397 11.456620 15.021587 12.051075
##        351       352       353       354       355       356       357
## 14.010561 17.578485 12.891255 11.357411 14.767135  9.457941  9.909236
##        358       359       360       361       362       363       364
## 11.814859 18.283519  9.352239 20.335461 15.897062 12.285710 10.322908
##        365       366       367       368       369       370       371
## 12.202361 11.488471 17.657614  9.793510 11.600403 19.266664 12.541987
##        372       373       374       375       376       377       378
##  9.219852 12.311869 12.203883 12.658638 12.454957 14.714298 12.330108
##        379       380       381       382       383       384       385
## 11.416341 11.529731 13.854454 10.525373 14.469700 16.170221 11.335644
##        386       387       388       389       390       391       392
## 10.282036 22.000278 10.536570 13.610527 16.257226 17.797695 11.208554
##        393       394       395       396       397       398       399
## 13.631540 19.077559 13.692732 13.848824 11.580808 15.362675 19.678855
##        400       401       402       403       404       405       406
##  9.885539  9.848037 13.341115 19.225149 20.540699 13.252570 20.415222
##        407       408       409       410       411       412       413
## 16.178124 11.491300 14.849233  9.605722 12.873510 11.366488 10.758543
##        414       415       416       417       418       419       420
## 11.732596 11.739111 19.339206 11.435819 14.443274 20.123881 11.843433
##        421       422       423       424       425       426       427
##  9.413430 15.104045 11.208913  9.079563 11.419607 12.620161 11.918528
##        428       429       430       431       432       433       434
## 14.756366 10.175104 15.235975 13.637797 18.376042 12.030947 18.439389
##        435       436       437       438       439       440       441
## 10.993764 14.107290 18.704320 12.934587  8.687036 11.703050 12.985477
##        442       443       444       445       446       447       448
## 13.608030 15.111169 13.420938 17.235043  9.544859 13.774576 12.048991
##        449       450       451       452       453       454       455
## 11.862941 17.024098 10.463613 12.352649 19.548341 11.776449 11.921888
##        456       457       458       459       460       461       462
## 14.452065 13.591839 20.653110  8.743534 13.005946 27.792221 18.748633
##        463       464       465       466       467       468       469
## 11.059101 13.798022 17.192588 12.454970 13.220041 17.898250 10.258778
##        470       471       472       473       474       475       476
## 14.031429 12.830340 14.922566 13.042222 19.497573 12.058126 18.132271
##        477       478       479       480       481       482       483
## 12.075817 20.994703 14.943392 13.920304 14.485221 14.477683 18.635346
##        484       485       486       487       488       489       490
##  9.842350 11.680963 15.749211  9.712819 22.385237 13.189419 10.776610
##        491       492       493       494       495       496       497
## 18.029867 20.506722 15.468774 10.954275  8.577949 12.786878  9.905631
##        498       499       500       501       502       503       504
## 13.133849 19.918001 15.612849 16.593408 15.955677 16.134650 10.461069
##        505       506       507       508       509       510       511
## 11.589802 11.254999 14.243101 14.802300 21.201838 15.531859 13.134412
##        512       513       514       515       516       517       518
## 17.821994 11.811511 13.628630 16.454032 12.741866 20.440264 19.576431
##        519       520       521       522       523       524       525
## 18.196992 13.215368 10.445775 12.482701 15.126776  7.655483  7.013920
##        526       527       528       529       530       531       532
## 12.899589 12.645259 17.661343 11.397083  9.678853 12.010972  7.396690
##        533       534       535       536       537       538       539
```

```
##      533       534       535       536       537       538       539
## 12.743932 16.470690 19.605065 12.855586 11.555852 11.731998 13.869940
##      540       541       542       543       544       545       546
## 11.607248 16.961566  9.287247 12.617860 20.342736 20.787300 12.936930
##      547       548       549       550       551       552       553
##  8.954094 12.760473 14.041482 12.086192 12.797706 11.166680 12.253060
##      554       555       556       557       558       559       560
## 11.756259 13.197059 21.500697 11.522043 14.728413 11.088746 14.836915
##      561       562       563       564       565       566       567
## 14.332544 12.221265 14.414045 12.875661 13.145596 10.312021 15.221633
##      568       569
## 14.501868 21.331349
```

residuals(fit)

```
##             1             2             3             4             5
## -1.079606e-02 -4.200311e-02 -5.792375e-02  4.683605e-02  1.932482e-02
##             6             7             8             9            10
##  2.161625e-03  5.607716e-02  4.972870e-02 -4.179543e-02 -5.814872e-02
##            11            12            13            14            15
## -1.439177e-01 -5.133050e-05 -2.246144e-02 -1.487019e-03  7.680398e-02
##            16            17            18            19            20
## -5.778723e-02  4.115070e-03 -3.868189e-03 -1.228472e-01 -8.821355e-02
##            21            22            23            24            25
## -1.127893e-02  6.992970e-02 -7.124048e-02  1.492644e-01 -1.962743e-02
##            26            27            28            29            30
## -1.014367e-02 -1.281546e-03 -8.163794e-02  4.237058e-02  1.634517e-02
##            31            32            33            34            35
## -8.871392e-03 -3.684127e-02 -1.299025e-01  8.318675e-03  3.127941e-02
##            36            37            38            39            40
## -5.867242e-02  4.295286e-02 -1.176356e-01 -2.642217e-02 -5.303030e-02
##            41            42            43            44            45
##  4.216514e-02 -2.402078e-02  2.823725e-01 -3.397294e-02 -2.021642e-02
##            46            47            48            49            50
##  6.120616e-02 -5.834294e-02 -6.286112e-02  5.753063e-03  7.188634e-02
##            51            52            53            54            55
##  7.276644e-02  5.292969e-02 -1.315299e-02  3.741858e-02 -3.377137e-01
##            56            57            58            59            60
##  2.614575e-01 -4.427740e-02 -6.006137e-02 -1.240946e-01  1.499480e-01
##            61            62            63            64            65
##  2.518922e-02  2.630713e-02 -2.451567e-02 -2.893653e-02  1.527778e-01
##            66            67            68            69            70
## -3.554227e-03  7.990556e-03  3.868999e-02  1.057459e-02 -1.496605e-03
##            71            72            73            74            75
## -7.120115e-03 -6.889471e-02  2.357409e-01  1.016182e-01  7.000246e-02
##            76            77            78            79            80
##  2.146416e-02  6.380211e-02 -5.962550e-03 -3.413384e-02  6.132944e-02
##            81            82            83            84            85
##  2.967509e-02  2.788904e-02 -1.647675e-02  4.321476e-02 -1.524079e-02
##            86            87            88            89            90
## -1.152935e-02 -1.972162e-02 -6.716320e-02  2.036366e-01  3.037466e-02
##            91            92            93            94            95
## -5.066959e-02 -5.942041e-02  3.469855e-02  2.109905e-02  3.829642e-01
##            96            97            98            99           100
## -2.551160e-02 -1.102376e-01 -1.638392e-02 -2.417801e-02 -5.477889e-02
##           101           102           103           104           105
##  9.708275e-02 -5.159741e-02 -2.373101e-03 -2.601107e-02 -1.215227e-03
##           106           107           108           109           110
## -4.897288e-02 -1.171143e-02 -9.695522e-03 -1.181830e-02 -3.412014e-02
##           111           112           113           114           115
##  1.787607e-02  1.129588e-01  1.059482e-01 -4.201758e-02 -2.409639e-02
##           116           117           118           119           120
##  1.259260e-01  1.515090e-02  4.818501e-02  1.043990e-01  6.700065e-02
##           121           122           123           124           125
##  1.070888e-02  1.974789e-01 -6.831950e-02  1.490917e-01 -2.285115e-02
##           126           127           128           129           130
## -1.978111e-02  4.277380e-02  1.932737e-02  2.453944e-02 -4.944102e-02
##           131           132           133           134           135
## -1.132012e-01 -3.101283e-02 -2.907765e-02  2.448166e-02 -1.208182e-02
##           136           137           138           139           140
## -6.859498e-05 -2.353061e-02 -4.190312e-02 -4.595764e-02 -1.432018e-02
##           141           142           143           144           145
```

```
## -2.937039e-02  5.942977e-02  9.566280e-02 -5.424407e-02  3.426631e-03
##           146           147           148           149           150
## -4.372191e-02  2.623497e-03  4.134473e-02  3.747225e-03  7.641064e-03
##           151           152           153           154           155
## -2.888757e-02 -3.966288e-03 -4.227076e-02 -5.092995e-02 -2.522469e-02
##           156           157           158           159           160
## -4.964343e-02  1.870083e-02 -6.700374e-02 -3.115560e-02 -9.586291e-03
##           161           162           163           164           165
##  9.566616e-03 -4.163846e-03 -2.596598e-03 -7.247653e-02  4.741866e-02
##           166           167           168           169           170
##  2.199177e-02 -1.777000e-02 -1.203907e-01 -5.412858e-02 -2.965816e-03
##           171           172           173           174           175
##  2.310112e-02  1.847179e-02  5.937605e-02  7.917926e-02  4.336141e-02
##           176           177           178           179           180
## -1.317891e-02  1.147859e-01 -4.777210e-02  6.214831e-02 -1.546518e-02
##           181           182           183           184           185
##  7.871836e-03  3.631984e-02 -1.223225e-02 -8.646260e-02 -1.007831e-01
##           186           187           188           189           190
## -3.129127e-02 -5.128594e-02  2.805115e-02  6.604002e-02 -5.575845e-02
##           191           192           193           194           195
##  1.979909e-02 -4.175359e-02  2.100166e-02 -6.407120e-02  8.976728e-02
##           196           197           198           199           200
## -3.059553e-01  1.216435e-02 -2.720029e-02  5.251145e-03 -2.341866e-02
##           201           202           203           204           205
##  3.673634e-02 -3.740483e-02 -3.348004e-03  6.182943e-02 -5.615047e-02
##           206           207           208           209           210
## -5.979209e-02  4.053110e-03 -3.842260e-02 -3.960517e-03  1.327664e-01
##           211           212           213           214           215
## -2.361989e-02  1.739407e-01  8.941483e-02  9.392566e-03 -9.315888e-05
##           216           217           218           219           220
## -3.402132e-03  1.400660e-02  1.451961e-02  3.614101e-02  1.398744e-01
##           221           222           223           224           225
## -9.716832e-03  3.604295e-03  4.944397e-02 -3.574996e-02 -7.376787e-02
##           226           227           228           229           230
## -7.303717e-02  2.488195e-01 -1.866404e-02  3.990165e-03 -6.680708e-02
##           231           232           233           234           235
##  1.021596e-02 -1.198651e-04 -7.330231e-02  4.891387e-03 -5.296990e-02
##           236           237           238           239           240
## -5.113353e-02 -8.180657e-02 -3.277645e-02 -2.582378e-02 -4.602031e-02
##           241           242           243           244           245
##  1.021852e-02 -7.088807e-02 -3.132733e-02  1.142350e-01  1.797505e-01
##           246           247           248           249           250
## -4.846615e-04 -5.767388e-02 -1.576532e-01 -2.299021e-02 -1.802314e-02
##           251           252           253           254           255
## -6.638165e-03 -1.882317e-01  5.818555e-03 -3.405226e-01 -7.197468e-03
##           256           257           258           259           260
## -4.973697e-02 -4.600828e-02 -5.925813e-02 -1.229940e-03 -1.942212e-02
##           261           262           263           264           265
##  1.787778e-02  4.637202e-02 -3.024081e-02  1.498666e-02  6.360761e-03
##           266           267           268           269           270
## -3.759355e-02 -3.765460e-02 -1.550299e-02 -5.219602e-02 -6.431051e-02
##           271           272           273           274           275
## -1.460145e-02 -4.405262e-01  1.238478e-02 -6.834785e-02 -1.326310e-01
##           276           277           278           279           280
## -1.900592e-01  8.040964e-03  1.946335e-03 -1.126827e-02 -1.556815e-04
##           281           282           283           284           285
##  1.719414e-01 -5.217071e-02  6.072774e-03  1.697060e-02  1.785257e-02
##           286           287           288           289           290
##  2.513018e-03  4.364147e-02  5.388599e-02  8.472036e-02  3.543940e-02
##           291           292           293           294           295
## -2.671485e-03 -2.760815e-02 -6.631022e-02 -1.073743e-02  3.442968e-02
##           296           297           298           299           300
## -7.073924e-02 -1.457733e-01 -2.841123e-02 -3.609399e-02 -1.287048e-01
##           301           302           303           304           305
## -2.306861e-02 -8.955680e-04 -5.227889e-03 -3.518845e-02  7.566072e-02
##           306           307           308           309           310
##  2.716173e-02 -8.835779e-02  2.433422e-02 -1.749090e-02 -1.547101e-02
##           311           312           313           314           315
##  4.325356e-02  6.149379e-03  5.587036e-02 -2.139555e-02  2.102979e-02
##           316           317           318           319           320
## -3.391701e-02 -1.736214e-01  1.285094e-01 -2.448106e-02  4.651351e-02
##           321           322           323           324           325
## -6.044749e-02  2.755539e-02  1.699015e-01 -9.315603e-03 -2.720453e-02
```

```
## -6.044749e-02  2.755559e-02  1.699015e-01 -9.515005e-03 -2.720455e-02
##           326           327           328           329           330
## -6.866920e-02  2.425310e-02 -8.051032e-02 -5.978090e-02  5.358490e-02
##           331           332           333           334           335
## -6.151425e-02 -2.255919e-02 -4.866771e-02 -6.508382e-02  2.236759e-01
##           336           337           338           339           340
##  1.452973e-02 -5.004310e-02  2.608987e-01  1.145707e-01  7.350459e-02
##           341           342           343           344           345
##  1.760219e-02  4.591696e-01 -9.618796e-02  5.648696e-02 -2.702881e-02
##           346           347           348           349           350
## -2.642200e-03 -8.396964e-03 -2.661981e-02  2.841269e-02 -6.107483e-02
##           351           352           353           354           355
##  9.439012e-03 -8.484985e-03 -1.125496e-02 -1.741142e-02  1.286468e-02
##           356           357           358           359           360
##  7.059287e-03 -3.323593e-02  2.514054e-02 -3.351873e-02 -1.923942e-02
##           361           362           363           364           365
##  1.445389e-01 -4.706172e-02 -1.571029e-02 -6.290815e-02 -2.236133e-02
##           366           367           368           369           370
##  5.152945e-02  2.238630e-02 -3.850991e-02 -6.040271e-02  1.833358e-01
##           371           372           373           374           375
## -1.987133e-03 -4.685186e-02 -1.186945e-02 -4.388304e-02 -3.863830e-02
##           376           377           378           379           380
##  5.042582e-03  2.570233e-02  5.989242e-02 -8.634124e-02 -9.731326e-03
##           381           382           383           384           385
## -4.454473e-03 -1.537314e-02  1.029971e-02 -4.022116e-02  4.356472e-03
##           386           387           388           389           390
## -2.203613e-02 -2.502784e-01 -4.656967e-02 -5.268848e-04  4.277441e-02
##           391           392           393           394           395
## -4.769503e-02 -8.553516e-03  8.459754e-03  8.244093e-02 -1.273241e-02
##           396           397           398           399           400
##  3.117565e-02  2.919244e-02  7.325053e-03  1.145127e-03 -9.853866e-02
##           401           402           403           404           405
## -1.037298e-03  2.888483e-02  4.485063e-02  9.930123e-02 -1.256961e-02
##           406           407           408           409           410
##  2.477825e-02 -8.123776e-03 -8.129965e-02  2.076723e-02 -3.872163e-02
##           411           412           413           414           415
##  1.649033e-02 -4.648767e-02 -8.542979e-03 -2.259618e-02  8.885284e-04
##           416           417           418           419           420
##  1.007943e-01 -5.818508e-03 -2.327392e-02  7.611860e-02 -4.343314e-02
##           421           422           423           424           425
##  3.175696e-01 -4.044625e-03 -5.891309e-02  1.884371e-01 -9.607385e-03
##           426           427           428           429           430
##  5.983886e-02  3.147196e-02  1.036338e-01 -1.510448e-02  8.402501e-02
##           431           432           433           434           435
## -2.779678e-02 -6.604220e-02 -3.094684e-02  5.061098e-02 -2.376371e-02
##           436           437           438           439           440
##  2.710404e-03  1.056796e-01 -2.458749e-02 -6.903553e-02  4.694983e-02
##           441           442           443           444           445
## -5.477018e-03  1.196985e-02 -5.116851e-02  4.906165e-02  2.249574e-01
##           446           447           448           449           450
## -4.085905e-02 -2.457613e-02 -1.899092e-02  2.705912e-02  5.590196e-02
##           451           452           453           454           455
## -2.361332e-02 -1.264882e-02  1.658541e-03  9.355148e-02 -3.188806e-02
##           456           457           458           459           460
## -1.206458e-02 -6.183933e-02  7.688957e-02 -7.253426e-02  4.053957e-03
##           461           462           463           464           465
## -3.722210e-01  7.136728e-02 -1.910110e-02 -1.802200e-02 -5.258827e-02
##           466           467           468           469           470
## -5.496980e-02 -2.004138e-02  1.317498e-01 -8.778209e-03  8.570516e-03
##           471           472           473           474           475
## -6.033997e-02  4.743412e-02 -1.222161e-02  3.242683e-02 -1.812595e-02
##           476           477           478           479           480
##  8.772909e-02 -2.581687e-02  1.052968e-01  1.660822e-02 -1.003041e-01
##           481           482           483           484           485
##  1.477868e-02 -5.768260e-02 -5.345813e-03  6.164972e-02 -2.096274e-02
##           486           487           488           489           490
##  7.889426e-04 -4.581931e-02 -1.152372e-01 -2.941946e-02  3.033900e-01
##           491           492           493           494           495
## -1.986655e-02  9.327817e-02 -8.773645e-03  5.724524e-03  2.005149e-02
##           496           497           498           499           500
##  9.312175e-02 -2.963064e-02  3.615081e-02 -3.680014e-01 -8.284909e-02
##           501           502           503           504           505
##  9.659204e-02  6.432318e-02 -4.650230e-03  1.089306e-01  3.019837e-02
```

```
##           506           507           508           509           510
## -3.499864e-02  4.689943e-02  7.699973e-03 -2.818383e-01 -3.185930e-02
##           511           512           513           514           515
## -5.441151e-02  1.080064e-01  2.848887e-02  2.136999e-02 -1.040324e-01
##           516           517           518           519           520
##  8.813414e-02  1.297359e-01  1.135693e-01  2.300823e-02 -1.053682e-01
##           521           522           523           524           525
##  3.422503e-02 -1.270140e-02  3.223719e-03  1.045174e-01 -3.291988e-02
##           526           527           528           529           530
## -2.958851e-02 -2.525879e-02  2.886568e-01 -2.708331e-02 -1.085279e-02
##           531           532           533           534           535
## -7.097168e-02  2.943095e-01 -2.393185e-02 -1.068988e-02  1.849355e-01
##           536           537           538           539           540
## -2.558607e-02 -3.585247e-02 -3.199847e-02  6.028140e-05 -7.248124e-03
##           541           542           543           544           545
##  4.843429e-02  7.753113e-03 -3.785965e-02 -2.735767e-03 -6.073000e-01
##           546           547           548           549           550
##  1.307035e-02 -4.093689e-03 -4.726536e-04  8.518260e-03 -3.619224e-02
##           551           552           553           554           555
##  5.229423e-02 -2.668049e-02  2.069400e-01 -6.259463e-03  1.294144e-02
##           556           557           558           559           560
##  1.093033e-01 -2.204257e-02 -3.841315e-02 -8.745985e-03 -3.691462e-02
##           561           562           563           564           565
## -8.254353e-02 -2.126524e-02 -1.404471e-02 -1.566133e-02  2.440390e-02
##           566           567           568           569
## -5.202071e-02  5.836736e-02  2.813217e-02  3.865109e-02
```

```r
#Anova Table
anova(fit)
```

```
## Analysis of Variance Table
##
## Response: radius_mean
##                   Df Sum Sq Mean Sq    F value      Pr(>F)
## texture_mean       1  739.5   739.5 9.4163e+04 < 2.2e-16 ***
## perimeter_mean     1 6284.4  6284.4 8.0022e+05 < 2.2e-16 ***
## area_mean          1    2.3     2.3 2.9053e+02 < 2.2e-16 ***
## smoothness_mean    1    8.7     8.7 1.1111e+03 < 2.2e-16 ***
## compactness_mean   1   14.3    14.3 1.8156e+03 < 2.2e-16 ***
## concavity_mean     1    0.3     0.3 3.8966e+01 8.533e-10 ***
## points_mean        1    0.0     0.0 4.8960e-01   0.48439
## symmetry_mean      1    0.0     0.0 1.4625e+00   0.22705
## dimension_mean     1    0.0     0.0 5.9517e+00   0.01501 *
## Residuals        559    4.4     0.0
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
vcov(fit)
```

```
##                    (Intercept) texture_mean perimeter_mean      area_mean
## (Intercept)       1.801117e-02 -2.735301e-05 -1.482383e-04  6.543103e-06
## texture_mean     -2.735301e-05  8.870681e-07  3.066431e-08 -2.449902e-09
## perimeter_mean   -1.482383e-04  3.066431e-08  1.788323e-06 -9.700624e-08
## area_mean         6.543103e-06 -2.449902e-09 -9.700624e-08  6.137724e-09
## smoothness_mean  -1.218603e-02  5.815920e-05  5.471711e-05  7.236282e-08
## compactness_mean  2.387746e-02 -2.461439e-05 -2.061845e-04  1.116341e-05
## concavity_mean   -1.856614e-03 -1.057213e-05  3.610551e-05 -1.777372e-06
## points_mean       1.579690e-02  6.004680e-06 -1.127068e-04 -2.007999e-06
## symmetry_mean    -5.880657e-03  2.835559e-07  2.243630e-05 -4.588038e-07
## dimension_mean   -1.430168e-01  1.048410e-04  9.743756e-04 -3.863843e-05
##                  smoothness_mean compactness_mean concavity_mean
## (Intercept)        -1.218603e-02     2.387746e-02  -1.856614e-03
## texture_mean        5.815920e-05    -2.461439e-05  -1.057213e-05
## perimeter_mean      5.471711e-05    -2.061845e-04   3.610551e-05
## area_mean           7.236282e-08     1.116341e-05  -1.777372e-06
## smoothness_mean     2.038000e-01    -8.721047e-03   2.406632e-02
## compactness_mean   -8.721047e-03     7.043883e-02  -1.374708e-02
## concavity_mean      2.406632e-02    -1.374708e-02   2.445530e-02
## points_mean        -1.005999e-01    -1.464166e-02  -4.067089e-02
## symmetry_mean      -1.156537e-02    -8.564231e-03   1.465089e-04
## dimension_mean     -1.252338e-01    -2.352265e-01  -1.893838e-02
##                    points_mean symmetry_mean dimension_mean
## (Intercept)       1.579690e-02 -5.880657e-03  -1.430168e-01
## texture_mean      6.004680e-06  2.835559e-07   1.048410e-04
## perimeter_mean   -1.127068e-04  2.243630e-05   9.743756e-04
## area_mean        -2.007999e-06 -4.588038e-07  -3.863843e-05
## smoothness_mean  -1.005999e-01 -1.156537e-02  -1.252338e-01
## compactness_mean -1.464166e-02 -8.564231e-03  -2.352265e-01
## concavity_mean   -4.067089e-02  1.465089e-04  -1.893838e-02
## points_mean       1.992213e-01 -7.745712e-03   3.596348e-02
## symmetry_mean    -7.745712e-03  3.261990e-02   9.183036e-03
## dimension_mean    3.596348e-02  9.183036e-03   1.776438e+00
```

cov2cor(vcov(fit))

```
##                  (Intercept) texture_mean perimeter_mean      area_mean
## (Intercept)       1.0000000 -0.216399269    -0.82597418  0.622313415
## texture_mean     -0.2163993  1.000000000     0.02434623 -0.033202170
## perimeter_mean   -0.8259742  0.024346231     1.00000000 -0.925918929
## area_mean         0.6223134 -0.033202170    -0.92591893  1.000000000
## smoothness_mean  -0.2011357  0.136784804     0.09063543  0.002046019
## compactness_mean  0.6703648 -0.098470123    -0.58093404  0.536892121
## concavity_mean   -0.0884635 -0.071778993     0.17264895 -0.145073494
## points_mean       0.2637140  0.014283792    -0.18882491 -0.057423804
## symmetry_mean    -0.2426128  0.001666936     0.09289385 -0.032425148
## dimension_mean   -0.7995415  0.083517544     0.54667390 -0.370033249
##                  smoothness_mean compactness_mean concavity_mean
## (Intercept)        -0.201135654       0.67036483    -0.088463502
## texture_mean        0.136784804      -0.09847012    -0.071778993
## perimeter_mean      0.090635429      -0.58093404     0.172648952
## area_mean           0.002046019       0.53689212    -0.145073494
## smoothness_mean     1.000000000      -0.07278812     0.340895381
## compactness_mean   -0.072788116       1.00000000    -0.331221097
## concavity_mean      0.340895381      -0.33122110     1.000000000
## points_mean        -0.499260760      -0.12359937    -0.582678921
## symmetry_mean      -0.141845740      -0.17866561     0.005187239
## dimension_mean     -0.208134732      -0.66497482    -0.090861789
##                   points_mean symmetry_mean dimension_mean
## (Intercept)        0.26371395  -0.242612755    -0.79954153
## texture_mean       0.01428379   0.001666936     0.08351754
## perimeter_mean    -0.18882491   0.092893849     0.54667390
## area_mean         -0.05742380  -0.032425148    -0.37003325
## smoothness_mean   -0.49926076  -0.141845740    -0.20813473
## compactness_mean  -0.12359937  -0.178665612    -0.66497482
## concavity_mean    -0.58267892   0.005187239    -0.09086179
## points_mean        1.00000000  -0.096084237     0.06045313
## symmetry_mean     -0.09608424   1.000000000     0.03814784
## dimension_mean     0.06045313   0.038147837     1.00000000
```

```
temp <- influence.measures(fit)
temp
```

```
## Influence measures of
##   lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +     smoothness_mean + compactn
ess_mean + concavity_mean + points_mean +     symmetry_mean + dimension_mean, data = cancer) :
##
##         dfb.1_   dfb.txt_   dfb.prm_   dfb.ar_m  dfb.smt_   dfb.cmp_   dfb.cnc_
## 1    -2.86e-03   6.97e-03   9.87e-04   6.54e-04 -2.27e-03   1.35e-03   7.12e-04
## 2    -3.76e-02   6.49e-04   3.57e-02  -2.95e-02 -3.93e-05  -4.18e-02   4.51e-03
## 3    -1.61e-02   2.35e-03   1.87e-02  -1.51e-02 -3.76e-02  -1.12e-02   2.73e-03
## 4     7.28e-02  -2.62e-02  -5.66e-02   3.64e-02  2.72e-02   6.14e-02  -2.95e-02
## 5    -1.25e-03  -1.53e-02   7.30e-03  -4.70e-03 -6.56e-03   1.73e-03  -7.66e-04
## 6    -1.23e-04   3.46e-06   8.75e-06   1.44e-04 -3.44e-04  -6.97e-05   8.73e-04
## 7     2.65e-02   3.12e-02  -1.55e-02  -3.41e-04  1.51e-04   1.08e-03   2.39e-02
## 8    -2.25e-02   3.53e-02   8.04e-03  -1.45e-02  3.28e-02  -1.17e-02  -1.67e-02
## 9    -3.31e-03  -7.53e-03   1.64e-02  -2.08e-02 -1.30e-02  -1.42e-02  -1.72e-03
## 10    7.26e-03   1.67e-02  -8.95e-04   2.27e-03 -1.91e-03   1.54e-02   8.75e-03
## 11    5.22e-02   6.32e-03  -3.99e-02   8.14e-03 -5.85e-02   3.89e-02  -6.40e-02
## 12    1.47e-05   3.23e-06  -1.22e-05   1.08e-05  1.84e-05   2.05e-05   9.45e-07
## 13   -1.25e-02  -4.61e-04   3.26e-03  -2.95e-04 -1.46e-03  -1.14e-02  -1.43e-02
## 14    3.75e-04  -1.24e-04  -3.97e-04   1.75e-04 -8.29e-05   2.50e-04  -2.88e-04
## 15   -2.03e-02   4.11e-02   1.99e-02  -1.55e-02  5.96e-02  -5.35e-02   5.50e-02
## 16   -1.66e-02  -1.10e-02  -5.42e-03   3.70e-03  1.64e-03  -4.93e-02  -1.35e-02
## 17    5.98e-04  -2.75e-03   8.31e-04  -1.27e-03 -9.37e-04  -4.01e-05  -1.43e-03
## 18    4.47e-05   2.70e-04  -3.00e-04   4.21e-06 -3.04e-03  -7.19e-04  -8.23e-04
## 19    2.17e-01  -5.03e-02  -1.48e-01   1.09e-01  8.22e-02   1.89e-01   4.12e-02
## 20    6.68e-03   4.44e-02  -5.54e-03  -1.58e-03 -3.39e-02  -1.95e-02   2.65e-02
## 21   -3.54e-03   6.86e-04   1.87e-03   5.26e-04 -1.88e-03   2.25e-03   9.16e-04
## 22   -2.26e-02   6.49e-02  -1.45e-02   2.11e-02  4.21e-02   4.82e-02  -7.91e-02
## 23   -5.72e-03  -9.95e-03   8.89e-03  -1.10e-03 -1.67e-02   1.81e-02  -4.11e-04
## 24    1.22e-01  -6.28e-02  -5.93e-02   1.11e-02 -5.79e-03   1.81e-01  -1.54e-01
## 25    1.29e-02  -7.75e-03  -1.91e-03  -2.51e-03 -5.63e-03   1.27e-03   6.27e-03
## 26   -1.10e-03   3.99e-03  -1.19e-03   1.66e-03  6.94e-04  -4.02e-03   4.23e-03
## 27   -3.01e-04   1.93e-05   3.52e-05  -3.28e-05 -1.05e-03  -5.22e-04  -2.22e-04
## 28   -1.96e-02  -4.67e-02   1.55e-03   1.94e-02 -7.92e-03  -2.77e-02   7.45e-03
## 29    9.68e-03  -1.03e-02  -1.90e-02   1.67e-02 -3.51e-02  -7.26e-03   9.57e-03
## 30   -7.50e-04  -4.34e-03   3.97e-03  -2.81e-03 -3.75e-03  -1.31e-04   9.97e-04
## 31   -8.70e-04   4.92e-03  -1.44e-03   8.59e-04 -1.28e-03   4.59e-04  -1.93e-03
## 32    1.40e-02  -1.89e-02  -1.36e-02   1.42e-02 -5.92e-03   2.26e-02  -8.18e-03
## 33    6.96e-02  -2.13e-02  -7.59e-02   6.56e-02  1.20e-01   1.10e-02   3.17e-02
## 34    5.15e-03  -1.14e-03  -3.42e-03   1.71e-03 -2.06e-03   2.55e-03  -1.20e-03
## 35    1.04e-02  -2.17e-02   2.44e-03  -4.28e-03  1.43e-02   5.39e-03   1.47e-02
## 36    3.96e-03   2.99e-02  -1.66e-02   1.25e-02  1.94e-02  -8.46e-04  -1.64e-03
## 37    7.14e-03   2.25e-03  -3.11e-03   4.05e-03 -8.63e-03   2.00e-03  -1.68e-02
## 38    1.64e-01   2.38e-02  -9.62e-02   4.05e-02 -3.66e-02   4.26e-02   7.32e-02
## 39   -1.53e-03   4.46e-03  -3.91e-03   6.11e-03  1.12e-02   3.73e-03   9.72e-03
## 40   -2.38e-03   1.47e-02  -1.86e-02   2.55e-02 -1.69e-03  -1.03e-02  -1.63e-02
## 41   -1.89e-02   3.21e-02   6.85e-03   1.27e-03  1.66e-02  -2.33e-02   5.84e-03
## 42   -8.62e-03   1.07e-02   3.64e-03   3.15e-04 -4.26e-03   6.79e-03  -1.39e-02
## 43   -2.06e-01   7.39e-02   1.60e-02  -3.68e-03 -1.20e-02   6.34e-02  -1.49e-01
## 44    4.34e-02   1.41e-02  -3.49e-02   2.00e-02  4.84e-03   1.90e-02   7.50e-03
## 45    1.67e-03   8.28e-03  -6.45e-03   4.64e-03  1.56e-02   1.08e-03  -6.85e-05
## 46   -5.52e-03   8.46e-04   1.61e-02  -1.01e-02 -3.57e-02  -1.28e-02   1.41e-02
## 47   -1.99e-03   9.23e-03  -7.02e-04   5.48e-03  2.58e-02   2.72e-02   4.57e-03
## 48   -1.01e-01   5.91e-02   1.21e-01  -1.25e-01  2.28e-02  -6.77e-02   2.63e-02
## 49    2.58e-03  -6.72e-05  -9.84e-04  -2.65e-04  2.13e-03   2.28e-03  -5.22e-04
## 50    2.73e-02   8.56e-04  -1.33e-02   5.06e-03 -3.29e-02   2.96e-02  -6.37e-03
## 51   -1.42e-02  -2.11e-02   1.75e-02  -1.50e-02 -1.96e-02   2.49e-02  -3.18e-02
## 52    7.06e-03  -3.13e-02   9.97e-03  -6.74e-03 -2.43e-02   2.78e-02  -1.08e-02
## 53   -1.26e-03   1.57e-03   1.15e-03  -1.27e-03 -1.15e-03   1.15e-04  -1.71e-03
## 54    1.01e-03   3.33e-02   8.81e-03  -1.38e-02 -6.59e-03  -9.55e-04   1.23e-02
## 55   -1.35e-02  -1.15e-01   1.13e-01  -1.62e-01 -1.45e-01   1.35e-01  -3.93e-01
## 56    9.69e-02  -1.06e-01  -3.34e-02  -3.32e-02 -7.26e-02   1.02e-01  -1.31e-01
## 57   -6.38e-03   2.50e-02  -2.27e-03   3.57e-03  3.41e-02  -3.12e-03   2.89e-03
## 58   -3.45e-02   1.76e-02   3.82e-02  -3.72e-02 -1.60e-02  -1.92e-02  -6.27e-03
## 59   -5.17e-02   5.88e-02   8.40e-02  -9.58e-02 -1.31e-01  -2.77e-02  -1.42e-01
## 60   -2.49e-03  -5.25e-02   2.20e-02  -9.38e-03  2.62e-02   9.91e-03   7.55e-03
## 61    1.02e-02   3.03e-03  -4.82e-03   5.60e-03 -1.91e-02   3.14e-02  -7.19e-03
## 62    9.06e-03   1.05e-02  -2.99e-03  -2.72e-03  4.59e-03  -1.09e-03   1.09e-02
## 63    9.04e-03  -1.48e-02  -1.43e-02   1.15e-02 -2.63e-02   9.45e-03  -3.10e-02
## 64    4.02e-05  -7.93e-03  -3.41e-03   3.39e-03  3.46e-03  -5.29e-05  -1.51e-03
```

```
## 64     4.02e-03 -7.95e-03 -3.41e-03  3.39e-03  3.46e-03 -5.29e-05 -1.51e-03
## 65     6.60e-02 -1.38e-01 -4.51e-03 -3.02e-02 -9.90e-02  1.04e-01 -1.21e-02
## 66     1.50e-03 -1.84e-03 -9.93e-04  5.92e-04 -1.46e-03  1.11e-04  2.52e-04
## 67     5.94e-04 -1.69e-03  1.50e-03 -2.04e-03 -4.67e-04 -2.19e-03  1.36e-03
## 68    -3.74e-03 -1.66e-02  1.37e-02 -1.11e-02 -1.04e-02 -1.15e-02  3.54e-03
## 69    -1.87e-03 -4.35e-03  2.99e-03 -2.93e-03 -2.83e-04 -2.23e-03 -9.25e-04
## 70     1.99e-05 -3.63e-04  1.75e-04 -2.83e-04 -6.81e-04 -4.42e-04 -8.07e-06
## 71    -1.53e-03 -1.22e-03 -2.54e-05  1.16e-03 -1.15e-03 -1.73e-03 -2.21e-04
## 72    -4.01e-02  3.27e-05  4.91e-02 -4.20e-02 -1.90e-02 -2.67e-02  7.45e-03
## 73     5.11e-02 -3.22e-02 -1.68e-01  1.79e-01 -2.10e-01  9.29e-02  1.16e-01
## 74     4.29e-03 -8.69e-02  3.02e-02 -1.05e-02 -2.20e-02  4.65e-03 -1.50e-02
## 75    -1.96e-02 -1.13e-02  2.85e-02 -8.46e-03 -1.59e-02  7.78e-03  1.44e-02
## 76     2.17e-04  7.08e-03 -2.18e-04 -2.56e-03 -1.24e-02 -1.13e-03 -8.07e-03
## 77    -1.44e-02 -1.44e-02  2.19e-02 -1.03e-02 -5.95e-03 -9.87e-03 -4.66e-03
## 78    -4.82e-03 -6.15e-05  3.03e-03 -1.09e-03  1.95e-03 -4.07e-04 -4.69e-04
## 79    -5.73e-03  2.25e-02 -2.83e-03  3.00e-03  7.45e-03 -4.88e-03  2.34e-03
## 80    -2.09e-02  5.45e-03  2.14e-02 -2.13e-02 -6.65e-03 -1.46e-02 -3.30e-02
## 81    -3.53e-03 -5.38e-03  7.62e-03 -5.93e-03  1.01e-02  3.54e-03 -1.07e-02
## 82     2.82e-02 -1.37e-02 -1.53e-02  1.04e-02 -4.80e-03  2.36e-02  4.60e-03
## 83     9.16e-04 -5.14e-03 -2.35e-03  2.73e-03  7.46e-04  1.26e-03  1.16e-04
## 84     3.79e-03 -1.84e-02  4.42e-03 -1.05e-02  9.70e-03  7.00e-03 -1.57e-02
## 85    -2.05e-03  6.90e-03  3.13e-03 -4.70e-04 -9.45e-03  2.65e-03  2.45e-03
## 86    -3.40e-03  8.89e-03 -1.73e-03  2.41e-03  7.34e-03  1.72e-03 -2.33e-03
## 87    -9.65e-03  1.49e-02  3.31e-03 -4.57e-04  2.80e-03 -2.71e-03  1.58e-03
## 88     1.86e-02 -1.02e-01 -1.21e-02  1.74e-02 -1.61e-02  7.61e-03  3.41e-02
## 89     1.81e-02  4.96e-02 -9.23e-02  1.53e-01  2.27e-02  3.69e-02 -9.82e-02
## 90    -2.53e-02  2.30e-03  2.10e-02 -1.49e-02  9.21e-05 -1.01e-02 -1.11e-02
## 91     3.27e-02  2.72e-02 -3.45e-02  2.54e-02 -6.73e-04  4.02e-02 -6.87e-03
## 92    -1.42e-02  1.01e-02  1.64e-03  1.58e-03  1.08e-03 -1.28e-02  4.47e-03
## 93    -1.05e-02 -1.42e-03  1.71e-02 -1.26e-02 -4.94e-03 -1.01e-02  5.09e-03
## 94     3.15e-03  1.60e-02 -1.61e-03 -1.95e-04  1.28e-03  2.12e-03 -3.06e-03
## 95     1.24e-01  6.31e-02 -1.27e-01  1.78e-01  8.96e-03  6.33e-01  8.34e-02
## 96    -1.23e-02  1.63e-02 -1.47e-04  4.12e-03  7.42e-03 -1.35e-02  4.95e-03
## 97    -1.51e-02  2.38e-02 -7.19e-03  5.84e-03  8.36e-02 -2.90e-02  1.13e-02
## 98    -8.27e-03  2.75e-03  5.26e-03 -2.05e-03  6.56e-03 -1.54e-03  2.26e-03
## 99     1.59e-03 -2.40e-03  7.58e-03 -9.31e-03 -6.46e-03 -1.98e-03  9.71e-03
## 100   -4.27e-02  1.83e-03  5.83e-02 -6.42e-02  4.89e-02 -5.25e-02  4.53e-02
## 101    6.27e-02  2.22e-02 -6.60e-02  6.09e-02  6.64e-02  8.92e-02  2.26e-02
## 102    4.21e-03 -1.69e-03  7.66e-03 -6.46e-03  5.66e-02  3.57e-02  9.23e-03
## 103   -1.07e-03  1.37e-03  7.90e-04 -4.86e-04 -3.17e-05 -4.36e-04  4.65e-04
## 104    7.38e-03 -5.27e-03 -9.89e-03  1.20e-02 -6.93e-03  1.73e-02 -1.94e-03
## 105    3.67e-05  3.32e-04 -3.96e-04  3.41e-04  3.69e-04  3.42e-04 -7.14e-04
## 106    1.18e-02  1.72e-02 -8.24e-03  1.16e-03 -3.27e-02  8.03e-03 -2.43e-02
## 107   -7.77e-03  1.40e-03  2.73e-03  6.64e-04  3.56e-03 -3.23e-03 -2.91e-03
## 108    8.04e-03 -2.47e-03 -4.94e-03  1.45e-03 -9.47e-03  1.24e-03 -7.21e-03
## 109    3.53e-04 -8.20e-03  3.16e-03 -3.58e-03  5.14e-03 -8.06e-04  3.19e-03
## 110    3.18e-06 -1.76e-02  5.73e-03 -7.36e-03 -2.69e-02 -2.88e-03 -2.03e-03
## 111    2.36e-03  1.68e-03 -3.07e-03  2.47e-03  1.71e-02  2.93e-03  5.64e-03
## 112   -1.92e-02  2.95e-02 -6.80e-02  8.94e-02 -6.43e-02 -2.46e-02  7.39e-02
## 113   -1.03e-01 -3.07e-02  8.66e-02 -6.19e-02  2.39e-02 -1.19e-01  3.04e-02
## 114   -2.76e-03 -8.33e-03 -3.21e-03  5.39e-03 -4.57e-03 -3.50e-02 -1.19e-02
## 115   -2.81e-03 -9.69e-03  2.09e-02 -1.31e-03 -3.64e-03  7.00e-04 -2.11e-03
## 116    5.47e-02  5.64e-02 -1.22e-02  7.57e-03  6.50e-03  6.50e-02  3.87e-02
## 117   -4.84e-03  1.29e-03  6.44e-03 -7.22e-03 -1.09e-03 -4.90e-03  2.16e-03
## 118   -1.00e-02  1.66e-03  1.85e-02 -2.61e-02  2.22e-02 -2.04e-02  2.46e-02
## 119    1.42e-02  9.45e-04 -2.89e-02  4.64e-02 -2.56e-02  3.93e-02 -4.96e-02
## 120    1.58e-02 -2.09e-03 -6.87e-03 -4.28e-03  1.30e-02  2.13e-02 -1.16e-02
## 121   -5.56e-03 -1.58e-03  5.90e-03 -3.01e-03  3.10e-03 -1.31e-03  1.50e-03
## 122    1.86e-01 -1.68e-02 -1.26e-01  1.13e-01 -5.08e-03  1.62e-01  1.80e-03
## 123   -9.28e-03 -4.37e-02  1.32e-02 -6.98e-03  4.65e-02 -1.14e-03  1.67e-02
## 124    8.09e-02 -7.41e-02 -1.54e-01  2.20e-01  4.35e-02  4.96e-02 -1.72e-02
## 125    1.58e-03  4.53e-03 -1.47e-03  2.76e-03  5.37e-03  8.89e-03  4.21e-03
## 126   -7.91e-03  1.07e-03  5.11e-03 -4.30e-03 -7.92e-04 -7.95e-03 -1.64e-04
## 127   -1.52e-02 -1.12e-02  1.66e-02 -2.45e-02  4.92e-02 -2.86e-02  3.07e-02
## 128    5.46e-03  8.27e-03  1.16e-03 -7.15e-03 -2.62e-03 -7.43e-03  3.06e-03
## 129   -1.86e-03 -7.01e-03  2.59e-03  3.93e-03 -1.42e-03 -2.25e-04  6.13e-03
## 130   -5.50e-03 -1.58e-02 -9.10e-03  1.87e-02 -2.93e-02  9.33e-03 -4.32e-02
## 131   -8.95e-02  9.88e-03  1.26e-02  3.06e-02  3.64e-02 -8.84e-02 -1.11e-01
## 132   -8.27e-03  3.39e-03 -7.89e-04  5.32e-03  9.43e-03 -7.75e-03 -3.19e-04
## 133   -1.71e-04 -3.25e-02 -3.39e-04  5.19e-03  4.14e-03  1.40e-03  1.38e-02
## 134    3.03e-03  3.58e-03 -7.49e-03  5.32e-03  1.05e-02 -2.85e-02  1.57e-02
## 135    1.76e-02 -2.83e-03 -8.78e-03  5.83e-03 -2.02e-03  1.36e-02  9.59e-03
## 136   -5.97e-06 -1.24e-05  7.89e-06 -1.60e-06 -1.80e-05 -5.68e-07  1.09e-05
```

```
## 137 -1.80e-03 -1.35e-03  1.74e-02 -2.26e-02 -7.95e-03 -7.04e-03  5.68e-03
## 138 -8.59e-03  2.58e-02  1.53e-04  1.83e-03 -6.83e-03  4.19e-03 -3.25e-03
## 139  1.68e-02 -1.13e-02 -2.17e-02  3.22e-02 -1.51e-02  5.10e-02 -3.44e-03
## 140  5.20e-03 -8.39e-05 -3.99e-03  3.10e-03  4.98e-03  7.69e-03 -5.30e-04
## 141  8.24e-03  2.19e-03 -1.07e-02  6.70e-03 -6.42e-03  1.33e-02 -1.55e-02
## 142  2.04e-02 -9.02e-02  1.19e-03 -1.25e-02 -5.80e-02  3.38e-02 -1.91e-02
## 143 -3.20e-02  8.83e-02  9.00e-03 -3.65e-03  1.15e-02 -6.03e-02 -1.67e-02
## 144 -1.30e-02 -5.88e-03  2.49e-04  1.00e-02  1.40e-02 -2.28e-02 -1.60e-02
## 145  9.05e-04  4.85e-04 -3.03e-04 -6.62e-04 -2.35e-03  2.07e-03 -3.15e-03
## 146 -8.78e-03  1.37e-03  5.84e-03 -5.33e-03 -3.47e-02 -2.95e-03 -1.61e-02
## 147  6.34e-04 -7.06e-04  8.92e-06 -2.22e-04 -5.62e-04  1.05e-03 -1.09e-03
## 148 -7.48e-03 -4.44e-03  1.59e-02 -1.20e-02  1.86e-02 -5.25e-04 -3.19e-03
## 149  1.24e-03 -8.45e-04 -1.39e-04 -4.72e-04 -1.93e-03 -7.61e-04 -2.99e-04
## 150  5.57e-04 -1.38e-04  3.13e-04 -4.76e-04 -1.76e-03  4.27e-04 -1.16e-03
## 151 -2.94e-03  4.65e-03 -3.81e-03  2.78e-03 -9.26e-03  9.93e-04 -6.69e-03
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## 154 -6.92e-03  6.27e-03  1.56e-02 -1.79e-02 -1.30e-02  2.20e-03 -8.87e-03
## 155  1.79e-03  3.44e-03 -6.32e-03  7.52e-03  2.69e-02 -8.35e-03  1.35e-02
## 156  4.04e-04 -1.08e-02  1.87e-02 -1.99e-02 -1.42e-02  1.74e-02 -7.76e-04
## 157 -3.18e-03 -2.45e-03  6.54e-03 -4.92e-03 -2.15e-04 -5.24e-03  5.66e-03
## 158 -2.41e-02 -3.24e-02  3.14e-02 -1.35e-02 -5.72e-02 -4.29e-03 -5.93e-03
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## 160 -1.51e-03 -3.47e-03 -3.66e-05  1.22e-03  1.20e-03 -8.45e-04  1.37e-03
## 161  8.32e-03 -5.97e-03 -2.81e-03  2.04e-04 -6.14e-03  2.74e-03 -9.86e-04
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## 163  9.26e-04  6.39e-04 -1.28e-03  9.67e-04 -1.69e-04  7.65e-04  2.41e-04
## 164  8.01e-04  2.99e-02  2.26e-02 -2.07e-02  1.09e-01  5.29e-02  2.89e-02
## 165  1.76e-02 -1.53e-02 -3.93e-02  6.44e-02  9.33e-03  2.38e-02 -2.63e-03
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## 173 -4.84e-02  2.11e-02  2.53e-02 -1.30e-02  1.98e-02  5.71e-03 -3.78e-02
## 174  6.69e-03  1.94e-02  7.73e-03 -6.31e-03 -2.28e-02  2.68e-02 -7.74e-03
## 175  9.59e-03  3.53e-03  3.91e-04 -6.44e-03  7.20e-03 -7.73e-03  1.16e-02
## 176 -3.47e-03  1.05e-03  1.51e-03 -2.11e-03 -7.40e-03 -8.55e-03 -3.71e-04
## 177 -3.28e-02 -2.20e-02  1.85e-02  1.71e-03  2.13e-02 -2.16e-02 -2.83e-02
## 178 -5.81e-03  2.17e-02  8.05e-04 -8.81e-04  2.34e-02  1.13e-02 -1.08e-02
## 179  2.23e-02 -2.91e-02 -3.81e-03  1.68e-03  2.54e-02  2.46e-02  2.27e-02
## 180 -1.26e-03 -3.40e-03 -1.92e-04  1.95e-03  4.76e-03  5.32e-03 -1.09e-03
## 181  3.17e-03  1.10e-03 -2.59e-03  5.75e-04 -1.86e-03  7.36e-04 -3.93e-03
## 182  1.34e-02 -2.01e-03 -1.87e-03 -6.54e-03 -5.12e-03 -6.03e-03 -4.80e-04
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## 184  1.53e-02  3.19e-02 -3.75e-02  2.93e-02  3.25e-03  6.88e-05 -1.10e-02
## 185 -2.01e-03 -3.26e-02  2.29e-02 -3.58e-02 -9.79e-02 -3.51e-02 -1.23e-02
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## 190 -1.78e-02  1.17e-02  3.04e-02 -2.45e-02  2.14e-02  1.15e-02  1.17e-02
## 191 -9.04e-03 -3.48e-03  9.55e-03 -7.01e-03 -1.06e-03 -4.38e-03 -2.98e-03
## 192 -3.46e-02  3.93e-02  1.67e-02 -9.79e-03 -3.59e-03 -1.51e-02 -9.85e-03
## 193  3.22e-03 -1.33e-02  4.57e-03 -3.60e-03 -7.11e-03  6.04e-03  2.82e-04
## 194  5.99e-02 -6.46e-02 -4.21e-02  3.77e-02 -2.93e-02  3.44e-02 -2.28e-02
## 195  1.81e-02  9.55e-03  2.90e-03 -1.01e-02  2.36e-02  1.41e-02 -1.51e-02
## 196  3.07e-01 -2.82e-01 -2.48e-01  3.21e-01  1.28e-01  3.83e-01  4.34e-01
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## 198  8.80e-03 -1.62e-02 -8.42e-03  5.05e-03 -3.47e-03 -4.79e-03  9.55e-03
## 199 -3.94e-04  3.44e-04  5.30e-04  1.54e-04  3.87e-03  3.17e-03 -1.21e-03
## 200 -7.94e-03  1.55e-02  3.66e-04  1.71e-03  1.13e-02 -5.84e-04 -7.58e-03
## 201 -2.00e-02  3.09e-02  1.74e-02 -1.31e-02  2.31e-02 -1.58e-02  7.92e-04
## 202 -1.03e-02 -1.59e-02  1.44e-02 -1.10e-02  4.43e-04  7.25e-04 -9.06e-03
## 203  6.96e-04 -7.95e-04 -1.02e-03  7.54e-04  9.09e-04 -5.85e-04  4.18e-04
## 204 -1.74e-02  1.61e-02  1.82e-02 -2.98e-02 -2.85e-02 -3.07e-02 -2.00e-02
## 205  2.66e-02  6.39e-03 -1.41e-02  1.06e-02 -4.61e-02  3.29e-02 -7.59e-03
## 206  2.58e-02 -2.80e-02 -3.42e-02  3.48e-02 -4.76e-02  1.65e-03 -3.96e-02
## 207  2.19e-03 -2.03e-04 -1.28e-03  6.31e-04 -3.28e-04  7.40e-04  4.62e-04
## 208  8.42e-04 -4.66e-03  8.04e-04  5.37e-03 -1.83e-03  1.83e-02  1.46e-02
## 209 -9.97e-04  3.15e-03 -6.49e-04  3.54e-04  7.22e-04 -5.75e-04 -8.89e-04
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## 210 -9.04e-04  5.90e-02 -2.62e-02  3.18e-02 -1.20e-01  1.55e-01 -2.07e-01
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## 212 -6.45e-02  6.28e-02  5.98e-02 -8.93e-02  2.28e-02 -8.44e-02 -4.80e-02
## 213  7.52e-03  3.55e-02 -5.20e-03  1.55e-02  3.88e-02  7.23e-02  9.16e-03
## 214  8.11e-03 -7.18e-03 -3.01e-03  1.43e-03 -2.40e-03  7.07e-03  6.01e-05
## 215 -9.00e-06  2.82e-05  2.08e-05 -3.49e-05 -2.99e-05 -4.62e-05 -1.38e-05
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## 217 -6.30e-03 -1.25e-03  3.20e-03 -2.97e-05  9.87e-03  3.32e-03 -2.92e-03
## 218  3.68e-03  1.26e-03  1.91e-05  6.00e-04  9.08e-04  1.18e-02 -3.96e-03
## 219 -5.74e-03 -9.69e-03  3.51e-03 -8.93e-03  1.61e-02 -6.97e-03  2.18e-04
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## 221 -1.39e-03  5.10e-03 -8.36e-05 -7.46e-04 -2.59e-03 -4.84e-03  2.80e-03
## 222 -1.14e-03 -2.51e-03  1.55e-03 -1.35e-03 -1.19e-03 -1.83e-03 -5.70e-04
## 223 -1.79e-02 -1.16e-02  1.02e-02  2.28e-03  3.42e-02 -1.59e-02  3.29e-02
## 224  2.81e-02 -1.80e-02 -1.28e-02  4.03e-03 -2.76e-02  1.31e-02 -4.51e-03
## 225 -1.11e-02  2.34e-02  1.78e-02 -2.35e-02 -5.12e-03 -1.77e-03 -1.33e-02
## 226  5.55e-02 -2.89e-02  1.44e-02 -3.98e-02 -3.25e-02  4.49e-02  4.56e-03
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## 229  2.55e-03 -8.72e-04 -6.66e-04 -6.80e-05 -1.28e-03  2.37e-03 -2.02e-03
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## 233 -2.33e-03  4.18e-02 -4.54e-02  5.14e-02  8.77e-02 -1.12e-02 -1.22e-01
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## 235  1.51e-02 -7.00e-02 -1.07e-02  1.22e-02 -9.80e-03  1.97e-02 -4.83e-03
## 236 -6.76e-03  6.59e-03  9.42e-03 -8.92e-03 -4.10e-02 -1.14e-02  8.62e-04
## 237 -6.89e-02 -1.87e-02  2.55e-02  7.09e-03  2.26e-02 -9.35e-02  3.95e-02
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## 239 -2.59e-03 -2.34e-02  1.04e-02 -9.39e-03 -6.67e-03 -3.58e-03  4.27e-03
## 240 -3.20e-03 -1.71e-02  1.15e-02 -4.07e-03 -2.54e-02  2.40e-02 -8.92e-03
## 241  4.01e-03 -2.67e-03 -1.36e-03  4.99e-04  6.60e-03  6.03e-03  1.68e-03
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## 243 -1.33e-02 -1.26e-02  1.76e-02 -1.52e-02  1.29e-02 -1.49e-03 -3.37e-03
## 244 -7.03e-02  5.00e-02  5.86e-02 -1.44e-02  5.86e-02 -6.72e-03  3.77e-03
## 245 -7.02e-02 -4.97e-02  6.49e-02 -7.72e-04  9.71e-02  1.44e-03  1.85e-01
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## 255  4.05e-03  3.33e-03 -4.40e-03  4.82e-03 -7.37e-03  6.67e-03 -2.74e-03
## 256 -4.06e-03 -3.04e-02  2.93e-02 -2.98e-02 -2.44e-02  5.26e-03 -7.65e-04
## 257  5.21e-03  4.12e-03 -2.04e-02  1.70e-02 -1.10e-02  7.19e-03 -3.85e-02
## 258 -2.67e-02  4.86e-03  1.76e-02 -6.94e-03  4.69e-03  1.10e-03  2.00e-04
## 259 -2.38e-04  2.14e-04 -4.31e-05  1.91e-04 -6.71e-04  2.66e-04 -3.45e-04
## 260 -7.15e-03  1.05e-02  5.72e-04  3.65e-03 -4.94e-04  1.01e-03  5.84e-06
## 261  7.43e-03 -1.32e-03 -5.99e-03  4.11e-03  5.67e-03  8.68e-03 -3.00e-03
## 262  4.39e-02  4.96e-02 -4.35e-02  2.60e-02 -7.31e-04  1.94e-02 -4.55e-04
## 263 -1.37e-02  1.58e-03  1.96e-03  7.54e-03 -1.43e-02  5.18e-04 -1.13e-02
## 264 -1.19e-03  2.39e-05  3.92e-03 -3.41e-03 -2.29e-03 -2.39e-03  1.44e-03
## 265 -2.28e-03  3.00e-03  3.18e-03 -5.34e-03  3.07e-03 -7.75e-03  5.52e-03
## 266 -3.24e-03 -1.28e-02  3.44e-03  7.65e-03 -1.36e-02 -5.17e-03  2.08e-03
## 267 -1.07e-02  6.60e-03  1.27e-02 -1.07e-02  1.67e-02  7.47e-03 -2.09e-02
## 268  1.11e-02  5.55e-03  1.40e-03 -6.67e-03  1.74e-02  2.40e-03  1.08e-02
## 269  9.14e-03 -2.48e-02 -8.29e-03  6.98e-03  6.71e-03  1.10e-02  1.99e-03
## 270  2.88e-02 -1.30e-02 -3.17e-02  1.63e-02 -3.85e-02  8.54e-03 -5.97e-02
## 271 -1.48e-02  5.08e-03  6.77e-03 -1.33e-03  9.69e-03 -7.63e-03  1.83e-03
## 272  6.56e-01 -1.49e-01 -5.12e-01  3.37e-01  6.11e-01 -2.13e-02  5.10e-01
## 273 -2.64e-03 -2.52e-03  5.00e-03 -5.64e-03 -7.21e-03 -5.90e-03 -4.22e-03
## 274 -1.57e-02  1.61e-02  4.68e-03 -1.16e-03 -7.14e-03 -7.56e-03 -3.65e-03
## 275 -3.78e-02 -3.88e-03  1.87e-02 -4.73e-02  3.03e-02 -1.38e-01  5.45e-02
## 276 -2.62e-01  1.55e-01  5.90e-01 -8.06e-01 -2.71e-01 -1.10e-01 -2.43e-01
## 277  3.81e-04  1.12e-03  1.92e-03 -2.93e-03  1.95e-03 -9.81e-04 -4.06e-04
## 278 -2.45e-04  1.72e-03  4.79e-04 -4.57e-04 -1.36e-04  1.97e-04 -1.29e-04
## 279 -2.66e-03 -3.81e-03  3.24e-03 -2.95e-03  5.63e-03 -8.89e-04  1.35e-03
## 280 -4.75e-06 -1.64e-04  1.46e-04 -1.51e-04  1.50e-04  5.10e-05  1.04e-04
## 281  1.25e-01 -1.19e-01 -8.51e-02  6.57e-02 -1.21e-01  2.28e-01 -1.98e-01
## 282  2.49e-02 -1.43e-02 -1.41e-02  7.47e-03  6.34e-03  2.74e-02  1.92e-03
```

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## 282   2.49e-02 -1.45e-02 -1.41e-02  7.47e-03  6.34e-03  2.74e-02  1.02e-03
## 283 -2.23e-04  3.96e-04  3.56e-04  7.65e-05 -5.51e-04  4.13e-04 -7.07e-04
## 284  3.69e-03 -6.20e-03  1.10e-03 -3.27e-03  2.29e-03 -1.88e-03  7.45e-04
## 285 -5.36e-03  5.23e-03  5.50e-03 -4.72e-03  3.93e-03 -6.47e-03 -1.09e-03
## 286  8.33e-04 -8.57e-04  2.75e-04 -3.20e-04  8.08e-04  6.23e-04  9.98e-04
## 287 -6.15e-03  2.05e-02  8.50e-03 -1.63e-02 -2.48e-02 -4.04e-03 -1.60e-02
## 288 -3.94e-02  4.89e-04  2.84e-02 -1.40e-02  4.41e-03 -2.81e-02 -1.57e-02
## 289  1.17e-02  6.24e-03 -1.31e-02  8.17e-03 -1.42e-02 -4.52e-02  6.49e-02
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## 292  2.25e-03  1.02e-02 -6.98e-03  4.88e-03  5.74e-03 -1.89e-04  2.19e-04
## 293  4.84e-02 -3.47e-02 -4.24e-02  4.21e-02 -6.65e-02  4.89e-02 -4.04e-02
## 294 -2.85e-03  8.44e-04  1.13e-03 -7.22e-04 -3.09e-03 -1.99e-03 -3.11e-03
## 295  2.41e-02 -4.14e-03 -2.25e-02  1.73e-02 -1.79e-02  1.35e-02 -2.26e-02
## 296  1.47e-02  1.27e-02  4.32e-02 -8.38e-02  5.39e-02 -2.94e-02  8.36e-02
## 297  5.66e-03  1.65e-02 -1.76e-03  1.14e-02  8.82e-02  3.11e-02  8.83e-02
## 298 -5.80e-03 -4.25e-03  6.43e-03 -7.22e-03 -7.01e-03  6.87e-03 -1.71e-03
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## 300 -2.15e-02  3.94e-02 -3.48e-02  5.33e-02  1.18e-02 -3.57e-02 -8.88e-02
## 301 -2.40e-02  1.67e-02  1.36e-02 -7.56e-03  1.95e-02 -1.39e-02  1.98e-02
## 302  1.72e-04  2.12e-04 -3.72e-04  2.68e-04  7.21e-04  1.25e-04  2.15e-06
## 303 -4.44e-03  3.67e-03  2.81e-03 -1.86e-03  3.14e-03 -1.45e-03  5.47e-04
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## 308 -2.44e-03 -5.91e-03  4.09e-03 -1.52e-03  9.13e-03  5.69e-03 -1.56e-03
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## 343  9.18e-02 -3.22e-02 -9.12e-02  8.20e-02 -1.00e-01  1.03e-01 -1.05e-01
## 344 -5.06e-02 -7.51e-03  3.55e-02 -1.77e-02  3.50e-03 -3.67e-02  7.67e-02
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## 348 -1.56e-03 -4.56e-04  4.89e-03 -7.90e-03 -2.13e-02 -1.34e-02  5.31e-03
## 349 -6.42e-03 -8.33e-04  1.21e-02 -1.12e-02  4.46e-03 -6.46e-03  4.93e-03
## 350  3.73e-02 -5.58e-02 -1.84e-02  2.16e-02 -9.44e-04  3.75e-02  2.87e-02
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## 354  3.75e-03 -6.39e-03 -2.46e-03  2.46e-03  1.23e-03  7.68e-03 -4.33e-03
```

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## 360 -6.13e-03 -1.02e-02  1.16e-02 -9.57e-03 -8.79e-04  3.69e-03 -4.14e-03
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## 367  6.56e-03 -4.20e-04 -9.97e-05 -4.73e-03  4.11e-03  4.22e-03 -8.19e-04
## 368 -3.00e-02 -4.55e-02  3.55e-02 -2.41e-02  1.43e-02 -9.88e-03  9.96e-03
## 369 -9.05e-03  5.53e-02  1.78e-03 -6.44e-03  1.42e-02 -5.75e-03 -2.84e-03
## 370 -1.14e-02 -2.67e-02  1.15e-02  1.57e-02  8.11e-02 -1.09e-02  1.83e-02
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## 374  2.25e-04  1.82e-03 -3.42e-03 -1.93e-04 -7.70e-03 -9.38e-03 -1.11e-04
## 375  7.16e-04  6.50e-03 -5.40e-03  7.18e-03  7.35e-03  1.07e-02 -1.27e-03
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## 380 -3.66e-03  3.48e-03  2.85e-03 -1.72e-03 -2.51e-03 -1.34e-03 -1.73e-04
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## 391  1.26e-02 -4.08e-02 -1.76e-02  1.87e-02 -2.07e-02  1.36e-02 -2.45e-02
## 392 -5.92e-03 -1.10e-02  4.77e-03 -3.06e-03 -4.27e-04 -3.81e-03  1.76e-04
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## 398 -7.28e-04  2.64e-03  2.52e-03 -4.64e-03 -4.04e-03 -4.16e-03 -2.50e-03
## 399 -2.58e-05  1.29e-05  1.44e-04 -2.58e-04 -3.63e-04 -5.20e-04  1.64e-05
## 400  3.17e-02 -4.63e-02  8.95e-03 -2.02e-02 -5.61e-02  4.17e-02  4.39e-03
## 401 -6.85e-04  2.32e-04  7.38e-04 -5.56e-04  3.87e-04 -4.09e-04  7.23e-04
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## 404  7.44e-03 -4.83e-02 -7.90e-03  3.05e-02  1.74e-02 -1.57e-02  2.72e-02
## 405 -2.00e-03  7.99e-04 -1.33e-03  5.13e-04  2.63e-03 -6.84e-03 -5.57e-03
## 406 -5.34e-03  2.53e-03  1.21e-03  6.69e-03 -1.04e-03  4.97e-03 -1.44e-02
## 407  5.01e-03  3.35e-03 -5.08e-03  2.87e-03  2.00e-03 -3.04e-03  6.56e-03
## 408 -4.38e-02  7.16e-02  2.28e-02 -1.03e-02  8.63e-03 -8.25e-03  2.96e-03
## 409  1.35e-03 -7.39e-03  3.30e-03 -7.55e-03  3.51e-03 -4.73e-04  1.69e-03
## 410 -2.19e-02  7.87e-03  2.40e-02 -1.50e-02  2.38e-02  9.96e-03  1.08e-02
## 411  1.28e-02 -1.40e-02 -3.26e-03  1.28e-03 -2.71e-03  1.24e-02  1.32e-02
## 412 -7.41e-03 -4.34e-02  1.03e-02 -6.12e-03  2.80e-02  4.36e-03 -4.28e-03
## 413 -9.96e-03  4.42e-03  6.62e-03 -4.61e-03  2.72e-03 -5.57e-03 -1.13e-03
## 414 -1.04e-02  2.03e-03  5.94e-03 -2.52e-03 -1.97e-02 -1.78e-03 -5.95e-03
## 415 -7.00e-05 -4.71e-04  7.01e-05 -1.99e-04 -1.04e-03 -6.66e-04 -3.73e-04
## 416 -7.49e-03 -2.81e-02  2.62e-02 -3.82e-02  1.69e-02 -7.45e-02  5.47e-02
## 417 -4.61e-03  2.01e-03  3.22e-03 -1.74e-03 -6.28e-04 -2.05e-03  5.61e-04
## 418  9.93e-03  7.32e-03 -1.16e-02  7.94e-03 -1.92e-03  5.68e-04 -1.21e-03
## 419  2.17e-02  4.84e-02 -1.86e-02 -7.41e-04 -6.58e-02  1.67e-02 -1.06e-01
## 420 -6.40e-03  1.58e-02  8.47e-03  1.27e-03  2.40e-02 -6.46e-04 -9.27e-04
## 421 -6.76e-01 -2.42e-01  4.92e-01 -4.38e-01  7.60e-03 -1.37e+00  1.79e+00
## 422  1.57e-03 -1.42e-03 -1.83e-03  1.35e-03 -1.41e-03  1.03e-03 -7.86e-04
## 423 -6.58e-03  3.01e-02  5.97e-03 -4.26e-03 -1.39e-02  1.44e-02 -7.67e-03
## 424 -1.59e-01 -3.78e-02 -7.31e-02  1.76e-01  3.32e-01  1.50e-01 -1.48e-01
## 425 -7.98e-03  4.70e-03  4.08e-03 -2.31e-03 -1.28e-03 -4.58e-03 -3.00e-03
## 426  1.98e-02  3.86e-02 -1.79e-02 -2.88e-03  1.49e-02  9.54e-04 -1.49e-02
## 427 -5.70e-03 -9.04e-03 -4.80e-03  1.47e-02  2.67e-02  2.87e-02 -1.35e-02
```

```
## 428 -1.96e-02 -2.50e-02  3.96e-02 -2.80e-02  1.65e-02 -1.12e-03 -3.46e-03
## 429 -7.94e-03 -3.99e-03  1.09e-02 -1.03e-02 -5.61e-03 -9.38e-03  5.00e-03
## 430 -2.58e-03 -2.65e-02  1.72e-02 -4.22e-02  2.04e-02 -1.83e-03  1.68e-03
## 431  1.57e-02 -2.04e-02 -1.30e-02  1.08e-02 -5.77e-03  1.09e-02 -1.90e-03
## 432  1.81e-02 -3.23e-03 -2.25e-02  2.35e-02 -1.97e-02  3.32e-02 -9.08e-03
## 433 -1.84e-03  9.80e-03  1.16e-03 -2.82e-03 -1.24e-02 -1.68e-03 -1.23e-02
## 434 -5.04e-02 -1.41e-02  4.12e-02 -2.98e-02 -1.65e-02 -4.86e-02 -1.11e-02
## 435 -2.13e-02  6.97e-03  1.41e-02 -7.73e-03  9.74e-03 -1.33e-02 -2.24e-03
## 436 -2.11e-04 -1.70e-03  9.62e-04 -8.49e-04  7.67e-04 -5.54e-04 -1.48e-04
## 437 -2.15e-02 -1.39e-03  2.95e-02 -1.19e-02  4.06e-02 -4.67e-02  2.95e-02
## 438 -3.43e-03  8.63e-03 -2.55e-03  4.78e-03  1.15e-02  5.54e-03 -2.83e-03
## 439  7.10e-04  3.80e-02  2.91e-02 -3.55e-02  6.59e-03  3.35e-02 -3.11e-03
## 440  1.73e-02  1.09e-02 -1.90e-02  1.45e-02  2.51e-02  2.48e-02 -2.16e-03
## 441  1.15e-03 -2.07e-04 -1.37e-03  7.07e-04 -1.02e-03 -1.32e-03 -7.22e-04
## 442 -2.95e-03  6.84e-03  2.89e-03 -2.22e-03  4.42e-03 -9.45e-04 -1.55e-04
## 443 -3.24e-02  5.76e-03  7.15e-03  1.31e-02  6.79e-03 -1.54e-02 -3.20e-03
## 444 -5.03e-03 -2.30e-02  1.05e-02 -1.35e-02 -1.12e-04  2.87e-03 -3.19e-02
## 445 -9.31e-02  5.31e-01  5.51e-02 -1.02e-01  1.46e-02 -8.28e-02 -8.85e-02
## 446 -5.93e-03  2.06e-02  1.66e-02 -1.53e-02 -4.47e-04  1.27e-02  4.28e-03
## 447 -5.12e-03 -1.14e-02  2.55e-04  1.07e-03  1.37e-03 -5.22e-03 -4.71e-03
## 448  4.65e-03  7.17e-04 -5.42e-03  3.96e-03  7.32e-03  7.05e-03  1.51e-03
## 449  1.75e-02 -3.67e-03 -1.35e-02  1.04e-02 -4.06e-03  2.24e-02 -4.05e-03
## 450 -4.78e-02  5.24e-02  2.86e-02 -1.55e-02  1.22e-02 -2.74e-02 -1.12e-02
## 451 -7.54e-03  4.40e-03  1.14e-02 -1.26e-02 -1.32e-02 -1.13e-02  4.96e-03
## 452  2.47e-03 -1.20e-02  1.39e-04  1.37e-05 -3.00e-03 -1.85e-03 -8.54e-04
## 453 -7.15e-04  4.12e-04  7.08e-04 -6.35e-04  1.24e-04 -1.09e-03  5.25e-04
## 454  5.10e-02  6.04e-03 -2.27e-02  9.51e-03 -1.16e-01  4.53e-02 -4.52e-04
## 455  5.84e-03 -1.26e-02  5.21e-04 -2.34e-03 -6.12e-03 -1.86e-03  7.34e-03
## 456 -9.53e-04  5.62e-03 -2.93e-03  4.43e-03 -6.20e-04  9.35e-04  6.61e-04
## 457  4.47e-02  4.06e-02 -3.49e-02  3.44e-02 -4.80e-02  4.94e-02  1.73e-02
## 458 -1.05e-02  9.33e-02 -4.68e-02  7.80e-02  2.00e-02  7.29e-03 -2.08e-02
## 459 -2.19e-02  2.05e-02  4.87e-02 -5.14e-02  1.06e-02  8.42e-03  5.10e-03
## 460  4.37e-04  1.26e-03  5.63e-04 -7.20e-04 -2.45e-03 -8.62e-04  5.51e-04
## 461 -9.50e-01 -5.77e-03  1.68e+00 -2.06e+00 -3.26e-01 -7.29e-01 -3.97e-01
## 462 -2.83e-02  1.00e-02  1.99e-02 -6.64e-03  1.19e-02 -1.52e-02  9.00e-03
## 463 -7.96e-03  9.41e-03  6.42e-03 -3.92e-03  1.71e-02 -1.77e-03  4.82e-03
## 464  3.63e-03  6.11e-03 -6.62e-03  2.32e-03 -6.68e-03 -4.57e-03 -1.35e-03
## 465  1.39e-02  2.91e-02 -1.09e-02  2.54e-02  6.57e-02  1.11e-02  6.12e-02
## 466  2.93e-02  4.37e-03 -2.20e-02  6.91e-03 -2.71e-02 -1.30e-02 -1.04e-02
## 467  9.45e-03  5.94e-03 -9.78e-03  4.02e-03 -3.99e-03  2.15e-03 -3.19e-03
## 468 -3.91e-03 -6.71e-02  3.71e-02 -1.51e-02 -1.66e-02  4.49e-02 -4.31e-03
## 469 -2.15e-03  1.33e-03  3.83e-03 -2.84e-03  1.07e-03 -6.95e-04  3.59e-03
## 470 -3.29e-03 -2.82e-03  4.32e-03 -3.77e-03 -2.57e-03 -4.34e-03 -4.93e-04
## 471  2.86e-02 -2.35e-02 -2.32e-02  2.25e-02  1.93e-02  3.20e-02  1.95e-02
## 472 -3.19e-03  3.02e-03  1.37e-02 -8.34e-03  1.49e-02  4.70e-03  6.19e-03
## 473  3.99e-03 -1.05e-03 -5.23e-03  6.24e-03 -2.06e-04  1.02e-02  6.67e-05
## 474  6.98e-03  4.20e-02 -1.28e-02  1.98e-02  7.00e-03  2.08e-02 -4.45e-03
## 475 -4.40e-03 -2.09e-02  5.81e-03 -2.40e-03  5.21e-04 -1.42e-03  5.06e-03
## 476 -1.56e-03 -1.55e-02  1.39e-02 -1.32e-02 -2.30e-03 -7.05e-03 -2.17e-02
## 477 -1.15e-02 -6.72e-03  3.51e-03  1.28e-03  3.11e-02 -1.04e-02  7.97e-03
## 478  1.86e-02 -8.09e-03 -2.59e-02  2.45e-02 -4.09e-02 -3.71e-02 -6.44e-02
## 479  4.53e-04 -1.03e-03  2.88e-03 -3.92e-03 -5.50e-03  2.50e-03 -7.49e-03
## 480  6.96e-02 -6.86e-02 -4.28e-02  3.45e-02 -3.79e-02  5.35e-03  1.02e-02
## 481 -4.07e-03 -1.31e-02  7.31e-03 -7.15e-03  5.42e-03 -4.35e-03  7.25e-04
## 482  1.60e-02 -3.77e-03 -2.26e-02  2.69e-02  1.19e-02  1.43e-02  1.32e-02
## 483 -2.78e-03 -1.82e-03  1.70e-03 -9.47e-05  1.53e-03 -1.51e-03  5.00e-04
## 484 -2.51e-02 -2.05e-03  2.95e-03  2.11e-03 -2.91e-02 -3.35e-02  2.45e-02
## 485 -6.18e-03  4.11e-03  3.06e-03 -6.00e-04  1.26e-02  3.42e-03  2.31e-03
## 486 -1.12e-04 -1.93e-04  3.29e-04 -5.29e-04  8.37e-05 -1.49e-04  5.72e-04
## 487 -1.69e-02 -2.87e-03  3.06e-02 -2.65e-02  1.94e-02  6.59e-04  4.93e-03
## 488 -2.38e-02  6.51e-02  1.62e-02 -1.43e-02 -7.47e-02  1.18e-02 -1.85e-01
## 489  1.08e-02 -4.81e-03 -1.14e-02  8.29e-03  1.72e-02  8.81e-03  2.82e-03
## 490  2.06e-01 -2.23e-02 -2.43e-01  2.14e-01  9.00e-02  3.95e-01 -4.86e-03
## 491  1.11e-02 -9.70e-04 -9.12e-03  5.70e-03  1.20e-03  4.27e-03  5.99e-03
## 492  1.84e-02  5.88e-02 -8.07e-03 -7.75e-04  1.29e-02  5.84e-02  6.19e-02
## 493  3.57e-03  7.35e-03 -6.05e-03  8.30e-03 -2.95e-03  9.46e-03 -3.64e-03
## 494  4.39e-03 -6.55e-04 -3.60e-03  2.56e-03  3.17e-04  3.77e-03 -8.59e-04
## 495  1.52e-02  1.21e-02 -2.60e-02  2.70e-02  3.43e-02  1.80e-02  6.21e-03
## 496  6.61e-03  8.42e-03 -1.65e-02  1.92e-02  4.54e-02  1.01e-01 -1.22e-01
## 497 -3.49e-02 -3.09e-03  3.43e-02 -2.50e-02 -3.11e-03 -2.42e-02  2.28e-03
## 498  1.25e-02  1.16e-02 -5.11e-03 -4.59e-03 -3.82e-03  4.53e-03 -9.17e-03
## 499 -2.07e-01 -2.61e-01  1.65e-01 -1.19e-01  3.54e-01 -4.47e-01  4.82e-01
## 500  4.24e-02 -1.33e-01 -3.52e-02  4.63e-02 -1.79e-02  1.90e-02 -1.05e-02
```

```
## 500   4.24e-02 -1.33e-01 -3.52e-02  4.63e-02 -1.79e-02  1.90e-02 -1.05e-02
## 501 -3.98e-02 -3.37e-03  4.59e-02 -1.38e-02 -1.88e-02  1.33e-02  5.74e-03
## 502 -3.82e-02  3.04e-02  3.63e-02 -2.39e-02 -8.54e-03 -1.97e-02 -1.88e-02
## 503  1.96e-03 -4.77e-04 -1.84e-03  2.14e-03  1.12e-03 -4.31e-04  3.41e-03
## 504 -7.90e-02 -5.59e-04  4.95e-02 -4.95e-02 -1.20e-01 -1.19e-01  1.27e-01
## 505  4.00e-03  8.86e-04 -6.96e-03  3.78e-03  1.07e-02  1.03e-02 -8.49e-03
## 506  1.03e-02 -6.70e-02  2.97e-03 -8.04e-04  7.51e-03  1.47e-02  5.36e-03
## 507 -1.49e-02 -1.60e-02  2.59e-02 -1.88e-02 -3.06e-02 -2.05e-02  8.06e-03
## 508 -6.64e-04 -4.14e-03  2.93e-03 -2.34e-03  8.23e-04 -1.68e-03  2.27e-03
## 509  1.16e-01 -6.58e-02 -1.16e-01  1.11e-01  5.29e-02  1.31e-01 -1.68e-01
## 510  4.97e-03 -5.78e-03  7.52e-04 -6.23e-04 -2.78e-03  1.06e-03  6.58e-03
## 511  2.50e-02  1.52e-02 -1.87e-02  4.52e-03 -2.21e-02 -2.27e-02  1.90e-02
## 512 -7.71e-02  6.47e-02  6.09e-02 -2.96e-02  2.99e-02 -4.76e-02 -1.10e-02
## 513 -2.24e-02  2.07e-03  9.58e-03 -4.57e-03 -1.90e-03 -1.07e-02 -2.59e-04
## 514 -5.95e-03 -1.31e-02  9.99e-03 -6.24e-03  7.14e-03  8.57e-04  2.98e-04
## 515  1.99e-03 -2.51e-02 -2.47e-02  4.30e-02  3.05e-02  1.80e-02 -2.92e-02
## 516  1.44e-02  2.43e-02 -1.02e-02 -2.45e-03  1.41e-03  3.73e-02  1.80e-02
## 517 -1.11e-01 -4.11e-02  5.44e-02  1.34e-02 -5.12e-02 -9.37e-02 -4.56e-02
## 518  4.06e-02  6.03e-05 -3.26e-02  6.82e-03 -2.70e-02 -1.01e-02 -5.33e-02
## 519 -7.42e-03 -3.60e-03  7.86e-03 -8.61e-03  6.15e-03 -1.13e-02  6.15e-04
## 520  6.28e-02 -4.76e-02 -4.47e-02  3.62e-02  3.86e-02 -7.16e-03  7.18e-02
## 521  6.97e-03 -1.32e-02 -1.14e-02  1.27e-02 -6.72e-04  8.04e-03  4.61e-03
## 522 -1.88e-03  4.08e-04  9.24e-04 -1.58e-04 -2.26e-03 -2.22e-03 -1.94e-03
## 523 -2.07e-03  4.14e-03  1.64e-03 -1.31e-03  9.74e-04 -2.11e-03  1.25e-03
## 524  2.67e-01  5.60e-02 -2.66e-01  2.01e-01 -2.24e-01  1.54e-01 -1.05e-01
## 525 -5.10e-03  5.82e-03  3.96e-02 -4.94e-02 -2.09e-02 -6.38e-03  9.76e-03
## 526  5.86e-03  7.95e-03 -7.24e-03  3.22e-03 -1.46e-02  4.24e-03 -1.67e-02
## 527 -2.44e-03 -1.32e-02 -8.16e-04  1.93e-03  6.34e-03 -2.07e-03 -4.06e-03
## 528 -4.18e-02 -1.53e-02  6.06e-02 -3.93e-02 -6.66e-02 -9.43e-02 -1.26e-03
## 529 -3.10e-03 -2.44e-03  4.20e-03 -5.44e-04  9.13e-03  8.65e-03  3.15e-03
## 530 -5.47e-03 -2.92e-05  7.06e-03 -6.27e-03  4.64e-03 -1.72e-03  1.43e-03
## 531 -1.18e-03 -1.51e-02 -2.24e-03  1.17e-02  5.21e-02  4.45e-03  3.27e-02
## 532  2.45e-01  2.38e-01 -4.62e-01  4.56e-01 -2.31e-01  2.13e-01  6.20e-03
## 533 -9.09e-03  3.67e-03  1.79e-03  1.53e-03  7.69e-03 -1.00e-03  3.21e-03
## 534 -2.00e-03  1.45e-03 -2.52e-03  4.81e-03  2.72e-03 -3.86e-04 -2.03e-03
## 535 -6.19e-02  6.32e-02  6.54e-02 -6.66e-02  8.54e-03 -1.32e-01  1.77e-01
## 536 -9.79e-03  1.06e-02  1.76e-03  9.96e-04  4.77e-04 -5.83e-03 -3.93e-03
## 537 -6.00e-03 -3.81e-03  6.41e-03 -2.39e-03 -7.13e-03  7.02e-03 -3.86e-03
## 538  1.10e-02 -4.65e-03 -6.07e-03  3.11e-03  1.45e-03  1.19e-02 -1.78e-03
## 539 -5.72e-05  1.82e-05  4.62e-05 -2.53e-05  1.48e-05 -7.36e-06 -1.36e-05
## 540 -8.84e-04  4.58e-03  1.27e-05  9.56e-04  4.48e-03  2.04e-03  2.83e-03
## 541 -7.04e-03  1.28e-03  1.14e-02 -9.46e-03 -4.61e-03 -1.25e-02 -2.48e-03
## 542 -2.25e-03 -1.02e-03 -3.80e-03  6.15e-03  1.13e-02  2.65e-03 -1.81e-03
## 543  1.71e-02 -1.27e-03 -1.51e-02  7.27e-03 -5.17e-03  1.16e-02 -7.60e-03
## 544  1.48e-03 -9.35e-05 -9.80e-04  1.31e-03  1.18e-03  2.70e-03  5.87e-04
## 545  4.07e-01  1.31e-02 -3.76e-01  2.38e-01  5.74e-02 -5.22e-01 -2.03e-01
## 546 -7.12e-03 -2.80e-03  6.98e-03 -5.78e-03  4.11e-03 -7.86e-03  3.47e-03
## 547 -5.94e-03  1.74e-03  5.46e-03 -4.61e-03  4.92e-04 -5.03e-03 -7.59e-04
## 548  1.43e-04 -4.36e-05 -1.19e-04  4.29e-05 -2.05e-04 -3.51e-05 -1.58e-05
## 549 -2.24e-05  8.64e-03  2.66e-04 -8.35e-04  2.27e-03  4.41e-03 -6.18e-03
## 550 -2.02e-02  1.72e-02  1.05e-02 -7.91e-03 -2.59e-02 -1.74e-02 -1.83e-02
## 551  5.88e-03  8.13e-03  2.45e-03 -1.24e-03 -2.39e-02  1.03e-02  1.14e-02
## 552 -1.54e-02  1.77e-02  8.25e-03 -4.53e-03  2.37e-02 -2.36e-03 -3.88e-03
## 553  4.88e-02  9.22e-02 -6.03e-02  3.10e-02  7.68e-03  1.66e-01  3.28e-02
## 554 -1.04e-03 -1.01e-04  9.73e-04  1.05e-04 -1.13e-03  7.88e-05  2.89e-03
## 555 -1.46e-03  1.04e-02  1.92e-03 -2.35e-03  4.07e-03 -2.41e-03  1.70e-03
## 556 -1.05e-03 -5.72e-05 -7.37e-03 -1.79e-03 -2.03e-02 -3.18e-02 -1.27e-02
## 557 -6.59e-03 -1.02e-03  5.96e-03 -3.60e-03 -2.81e-03 -7.70e-04 -3.91e-05
## 558  2.24e-02  2.86e-02 -2.60e-02  1.76e-02  1.19e-02 -9.71e-03  1.76e-03
## 559  2.60e-03  2.02e-03 -1.45e-03  1.59e-03 -8.66e-04  5.79e-03  1.59e-03
## 560  1.83e-02  6.67e-03 -1.97e-02  8.46e-03 -1.28e-02 -5.59e-03 -5.94e-03
## 561  9.86e-03 -1.87e-02 -2.82e-02  3.71e-02 -2.35e-02  2.69e-02 -5.69e-02
## 562 -7.00e-04  8.06e-03 -1.57e-03  9.35e-04  4.14e-03 -4.35e-04  2.86e-03
## 563  4.65e-03 -1.18e-02 -5.44e-03  4.46e-03  5.67e-03  3.42e-03 -1.69e-03
## 564  4.56e-03  6.83e-03 -5.15e-03  3.61e-03 -1.39e-02  1.77e-03  6.09e-04
## 565  1.47e-02 -5.12e-03 -3.53e-03 -2.39e-03 -1.48e-02  2.77e-03  5.99e-05
## 566 -7.92e-03  1.73e-02  1.58e-02 -1.73e-02  2.85e-03 -9.54e-03  1.41e-02
## 567 -4.72e-02  2.23e-02  4.15e-02 -2.37e-02  3.75e-03 -2.04e-03 -1.13e-02
## 568 -7.77e-04 -1.32e-02  8.22e-03 -1.38e-02  7.67e-03 -1.08e-02 -1.11e-02
## 569 -9.78e-03 -3.04e-02  8.31e-03 -4.52e-03 -2.67e-02 -2.06e-02 -1.85e-02
##       dfb.pnt_   dfb.sym_   dfb.dmn_     dffit cov.r   cook.d     hat inf
## 1    -3.31e-03 -4.22e-03  4.12e-03 -1.33e-02 1.030 1.78e-05 0.01168
## 2     6.15e-03 -2.63e-03  3.74e-02 -5.41e-02 1.027 2.93e-04 0.01271
```

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## 3     2.79e-03  1.58e-02  2.17e-02 -5.98e-02 1.019 3.58e-04 0.00823
## 4     2.75e-02 -2.62e-02 -7.56e-02  1.03e-01 1.050 1.06e-03 0.03519
## 5    -5.64e-03  5.44e-03  2.04e-04  2.45e-02 1.030 6.03e-05 0.01238
## 6    -1.06e-03  1.61e-03 -1.56e-04  2.43e-03 1.028 5.92e-07 0.00975
## 7     1.41e-02 -6.05e-02 -9.52e-03  8.80e-02 1.030 7.75e-04 0.01864
## 8     2.01e-02  7.08e-03  8.13e-03  8.01e-02 1.032 6.42e-04 0.01960
## 9     2.27e-02 -3.98e-02  1.60e-02 -5.94e-02 1.030 3.54e-04 0.01541
## 10   -1.54e-02  9.94e-03 -2.20e-02 -5.38e-02 1.017 2.90e-04 0.00664
## 11    5.57e-02  2.96e-02 -3.25e-02 -1.75e-01 0.982 3.06e-03 0.01134
## 12   -3.72e-06 -3.35e-05 -1.65e-05 -4.95e-05 1.025 2.45e-10 0.00720
## 13    1.06e-02  1.18e-02  1.46e-02 -2.87e-02 1.030 8.24e-05 0.01251
## 14    7.48e-04 -9.38e-04  4.97e-05 -1.68e-03 1.028 2.84e-07 0.00990
## 15   -1.54e-02 -1.94e-02 -5.30e-03  1.19e-01 1.023 1.41e-03 0.01808
## 16    4.00e-02  4.56e-02  2.29e-02 -9.18e-02 1.030 8.44e-04 0.01910
## 17    1.80e-03  4.62e-04 -6.31e-04  4.57e-03 1.028 2.10e-06 0.00953
## 18    2.20e-03  4.50e-04  1.43e-03 -4.06e-03 1.027 1.65e-06 0.00850
## 19   -6.81e-02 -7.40e-02 -2.56e-01 -3.02e-01 1.026 9.08e-03 0.04326
## 20    1.56e-02 -9.33e-03  6.15e-03 -9.41e-02 1.009 8.86e-04 0.00879
## 21   -5.93e-03  6.33e-03  1.37e-03 -1.21e-02 1.027 1.48e-05 0.00895
## 22    3.41e-04  9.22e-03  3.76e-03  1.40e-01 1.037 1.97e-03 0.02983
## 23   -2.25e-02  5.23e-02 -1.44e-02 -7.99e-02 1.016 6.39e-04 0.00970
## 24    9.86e-02 -3.81e-02 -1.41e-01  2.79e-01 0.992 7.78e-03 0.02601
## 25    5.10e-03  2.05e-03 -1.57e-02 -2.88e-02 1.034 8.30e-05 0.01637
## 26   -1.54e-03  5.28e-03  2.17e-05 -1.05e-02 1.026 1.10e-05 0.00826
## 27    6.42e-04  3.75e-04  8.64e-04 -1.52e-03 1.029 2.31e-07 0.01082
## 28   -2.39e-02  2.25e-02  3.51e-02 -9.96e-02 1.014 9.92e-04 0.01142
## 29    7.75e-03  2.24e-02  1.36e-02  6.35e-02 1.031 4.04e-04 0.01708
## 30   -3.95e-03  2.06e-03  4.31e-04  1.43e-02 1.024 2.04e-05 0.00593
## 31    2.61e-03  2.34e-03  9.68e-04 -9.45e-03 1.027 8.95e-06 0.00878
## 32   -1.87e-03  7.56e-03 -1.34e-02 -3.68e-02 1.023 1.36e-04 0.00773
## 33   -3.39e-02  9.24e-02 -1.37e-01 -2.49e-01 1.006 6.18e-03 0.02721
## 34    2.18e-03  4.93e-03 -5.94e-03  9.91e-03 1.029 9.85e-06 0.01093
## 35   -1.14e-02 -2.20e-03 -2.01e-02  3.78e-02 1.027 1.43e-04 0.01123
## 36    1.22e-02 -1.82e-02 -2.95e-03 -5.64e-02 1.017 3.18e-04 0.00715
## 37    1.66e-02 -1.47e-02 -9.11e-04  4.52e-02 1.022 2.04e-04 0.00854
## 38    5.30e-02 -2.02e-02 -1.68e-01 -2.44e-01 1.018 5.97e-03 0.03175
## 39   -1.33e-02 -1.02e-02  1.72e-03 -2.72e-02 1.025 7.43e-05 0.00822
## 40    4.13e-03  1.96e-02  9.50e-03 -6.16e-02 1.022 3.80e-04 0.01038
## 41   -2.98e-03  4.76e-03  1.05e-02  5.94e-02 1.029 3.54e-04 0.01515
## 42   -7.44e-03  1.89e-04  9.57e-03 -3.57e-02 1.034 1.28e-04 0.01684
## 43    4.62e-02  4.13e-02  2.82e-01  7.39e-01 0.882 5.37e-02 0.04792   *
## 44    1.61e-02  6.82e-03 -5.13e-02 -6.48e-02 1.044 4.20e-04 0.02706
## 45    3.70e-03 -1.33e-02 -2.47e-03 -2.79e-02 1.032 7.77e-05 0.01450
## 46   -8.23e-03  2.31e-02  6.01e-03  7.50e-02 1.021 5.63e-04 0.01154
## 47   -2.75e-02  1.46e-02 -2.40e-02 -6.30e-02 1.019 3.98e-04 0.00901
## 48   -4.42e-02  3.46e-02  5.16e-02 -1.89e-01 1.075 3.56e-03 0.06224   *
## 49    9.01e-04 -1.29e-03 -3.90e-03  5.80e-03 1.026 3.37e-06 0.00786
## 50    3.76e-03  1.07e-03 -1.89e-02  6.15e-02 1.012 3.78e-04 0.00569
## 51   -1.44e-03  2.58e-02  9.95e-03  7.89e-02 1.015 6.22e-04 0.00906
## 52   -1.44e-02  1.83e-02 -1.21e-02  6.58e-02 1.024 4.33e-04 0.01186
## 53    2.51e-03 -4.51e-03  2.44e-03 -1.00e-02 1.022 1.01e-05 0.00454
## 54   -5.75e-04 -3.52e-02  3.07e-03  6.05e-02 1.035 3.66e-04 0.01972
## 55    1.40e-01 -8.97e-02  6.69e-02 -7.23e-01 0.802 5.10e-02 0.03282   *
## 56    1.63e-01 -5.46e-02 -5.31e-02  3.05e-01 0.878 9.19e-03 0.01034   *
## 57   -8.43e-03  2.56e-02 -2.00e-02 -6.00e-02 1.028 3.61e-04 0.01405
## 58    1.17e-02 -1.15e-03  2.99e-02 -6.58e-02 1.019 4.34e-04 0.00927
## 59    7.35e-02 -6.60e-02  1.10e-01 -3.42e-01 1.036 1.17e-02 0.05340   *
## 60   -1.64e-02  2.73e-03 -2.29e-02  1.43e-01 0.974 2.04e-03 0.00703
## 61   -9.68e-03  1.74e-02 -1.63e-02  5.19e-02 1.049 2.70e-04 0.03133
## 62    8.24e-03 -2.80e-02 -5.24e-03  4.08e-02 1.035 1.67e-04 0.01822
## 63    2.35e-02  2.79e-02  8.74e-04 -5.04e-02 1.049 2.55e-04 0.03123
## 64    5.00e-03 -1.07e-02  5.32e-03 -2.60e-02 1.023 6.78e-05 0.00628
## 65    2.52e-02  1.30e-01 -8.60e-02  2.97e-01 0.991 8.79e-03 0.02793
## 66    1.02e-03  2.19e-03 -1.42e-03 -4.15e-03 1.029 1.72e-06 0.01050
## 67    8.59e-04 -2.37e-03  7.28e-05  6.90e-03 1.024 4.77e-06 0.00580
## 68   -3.24e-03  1.04e-02  2.56e-03  4.29e-02 1.024 1.84e-04 0.00947
## 69    6.73e-05  9.27e-03 -1.04e-03  1.26e-02 1.029 1.60e-05 0.01100
## 70    6.56e-04 -1.41e-04  3.18e-04 -1.33e-03 1.024 1.78e-07 0.00616
## 71   -5.42e-04  3.04e-03  2.05e-03 -5.92e-03 1.023 3.52e-06 0.00539
## 72   -2.84e-03 -1.21e-02  3.92e-02 -7.55e-02 1.016 5.70e-04 0.00926
## 73   -8.34e-02  9.96e-02  1.10e-01  5.72e-01 0.930 3.23e-02 0.04192   *
## 74   -1.10e-02 -7.72e-02  2.16e-02  1.67e-01 1.015 2.79e-03 0.02033
## 75   -5.54e-02  4.84e-02 -2.59e-03  1.04e-01 1.024 1.08e-03 0.01681
```

```
## 76    9.95e-03  7.32e-03  3.17e-03  2.06e-02 1.024 4.23e-05 0.00711
## 77   -8.67e-03 -2.86e-03  1.23e-02  6.45e-02 1.017 4.17e-04 0.00791
## 78   -3.35e-03  2.09e-03  3.10e-03 -7.32e-03 1.030 5.37e-06 0.01158
## 79    2.34e-04  8.83e-03 -2.37e-04 -3.20e-02 1.022 1.02e-04 0.00681
## 80    2.92e-02  1.69e-02  1.48e-02  6.49e-02 1.018 4.22e-04 0.00865
## 81   -2.25e-03  3.99e-03 -5.73e-03  3.03e-02 1.024 9.19e-05 0.00807
## 82   -5.68e-03 -1.16e-03 -2.97e-02  3.84e-02 1.031 1.48e-04 0.01449
## 83    1.10e-03 -5.95e-03  2.29e-03 -1.38e-02 1.023 1.91e-05 0.00548
## 84    1.37e-02  1.45e-02 -1.52e-02  5.13e-02 1.025 2.63e-04 0.01083
## 85   -6.84e-03 -4.80e-05  2.58e-03 -2.23e-02 1.034 4.96e-05 0.01624
## 86   -1.51e-03  5.06e-03 -1.23e-03 -1.62e-02 1.033 2.64e-05 0.01515
## 87   -5.12e-03  8.44e-04  7.42e-03 -2.10e-02 1.026 4.42e-05 0.00877
## 88   -2.36e-02  5.38e-02 -1.67e-02 -1.26e-01 1.035 1.59e-03 0.02631
## 89   -3.87e-03  2.89e-02 -1.19e-02  3.12e-01 0.941 9.67e-03 0.01767    *
## 90   -2.63e-03 -5.96e-03  2.70e-02  3.64e-02 1.027 1.33e-04 0.01105
## 91    4.49e-03  1.37e-02 -4.26e-02 -6.97e-02 1.027 4.87e-04 0.01446
## 92   -2.54e-04  2.62e-02  8.66e-03 -4.57e-02 1.015 2.09e-04 0.00460
## 93   -8.68e-03 -8.74e-04  8.18e-03  3.44e-02 1.023 1.18e-04 0.00761
## 94    7.22e-04  2.14e-03 -7.46e-03  2.41e-02 1.027 5.81e-05 0.01004
## 95   -4.97e-01  1.83e-01 -2.97e-01  9.52e-01 0.746 8.76e-02 0.04295    *
## 96   -5.27e-03  5.53e-03  1.24e-02 -2.94e-02 1.027 8.64e-05 0.01022
## 97    1.32e-02 -5.98e-02  7.82e-03 -1.33e-01 1.001 1.76e-03 0.01112
## 98   -6.23e-03 -7.42e-03  7.10e-03 -1.73e-02 1.026 3.01e-05 0.00864
## 99   -8.10e-04 -3.53e-03 -3.99e-03 -2.60e-02 1.026 6.75e-05 0.00890
## 100  -4.02e-02  4.83e-02 -3.33e-03 -1.43e-01 1.062 2.05e-03 0.04848    *
## 101  -5.43e-02 -6.74e-02 -7.08e-02  1.48e-01 1.014 2.19e-03 0.01759
## 102  -3.29e-02 -1.24e-02 -4.41e-02 -8.79e-02 1.034 7.74e-04 0.02185
## 103  -6.77e-04  1.44e-04  7.06e-04 -2.31e-03 1.026 5.34e-07 0.00734
## 104  -9.39e-03  9.25e-03 -7.05e-03 -2.77e-02 1.025 7.68e-05 0.00876
## 105   4.47e-04  1.47e-04 -1.44e-04 -1.43e-03 1.029 2.05e-07 0.01068
## 106   3.16e-02  1.90e-03 -2.96e-03 -5.29e-02 1.022 2.81e-04 0.00902
## 107  -3.26e-03  7.66e-03  5.04e-03 -1.37e-02 1.029 1.88e-05 0.01051
## 108   1.37e-02 -5.95e-03 -1.74e-03 -1.66e-02 1.041 2.76e-05 0.02209
## 109   5.02e-05 -8.09e-03 -1.27e-03 -1.57e-02 1.032 2.47e-05 0.01354
## 110   1.19e-02  9.62e-03  7.57e-03 -3.95e-02 1.026 1.56e-04 0.01034
## 111  -6.97e-03 -4.53e-03 -7.97e-03  2.10e-02 1.028 4.40e-05 0.01059
## 112  -5.59e-02  7.29e-02  8.73e-02  2.60e-01 1.027 6.77e-03 0.03854
## 113  -3.41e-03  4.00e-02  9.18e-02  1.56e-01 1.009 2.44e-03 0.01651
## 114   2.48e-02  1.35e-02  1.09e-02 -7.23e-02 1.037 5.23e-04 0.02224
## 115   1.82e-03  8.29e-03  2.13e-03 -2.13e-02 1.023 4.56e-05 0.00610
## 116  -4.56e-02 -7.53e-02 -7.40e-02  1.71e-01 0.995 2.93e-03 0.01411
## 117   9.12e-04  3.05e-03  3.16e-03  1.11e-02 1.022 1.24e-05 0.00420
## 118   4.43e-03 -1.25e-02  3.72e-04  5.69e-02 1.024 3.24e-04 0.01073
## 119   3.96e-04  7.14e-02 -2.62e-02  1.39e-01 1.006 1.94e-03 0.01360
## 120   9.89e-03  1.17e-02 -2.97e-02  6.04e-02 1.014 3.65e-04 0.00631
## 121  -7.46e-03  1.24e-04  3.13e-03  1.19e-02 1.028 1.43e-05 0.00960
## 122  -8.24e-03 -2.10e-02 -2.15e-01  3.01e-01 0.946 9.01e-03 0.01751    *
## 123  -1.61e-02 -4.89e-02  4.55e-03 -9.46e-02 1.022 8.96e-04 0.01464
## 124  -5.19e-02  2.01e-02 -4.96e-02  3.22e-01 1.000 1.03e-02 0.03411
## 125  -9.59e-03  3.84e-03 -8.96e-03 -2.08e-02 1.023 4.31e-05 0.00641
## 126   2.53e-03  1.44e-02  3.93e-03 -2.01e-02 1.025 4.05e-05 0.00800
## 127   4.13e-03 -3.17e-02  8.53e-03  8.93e-02 1.047 7.99e-04 0.03212
## 128   1.16e-02 -3.23e-03 -5.91e-03  2.47e-02 1.030 6.12e-05 0.01255
## 129  -1.41e-02  1.97e-02 -5.44e-03  3.61e-02 1.034 1.30e-04 0.01643
## 130   1.56e-02 -4.58e-03  3.01e-02 -6.67e-02 1.027 4.45e-04 0.01391
## 131   3.63e-02  3.10e-02  1.09e-01 -2.46e-01 1.023 6.07e-03 0.03465
## 132  -2.96e-03 -1.65e-03  8.91e-03 -2.39e-02 1.021 5.71e-05 0.00462
## 133  -1.44e-02  4.47e-03  1.14e-03 -4.07e-02 1.032 1.66e-04 0.01498
## 134   1.84e-02 -9.63e-03  3.00e-03  5.66e-02 1.058 3.21e-04 0.03880    *
## 135  -6.29e-03 -3.38e-04 -2.17e-02 -2.72e-02 1.057 7.39e-05 0.03689    *
## 136  -2.16e-05 -1.71e-06  1.43e-05 -6.08e-05 1.024 3.71e-10 0.00611
## 137   9.07e-03 -9.22e-03 -2.24e-03 -3.70e-02 1.036 1.37e-04 0.01869
## 138  -2.16e-03  9.06e-03  5.66e-03 -4.11e-02 1.022 1.69e-04 0.00746
## 139  -4.26e-02  1.80e-02 -1.76e-02 -8.01e-02 1.037 6.43e-04 0.02282
## 140  -5.12e-04 -8.27e-03 -6.34e-03 -1.48e-02 1.026 2.18e-05 0.00821
## 141   8.61e-03  3.34e-03 -4.71e-03 -3.04e-02 1.025 9.25e-05 0.00828
## 142   3.70e-02  8.30e-03  3.40e-03  1.46e-01 1.056 2.14e-03 0.04356    *
## 143   4.38e-02 -2.64e-03  2.96e-02  1.48e-01 1.015 2.18e-03 0.01806
## 144   9.20e-04  2.14e-02  8.76e-03 -7.36e-02 1.026 5.42e-04 0.01407
## 145   2.75e-03  1.28e-03 -7.90e-04  5.41e-03 1.038 2.93e-06 0.01889
## 146   1.89e-02  2.07e-04  2.42e-02 -4.89e-02 1.023 2.39e-04 0.00964
## 147   6.56e-04 -1.28e-04 -6.80e-04  2.25e-03 1.024 5.09e-07 0.00575
## 148  -8.00e-03 -2.03e-02 -1.21e-03  4.43e-02 1.023 1.96e-04 0.00883
```

```
## 148 -8.00e-03 -2.05e-02 -1.21e-03  4.42e-02 1.023 1.96e-04 0.00885
## 149  1.80e-03 -8.48e-04 -6.60e-05  4.01e-03 1.027 1.61e-06 0.00885
## 150  5.10e-04 -1.31e-03  4.78e-04  5.27e-03 1.022 2.78e-06 0.00372
## 151  7.67e-03  2.47e-02  9.36e-04 -3.53e-02 1.028 1.25e-04 0.01149
## 152 -5.06e-04 -6.35e-03 -1.10e-03 -8.32e-03 1.052 6.94e-06 0.03242
## 153 -4.01e-03 -2.70e-03  8.16e-04 -3.59e-02 1.020 1.29e-04 0.00560
## 154  1.30e-02 -2.17e-02  9.25e-03 -5.13e-02 1.020 2.63e-04 0.00785
## 155 -1.02e-02  1.28e-02 -1.53e-02 -4.10e-02 1.037 1.68e-04 0.01997
## 156 -8.88e-03  3.17e-02 -2.30e-02 -7.03e-02 1.028 4.95e-04 0.01529
## 157 -6.08e-03  1.00e-03  1.54e-03  1.74e-02 1.024 3.04e-05 0.00674
## 158 -1.95e-02  2.43e-02  3.41e-02 -1.02e-01 1.026 1.04e-03 0.01763
## 159 -4.46e-03 -5.27e-02  1.59e-02 -6.35e-02 1.048 4.04e-04 0.03069
## 160 -1.49e-03 -2.16e-03  2.93e-03 -8.20e-03 1.024 6.74e-06 0.00569
## 161  5.19e-03 -4.81e-03 -4.86e-03  1.35e-02 1.034 1.83e-05 0.01526
## 162 -5.81e-03 -7.09e-03  3.70e-03 -1.19e-02 1.080 1.43e-05 0.05750    *
## 163  2.33e-04  1.14e-03 -1.10e-03 -2.73e-03 1.027 7.48e-07 0.00856
## 164 -6.74e-02 -3.34e-02 -7.79e-02 -1.57e-01 1.041 2.46e-03 0.03436
## 165 -2.66e-02 -2.58e-02 -8.49e-04  1.04e-01 1.050 1.09e-03 0.03542
## 166  2.42e-02 -1.26e-02 -8.06e-03  8.39e-02 1.122 7.05e-04 0.09395    *
## 167 -1.42e-03 -1.31e-02  1.26e-02 -2.59e-02 1.034 6.74e-05 0.01622
## 168 -5.46e-02 -8.10e-02  8.44e-02 -1.84e-01 1.002 3.37e-03 0.01763
## 169  2.35e-02 -9.02e-03 -3.03e-03 -5.60e-02 1.020 3.14e-04 0.00829
## 170  1.52e-03  8.70e-04  6.90e-04 -3.10e-03 1.027 9.61e-07 0.00844
## 171  1.41e-02  7.05e-03  2.82e-03  2.90e-02 1.029 8.41e-05 0.01208
## 172  7.84e-03 -9.73e-03  4.82e-03  1.97e-02 1.026 3.90e-05 0.00882
## 173 -1.17e-02  2.12e-02  3.40e-02  8.94e-02 1.027 8.01e-04 0.01722
## 174 -1.78e-02 -5.19e-03 -9.79e-03  7.47e-02 1.010 5.59e-04 0.00690
## 175  4.35e-03 -9.76e-03 -1.23e-02  3.65e-02 1.019 1.33e-04 0.00550
## 176  7.67e-03  2.12e-03  8.03e-03 -1.46e-02 1.027 2.15e-05 0.00954
## 177  6.55e-03  1.90e-02  2.32e-02  1.18e-01 0.996 1.38e-03 0.00809
## 178 -1.42e-03  8.51e-03 -1.41e-02 -5.26e-02 1.022 2.77e-04 0.00934
## 179 -1.71e-02 -1.26e-02 -3.93e-02  7.55e-02 1.021 5.71e-04 0.01135
## 180 -3.98e-03 -4.77e-03  3.72e-04 -1.50e-02 1.025 2.24e-05 0.00726
## 181  5.48e-03  3.19e-03 -3.00e-03  8.87e-03 1.028 7.88e-06 0.00979
## 182  1.97e-02  4.23e-03 -1.56e-02  3.92e-02 1.024 1.54e-04 0.00899
## 183  3.88e-03  1.53e-03 -2.93e-03 -1.36e-02 1.028 1.86e-05 0.00958
## 184  2.57e-02  2.40e-02 -1.22e-02 -7.88e-02 1.007 6.21e-04 0.00644
## 185  7.58e-02 -4.23e-02  5.78e-02 -1.47e-01 1.011 2.15e-03 0.01607
## 186 -1.23e-02  1.57e-02  4.39e-03 -3.77e-02 1.027 1.43e-04 0.01118
## 187 -3.15e-02 -1.13e-02  8.69e-03 -6.86e-02 1.026 4.71e-04 0.01369
## 188 -7.94e-03 -1.22e-03  1.02e-02  2.85e-02 1.024 8.15e-05 0.00800
## 189  5.60e-03  4.71e-02  1.67e-03  9.67e-02 1.025 9.36e-04 0.01631
## 190 -2.60e-02 -4.73e-02  3.58e-03 -7.95e-02 1.027 6.33e-04 0.01550
## 191 -1.21e-03  2.93e-03  7.60e-03  1.59e-02 1.022 2.53e-05 0.00501
## 192  3.62e-04  7.51e-03  3.31e-02 -5.77e-02 1.029 3.33e-04 0.01457
## 193 -5.23e-03  1.28e-03 -3.84e-03  2.29e-02 1.026 5.27e-05 0.00921
## 194  2.40e-02 -4.27e-02 -2.66e-02 -1.03e-01 1.028 1.05e-03 0.01937
## 195  1.11e-02 -2.70e-02 -3.40e-02  7.91e-02 1.005 6.25e-04 0.00602
## 196 -6.64e-01  3.64e-01 -5.05e-01 -9.90e-01 0.868 9.60e-02 0.06968    *
## 197  2.88e-03 -4.78e-03  9.51e-03  1.89e-02 1.037 3.59e-05 0.01838
## 198  7.06e-03  3.94e-04 -2.07e-03 -2.95e-02 1.026 8.74e-05 0.00911
## 199 -3.07e-03 -1.58e-03 -1.64e-03  6.71e-03 1.031 4.51e-06 0.01252
## 200  1.50e-04  3.01e-03  1.66e-03 -2.53e-02 1.026 6.40e-05 0.00900
## 201 -9.03e-03 -4.89e-03  6.02e-03  4.89e-02 1.029 2.39e-04 0.01354
## 202  3.52e-03 -2.71e-02  1.54e-02 -4.67e-02 1.027 2.19e-04 0.01198
## 203  9.33e-04 -1.73e-03  1.05e-04 -3.46e-03 1.027 1.20e-06 0.00825
## 204  5.00e-02 -2.55e-02  4.25e-02  8.02e-02 1.022 6.44e-04 0.01288
## 205  6.76e-03 -2.27e-02 -9.63e-03 -7.44e-02 1.024 5.54e-04 0.01342
## 206  3.48e-02  4.02e-02 -1.63e-03 -9.50e-02 1.029 9.04e-04 0.01910
## 207  5.10e-04 -1.56e-03 -1.56e-03  3.60e-03 1.024 1.30e-06 0.00614
## 208 -2.89e-02  1.26e-02 -1.05e-02 -4.48e-02 1.025 2.01e-04 0.01046
## 209  1.42e-03  1.32e-03  6.41e-04 -5.33e-03 1.032 2.84e-06 0.01385
## 210  8.37e-02  3.45e-02  2.05e-02  3.30e-01 1.021 1.09e-02 0.04433
## 211  4.44e-03  1.67e-02  1.35e-02 -3.81e-02 1.037 1.45e-04 0.01963
## 212  1.10e-01  1.32e-02  5.06e-02  2.03e-01 0.959 4.09e-03 0.01039
## 213 -6.37e-02 -1.62e-02 -4.23e-02  1.23e-01 1.014 1.51e-03 0.01439
## 214 -3.97e-04 -2.20e-03 -7.85e-03  1.25e-02 1.032 1.55e-05 0.01347
## 215  6.42e-05 -2.84e-06  1.47e-05 -1.04e-04 1.028 1.08e-09 0.00963
## 216  2.13e-03 -7.33e-03 -9.01e-04 -8.77e-03 1.069 7.71e-06 0.04745    *
## 217 -8.99e-03  7.89e-03 -5.03e-04  1.93e-02 1.033 3.75e-05 0.01457
## 218 -5.51e-03 -8.62e-03 -5.18e-03  1.82e-02 1.030 3.33e-05 0.01212
## 219  1.15e-02 -7.05e-03  6.07e-03  4.94e-02 1.030 2.44e-04 0.01428
## 220 -9.12e-03  4.74e-02  8.54e-02  3.26e-01 1.012 1.06e-02 0.03928
```

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## 221  2.92e-03  2.41e-03  2.28e-03 -1.07e-02 1.028 1.15e-05 0.00940
## 222  9.67e-04 -6.28e-04  2.32e-03  4.41e-03 1.030 1.95e-06 0.01150
## 223 -2.74e-02 -2.15e-02  1.34e-02  7.01e-02 1.028 4.92e-04 0.01534
## 224  2.05e-02 -1.64e-04 -2.02e-02 -4.70e-02 1.029 2.21e-04 0.01324
## 225  2.64e-02 -4.89e-02  1.70e-02 -8.47e-02 1.016 7.17e-04 0.01015
## 226  2.83e-02 -6.50e-02 -6.18e-02 -1.45e-01 1.035 2.09e-03 0.02903
## 227  2.52e-01 -1.59e-01  3.86e-01  7.94e-01 0.938 6.22e-02 0.06844   *
## 228 -1.08e-02  1.07e-02 -2.70e-03 -2.84e-02 1.035 8.10e-05 0.01762
## 229  2.04e-03 -2.68e-03 -2.07e-03  5.27e-03 1.032 2.78e-06 0.01335
## 230  1.13e-02 -2.48e-02 -1.20e-02 -6.45e-02 1.015 4.16e-04 0.00721
## 231 -6.05e-03  6.56e-04 -4.34e-03  1.67e-02 1.039 2.78e-05 0.02009
## 232 -2.71e-05  2.02e-05  2.00e-05 -1.08e-04 1.025 1.17e-09 0.00629
## 233  6.15e-02  5.99e-02 -3.30e-02 -2.38e-01 1.082 5.67e-03 0.07145   *
## 234  2.75e-04 -1.27e-04 -1.14e-04  5.86e-03 1.029 3.44e-06 0.01104
## 235  2.33e-03  6.66e-03 -5.66e-03 -8.22e-02 1.030 6.76e-04 0.01823
## 236  1.17e-02  2.81e-03  2.07e-02 -5.65e-02 1.022 3.19e-04 0.00941
## 237 -4.09e-02  7.20e-02  6.62e-02 -1.51e-01 1.028 2.29e-03 0.02551
## 238 -9.26e-03  1.39e-02 -6.34e-04 -4.99e-02 1.034 2.50e-04 0.01762
## 239  9.77e-04 -7.45e-03  5.79e-03 -3.25e-02 1.029 1.06e-04 0.01218
## 240 -1.60e-02  8.38e-03  1.03e-03 -6.01e-02 1.027 3.61e-04 0.01306
## 241 -3.88e-03 -5.02e-04 -8.43e-03  1.21e-02 1.029 1.48e-05 0.01086
## 242  3.04e-04  4.22e-02 -5.17e-02 -1.27e-01 1.031 1.62e-03 0.02408
## 243 -6.24e-03  3.06e-02 -9.06e-03 -5.20e-02 1.037 2.71e-04 0.02078
## 244 -9.65e-02  1.75e-03  2.27e-02  1.69e-01 1.004 2.84e-03 0.01654
## 245 -2.10e-01 -9.88e-02  4.42e-02  3.20e-01 0.967 1.02e-02 0.02358
## 246 -1.62e-04  1.36e-04  1.35e-04 -5.68e-04 1.029 3.23e-08 0.01057
## 247 -2.38e-02  1.20e-04 -3.10e-02 -7.16e-02 1.022 5.14e-04 0.01185
## 248  1.09e-01 -3.40e-02 -2.21e-02 -1.95e-01 0.973 3.79e-03 0.01169
## 249 -1.10e-02 -2.02e-04  1.43e-02 -3.98e-02 1.040 1.59e-04 0.02256
## 250 -8.51e-04  2.54e-03 -3.07e-03 -2.44e-02 1.032 5.95e-05 0.01398
## 251 -3.31e-03  3.24e-03 -5.25e-03 -9.99e-03 1.036 1.00e-05 0.01721
## 252 -9.90e-02 -2.20e-02  9.59e-02 -5.07e-01 0.985 2.56e-02 0.05101   *
## 253 -1.03e-03  1.67e-04  4.44e-03  8.55e-03 1.035 7.32e-06 0.01643
## 254  4.54e-01  1.28e-01  2.54e-01 -8.21e-01 0.803 6.56e-02 0.04088   *
## 255 -8.05e-04 -7.21e-04 -1.27e-03 -1.26e-02 1.042 1.58e-05 0.02290
## 256  3.77e-03 -2.57e-02  7.35e-03 -7.18e-02 1.029 5.16e-04 0.01585
## 257  3.25e-02  1.91e-02  3.06e-03 -5.69e-02 1.025 3.24e-04 0.01173
## 258 -2.00e-02  1.28e-02  1.62e-02 -5.12e-02 1.016 2.62e-04 0.00579
## 259 -2.87e-05  3.29e-04  4.53e-04 -1.30e-03 1.027 1.69e-07 0.00863
## 260 -7.20e-03 -4.37e-03  9.21e-03 -2.14e-02 1.027 4.59e-05 0.00938
## 261 -9.03e-04  3.54e-03 -1.14e-02  1.73e-02 1.025 3.00e-05 0.00726
## 262  2.30e-02 -2.31e-02 -3.50e-02  8.25e-02 1.038 6.82e-04 0.02372
## 263 -7.95e-03  4.55e-04  2.46e-02 -4.08e-02 1.030 1.66e-04 0.01389
## 264 -1.82e-03 -3.49e-04  9.02e-04  1.20e-02 1.023 1.45e-05 0.00503
## 265  3.52e-03  2.79e-03 -2.11e-04  1.35e-02 1.053 1.81e-05 0.03291
## 266 -1.41e-02 -9.98e-03  1.34e-02 -5.66e-02 1.033 3.21e-04 0.01724
## 267  5.51e-03 -2.45e-02  3.34e-03 -5.04e-02 1.029 2.54e-04 0.01370
## 268 -3.10e-03  3.38e-03 -2.94e-02 -4.30e-02 1.076 1.85e-04 0.05417   *
## 269  7.59e-04  8.77e-03 -1.36e-02 -4.73e-02 1.018 2.24e-04 0.00638
## 270  6.62e-02 -1.45e-02  7.37e-03 -9.43e-02 1.025 8.90e-04 0.01636
## 271 -8.88e-03  6.06e-03  1.02e-02 -1.99e-02 1.032 3.95e-05 0.01414
## 272 -2.65e-02 -3.54e-01 -7.34e-01 -1.29e+00 0.668 1.60e-01 0.05737   *
## 273  6.67e-03  9.09e-04  5.46e-03  1.35e-02 1.027 1.84e-05 0.00923
## 274  4.93e-03 -1.05e-03  2.00e-02 -4.77e-02 1.011 2.28e-04 0.00380
## 275  7.06e-02 -1.37e-03  6.31e-02 -2.11e-01 0.996 4.46e-03 0.01914
## 276  3.02e-01  1.17e-01  1.01e-01 -1.08e+00 1.112 1.15e-01 0.17176   *
## 277  1.97e-03 -4.85e-03 -9.45e-04  7.98e-03 1.026 6.39e-06 0.00764
## 278 -2.06e-04 -5.31e-04 -7.67e-05  2.45e-03 1.031 5.99e-07 0.01212
## 279 -7.73e-04 -1.92e-03  8.51e-07 -1.20e-02 1.027 1.44e-05 0.00875
## 280 -1.16e-04 -6.13e-05 -1.40e-04 -3.76e-04 1.063 1.42e-08 0.04213   *
## 281  9.46e-02  1.38e-02 -9.62e-02  3.36e-01 0.977 1.12e-02 0.02813
## 282  2.58e-03 -2.36e-03 -3.41e-02 -5.32e-02 1.020 2.83e-04 0.00803
## 283 -9.61e-04 -1.13e-03  7.88e-04  4.76e-03 1.023 2.27e-06 0.00478
## 284  3.22e-03  1.42e-05 -5.36e-03  1.51e-02 1.024 2.28e-05 0.00613
## 285  1.36e-03  5.30e-03  5.17e-04  1.69e-02 1.024 2.86e-05 0.00695
## 286 -1.05e-03 -1.36e-03 -1.29e-03  2.96e-03 1.029 8.76e-07 0.01066
## 287  2.19e-02  3.47e-02  1.46e-03  5.75e-02 1.027 3.31e-04 0.01329
## 288  4.70e-03 -3.41e-03  4.09e-02  6.85e-02 1.024 4.70e-04 0.01239
## 289  1.34e-02  5.10e-02 -1.59e-02  1.44e-01 1.024 2.08e-03 0.02183
## 290  8.93e-03 -2.59e-02 -2.01e-03  3.99e-02 1.025 1.60e-04 0.00979
## 291 -5.23e-04 -3.97e-04  1.43e-03 -4.82e-03 1.044 2.33e-06 0.02440
## 292  6.82e-03 -1.56e-02  2.22e-03 -2.84e-02 1.025 8.06e-05 0.00817
## 293  1.87e-02  2.16e-02 -2.33e-02 -9.86e-02 1.025 9.73e-04 0.01680
```

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## 294  3.42e-03  6.78e-04  4.56e-03 -8.45e-03 1.023 7.15e-06 0.00483
## 295  3.57e-02 -1.91e-02 -7.81e-03  6.09e-02 1.040 3.71e-04 0.02343
## 296 -1.96e-02 -3.71e-04 -6.68e-02 -1.88e-01 1.059 3.53e-03 0.05001    *
## 297 -1.34e-01 -4.57e-02 -3.83e-02 -2.14e-01 0.985 4.55e-03 0.01627
## 298 -8.00e-03  1.24e-02  3.50e-03 -3.63e-02 1.029 1.32e-04 0.01249
## 299  1.09e-02  1.49e-02 -4.38e-03 -4.26e-02 1.026 1.81e-04 0.01070
## 300  4.74e-02 -3.21e-02  6.23e-02 -1.85e-01 0.995 3.43e-03 0.01576
## 301 -2.54e-02  2.84e-03  1.58e-02 -4.20e-02 1.043 1.77e-04 0.02479
## 302  1.43e-04 -2.66e-04 -3.08e-04 -1.19e-03 1.032 1.41e-07 0.01342
## 303 -2.16e-03  1.91e-03  1.79e-03 -7.02e-03 1.032 4.94e-06 0.01380
## 304 -2.99e-02 -7.16e-03 -2.68e-02 -5.03e-02 1.031 2.54e-04 0.01559
## 305 -5.89e-03  1.44e-02  1.74e-02  5.79e-02 1.009 3.36e-04 0.00456
## 306 -1.13e-02 -1.62e-02  1.03e-02  4.47e-02 1.038 2.00e-04 0.02042
## 307  3.57e-02 -1.60e-03  1.22e-02 -1.74e-01 1.029 3.01e-03 0.02858
## 308 -9.95e-03 -1.61e-03 -2.51e-03  2.13e-02 1.023 4.53e-05 0.00594
## 309  1.01e-02 -1.07e-03 -1.10e-02 -2.39e-02 1.032 5.71e-05 0.01424
## 310  5.04e-03 -2.89e-03  6.32e-03 -1.64e-02 1.026 2.71e-05 0.00873
## 311  1.63e-02  3.62e-02 -1.31e-02  6.48e-02 1.031 4.20e-04 0.01705
## 312  3.08e-03 -9.94e-05 -1.25e-03  7.07e-03 1.028 5.00e-06 0.01018
## 313 -1.63e-02 -1.19e-03  5.98e-03  4.48e-02 1.016 2.01e-04 0.00500
## 314 -3.82e-02 -2.34e-03  1.79e-02 -5.69e-02 1.071 3.25e-04 0.05023    *
## 315  9.54e-03 -4.17e-06 -2.12e-03  2.00e-02 1.024 4.00e-05 0.00701
## 316  4.10e-03  9.68e-03 -1.72e-02 -5.24e-02 1.034 2.75e-04 0.01810
## 317  2.74e-02  9.43e-03 -4.03e-02 -2.60e-01 0.965 6.72e-03 0.01691
## 318  2.97e-02  1.33e-02  1.02e-01  2.88e-01 1.016 8.27e-03 0.03649
## 319  2.75e-03 -1.40e-02 -3.00e-03 -2.49e-02 1.025 6.21e-05 0.00800
## 320 -1.53e-03 -1.68e-02  1.13e-02  4.68e-02 1.021 2.19e-04 0.00782
## 321  3.13e-02 -2.08e-02 -2.58e-02 -8.49e-02 1.025 7.22e-04 0.01505
## 322 -2.21e-02  3.92e-03 -2.32e-02  3.72e-02 1.031 1.39e-04 0.01394
## 323 -4.09e-02  1.27e-01 -1.07e-03  2.25e-01 0.965 5.03e-03 0.01332
## 324  2.64e-03  1.56e-03  1.93e-03 -8.05e-03 1.024 6.49e-06 0.00581
## 325 -1.96e-03  9.93e-04 -6.99e-03 -2.70e-02 1.024 7.28e-05 0.00761
## 326 -2.46e-02 -5.67e-02 -5.22e-02 -1.04e-01 1.025 1.08e-03 0.01744
## 327 -1.01e-02 -7.60e-03  2.67e-03  2.57e-02 1.026 6.59e-05 0.00865
## 328  1.20e-02 -6.31e-03 -6.24e-02 -1.18e-01 1.019 1.38e-03 0.01620
## 329  5.05e-02 -1.07e-01  4.64e-03 -1.40e-01 1.051 1.97e-03 0.03992
## 330  2.56e-02 -8.70e-03 -1.35e-03  1.23e-01 1.052 1.52e-03 0.03839
## 331  1.21e-02 -3.25e-02 -8.09e-03 -8.02e-02 1.023 6.43e-04 0.01300
## 332  3.22e-03 -8.14e-03 -1.04e-02 -2.18e-02 1.024 4.77e-05 0.00725
## 333 -6.78e-03  3.96e-02 -3.67e-03 -7.20e-02 1.030 5.19e-04 0.01663
## 334  1.34e-02 -1.92e-02 -3.25e-03 -7.22e-02 1.018 5.21e-04 0.00948
## 335  1.05e-01 -2.77e-02 -1.29e-01  3.21e-01 0.920 1.02e-02 0.01554    *
## 336 -4.04e-03 -8.13e-03  6.91e-04  2.00e-02 1.033 4.01e-05 0.01448
## 337  2.65e-03 -4.32e-04  2.22e-02 -5.26e-02 1.021 2.77e-04 0.00855
## 338 -5.86e-01  4.64e-02  9.67e-03  1.24e+00 0.980 1.52e-01 0.13242    *
## 339 -9.48e-02  4.94e-02  2.71e-02  1.80e-01 1.006 3.22e-03 0.01856
## 340 -2.59e-02 -1.59e-02 -9.63e-03  9.93e-02 1.020 9.87e-04 0.01395
## 341 -3.64e-03  1.59e-03  6.64e-03  1.95e-02 1.027 3.82e-05 0.00951
## 342  2.75e-02  1.88e-01 -3.77e-02  4.84e-01 0.625 2.23e-02 0.00819    *
## 343  5.50e-02  1.27e-02 -4.25e-02 -1.64e-01 1.019 2.70e-03 0.02195
## 344 -7.05e-02  2.33e-02  4.96e-02  1.16e-01 1.043 1.34e-03 0.03093
## 345  1.80e-02 -2.00e-02  1.23e-02 -3.55e-02 1.030 1.26e-04 0.01322
## 346  2.26e-04  1.58e-03 -6.31e-04 -3.19e-03 1.030 1.02e-06 0.01124
## 347 -7.99e-03 -2.39e-03  3.75e-03 -1.57e-02 1.045 2.47e-05 0.02611
## 348  1.24e-02  1.24e-02  6.26e-03 -3.39e-02 1.029 1.15e-04 0.01242
## 349 -3.90e-03 -1.02e-02  4.14e-03  2.28e-02 1.021 5.20e-05 0.00501
## 350 -3.46e-02  3.18e-03 -4.41e-02 -8.56e-02 1.025 7.34e-04 0.01499
## 351  2.59e-03 -3.33e-04  5.72e-04  9.20e-03 1.025 8.48e-06 0.00736
## 352 -5.15e-03  1.38e-03 -4.91e-03 -1.13e-02 1.032 1.27e-05 0.01351
## 353  1.30e-03  1.90e-03  9.14e-04 -1.69e-02 1.036 2.86e-05 0.01715
## 354 -3.86e-04  8.61e-03 -8.62e-03 -1.89e-02 1.027 3.60e-05 0.00915
## 355  1.26e-02 -2.92e-03 -5.86e-05  1.98e-02 1.036 3.94e-05 0.01802
## 356  4.70e-04 -2.02e-03  1.71e-04  9.04e-03 1.031 8.18e-06 0.01257
## 357 -1.33e-03 -6.15e-03  2.63e-02 -4.71e-02 1.031 2.22e-04 0.01532
## 358 -5.14e-03 -9.64e-03 -5.62e-03  2.00e-02 1.022 4.01e-05 0.00494
## 359 -6.47e-04 -2.99e-03 -6.81e-03 -2.86e-02 1.021 8.22e-05 0.00568
## 360 -3.41e-03  2.62e-03  1.83e-04 -2.46e-02 1.030 6.04e-05 0.01250
## 361 -9.30e-02 -3.89e-02  2.17e-02  2.22e-01 0.987 4.94e-03 0.01789
## 362  1.41e-03 -1.27e-02  3.28e-02 -5.65e-02 1.024 3.19e-04 0.01108
## 363  5.06e-03 -6.43e-03 -1.14e-02 -2.93e-02 1.045 8.59e-05 0.02592
## 364 -1.38e-02  1.18e-03  1.01e-02 -6.92e-02 1.018 4.80e-04 0.00934
## 365 -2.87e-03 -6.89e-03 -1.67e-02 -2.67e-02 1.028 7.15e-05 0.01099
## 366 -2.31e-02 -5.06e-03 -6.83e-03  5.01e-02 1.019 2.52e-04 0.00733
```

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## 366 -2.31e-02 -5.06e-03 -6.85e-03  5.01e-02 1.019 2.52e-04 0.00755
## 367  8.02e-03 -3.06e-03 -1.12e-02  2.50e-02 1.027 6.25e-05 0.00961
## 368 -2.32e-02  5.18e-03  1.80e-02 -6.98e-02 1.040 4.87e-04 0.02456
## 369  1.39e-02 -2.39e-02  3.26e-03 -7.40e-02 1.021 5.48e-04 0.01153
## 370 -3.60e-02 -1.58e-02 -2.45e-02  1.86e-01 0.950 3.45e-03 0.00792
## 371  1.41e-03 -2.27e-04  2.43e-04 -2.52e-03 1.031 6.38e-07 0.01239
## 372 -3.10e-02 -6.20e-02 -5.95e-03 -1.08e-01 1.054 1.18e-03 0.03884    *
## 373  1.52e-03  1.36e-03 -4.34e-03 -1.02e-02 1.024 1.05e-05 0.00579
## 374  1.44e-02  2.53e-02 -3.04e-03 -4.13e-02 1.021 1.71e-04 0.00688
## 375 -4.61e-03 -1.32e-02 -6.36e-04 -3.10e-02 1.020 9.64e-05 0.00502
## 376  1.36e-03  7.19e-04  3.19e-03  6.93e-03 1.033 4.81e-06 0.01442
## 377 -3.47e-03  1.22e-02  4.11e-03  3.02e-02 1.027 9.16e-05 0.01066
## 378 -3.75e-02 -1.72e-02 -3.17e-02  7.84e-02 1.023 6.15e-04 0.01311
## 379  4.55e-02 -6.28e-02  2.06e-02 -1.12e-01 1.014 1.26e-03 0.01295
## 380 -6.86e-04 -1.67e-03  4.39e-03 -8.98e-03 1.025 8.09e-06 0.00662
## 381  9.57e-05  9.02e-04  1.88e-04 -3.67e-03 1.023 1.35e-06 0.00530
## 382 -1.28e-03  3.22e-03 -1.71e-03 -1.77e-02 1.028 3.14e-05 0.01023
## 383 -4.76e-03  6.78e-03 -7.67e-03  1.47e-02 1.034 2.15e-05 0.01545
## 384 -2.43e-03 -4.33e-03 -9.36e-05 -3.56e-02 1.021 1.27e-04 0.00610
## 385 -8.96e-04  9.22e-04 -2.60e-03  4.47e-03 1.026 2.00e-06 0.00815
## 386 -1.22e-02  6.03e-03 -2.66e-03 -2.38e-02 1.026 5.68e-05 0.00902
## 387  1.74e-01  1.18e-01  3.54e-02 -4.79e-01 0.902 2.26e-02 0.02684    *
## 388  2.45e-03  3.42e-02 -4.02e-03 -5.99e-02 1.026 3.59e-04 0.01267
## 389 -5.49e-05  2.02e-04  1.66e-04 -5.90e-04 1.028 3.49e-08 0.00967
## 390 -5.78e-03  5.69e-03  1.66e-02  4.82e-02 1.024 2.33e-04 0.00981
## 391  1.09e-02  1.56e-02  3.26e-03 -6.37e-02 1.027 4.07e-04 0.01366
## 392 -9.48e-04  1.04e-02  4.20e-03 -1.79e-02 1.052 3.19e-05 0.03210
## 393  1.70e-04 -4.58e-03  4.05e-03  1.03e-02 1.030 1.06e-05 0.01140
## 394 -1.75e-02  3.95e-03  3.10e-02  9.92e-02 1.014 9.84e-04 0.01112
## 395  5.72e-03  1.11e-03 -5.48e-03 -1.35e-02 1.027 1.82e-05 0.00866
## 396 -1.31e-02  6.41e-03  6.18e-04  3.79e-02 1.027 1.44e-04 0.01138
## 397  6.73e-03 -4.89e-03 -2.94e-02  3.91e-02 1.030 1.53e-04 0.01370
## 398  7.66e-03 -1.64e-03  2.43e-03  1.01e-02 1.033 1.02e-05 0.01452
## 399  6.32e-04  5.73e-04 -2.20e-05  1.47e-03 1.031 2.17e-07 0.01266
## 400  4.83e-04  9.07e-02 -6.45e-02 -1.62e-01 1.016 2.64e-03 0.02046
## 401 -8.11e-04  1.08e-03 -1.12e-04 -1.69e-03 1.039 2.85e-07 0.01998
## 402  1.08e-03 -1.40e-02 -1.99e-03  4.03e-02 1.031 1.63e-04 0.01489
## 403 -4.66e-02 -1.31e-03 -9.12e-04  7.59e-02 1.036 5.77e-04 0.02156
## 404 -2.00e-02 -3.70e-02  4.86e-03  1.35e-01 1.009 1.83e-03 0.01420
## 405  9.00e-03  5.14e-03  1.88e-03 -1.68e-02 1.032 2.84e-05 0.01374
## 406 -2.44e-03 -5.19e-03  6.63e-03  3.43e-02 1.032 1.18e-04 0.01464
## 407  2.00e-03 -2.68e-03 -3.83e-03 -1.31e-02 1.038 1.73e-05 0.01976
## 408 -2.54e-02  1.58e-02  2.41e-02 -9.55e-02 1.013 9.12e-04 0.01061
## 409  5.81e-03  3.83e-03 -5.31e-03  2.35e-02 1.027 5.53e-05 0.00988
## 410 -3.57e-02  1.28e-02 -6.61e-03 -5.69e-02 1.031 3.24e-04 0.01643
## 411 -1.01e-02 -1.03e-02 -1.13e-02  2.88e-02 1.041 8.31e-05 0.02292
## 412 -1.75e-03 -3.43e-02  7.42e-03 -7.76e-02 1.035 6.04e-04 0.02102
## 413 -1.24e-03  5.02e-03  6.90e-03 -1.23e-02 1.034 1.51e-05 0.01575
## 414  1.36e-04  2.29e-02  1.15e-02 -3.39e-02 1.035 1.15e-04 0.01711
## 415  8.65e-04  9.79e-04  4.69e-04  1.70e-03 1.047 2.90e-07 0.02730
## 416  4.25e-02 -3.03e-02  1.28e-02  1.49e-01 1.011 2.20e-03 0.01648
## 417 -2.04e-03  6.12e-04  4.37e-03 -6.50e-03 1.028 4.23e-06 0.00963
## 418  1.00e-02 -5.77e-03 -5.23e-03 -2.11e-02 1.023 4.47e-05 0.00640
## 419  1.17e-01 -1.67e-02  6.24e-03  1.54e-01 1.036 2.38e-03 0.03038
## 420 -1.61e-02 -5.79e-02  7.37e-03 -8.08e-02 1.040 6.54e-04 0.02585
## 421 -5.63e-01  4.21e-01  8.25e-01  2.27e+00 0.977 5.01e-01 0.23094    *
## 422  1.52e-03  3.74e-04 -4.59e-04 -3.73e-03 1.025 1.40e-06 0.00662
## 423 -1.52e-03 -1.53e-02  6.75e-03 -6.06e-02 1.018 3.67e-04 0.00817
## 424 -1.88e-01 -2.65e-02  1.29e-01  6.79e-01 1.018 4.58e-02 0.08485    *
## 425 -1.75e-05  1.35e-02  4.38e-03 -1.61e-02 1.040 2.61e-05 0.02126
## 426  4.30e-02 -1.38e-02 -2.21e-02  8.11e-02 1.024 6.58e-04 0.01404
## 427 -3.31e-02  4.10e-02 -1.87e-02  7.40e-02 1.058 5.48e-04 0.04002    *
## 428 -2.85e-02 -1.89e-02  5.25e-03  9.20e-02 0.999 8.45e-04 0.00610
## 429  1.25e-03  3.29e-04  8.35e-03 -1.79e-02 1.029 3.21e-05 0.01082
## 430  4.23e-02  1.25e-02 -1.38e-02  1.44e-01 1.024 2.08e-03 0.02210
## 431  5.78e-03 -3.25e-03 -9.34e-03 -2.85e-02 1.025 8.14e-05 0.00814
## 432 -1.45e-02  2.22e-03 -7.25e-03 -6.69e-02 1.016 4.48e-04 0.00794
## 433  1.74e-02 -2.43e-02  1.42e-02 -3.87e-02 1.028 1.50e-04 0.01200
## 434  1.76e-02 -1.49e-03  6.51e-02  7.99e-02 1.032 6.40e-04 0.01889
## 435 -7.27e-03  2.07e-02  9.65e-03 -3.32e-02 1.032 1.10e-04 0.01487
## 436  4.76e-05 -1.70e-03  3.31e-04  3.42e-03 1.031 1.17e-06 0.01225
## 437 -2.40e-02 -9.80e-03  4.27e-04  1.30e-01 1.004 1.70e-03 0.01165
## 438 -3.98e-03 -1.17e-02  2.22e-03 -2.54e-02 1.025 6.46e-05 0.00825
```

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## 439 -1.42e-02  1.23e-02 -4.70e-02 -1.13e-01 1.028 1.27e-03 0.02017
## 440 -9.28e-03  7.26e-03 -3.14e-02  5.16e-02 1.022 2.66e-04 0.00931
## 441  3.07e-03  6.18e-04 -2.93e-04 -4.78e-03 1.024 2.29e-06 0.00593
## 442 -3.01e-03 -4.43e-04 -3.78e-04  1.12e-02 1.025 1.25e-05 0.00678
## 443 -2.87e-02  1.86e-02  3.33e-02 -6.64e-02 1.025 4.41e-04 0.01289
## 444  2.30e-02 -1.34e-02  1.05e-02  5.66e-02 1.023 3.21e-04 0.01027
## 445  1.47e-01 -3.46e-02  3.02e-02  5.77e-01 0.945 3.30e-02 0.04653   *
## 446 -1.51e-02 -2.58e-04 -1.15e-02 -5.30e-02 1.027 2.81e-04 0.01289
## 447  6.89e-03 -7.62e-03  1.21e-02 -2.74e-02 1.026 7.50e-05 0.00957
## 448 -1.63e-03  7.73e-03 -1.15e-02 -2.14e-02 1.027 4.61e-05 0.00983
## 449 -3.71e-03  6.78e-03 -1.95e-02  3.00e-02 1.026 9.02e-05 0.00949
## 450 -7.09e-03  1.66e-03  3.97e-02  7.52e-02 1.025 5.66e-04 0.01384
## 451  6.24e-03  1.35e-03  9.19e-03 -2.71e-02 1.027 7.35e-05 0.01014
## 452  3.15e-03 -1.05e-04 -3.05e-04 -1.54e-02 1.029 2.36e-05 0.01134
## 453  1.57e-04  5.28e-04  4.01e-04  1.92e-03 1.029 3.68e-07 0.01029
## 454  1.94e-02 -8.07e-02  1.83e-02  1.79e-01 1.025 3.21e-03 0.02726
## 455  5.29e-03 -1.84e-02  1.76e-03 -3.18e-02 1.024 1.01e-04 0.00768
## 456 -3.14e-03  2.76e-03  1.28e-03 -1.07e-02 1.024 1.16e-05 0.00616
## 457 -2.01e-02 -6.31e-02 -1.60e-02 -1.33e-01 1.044 1.76e-03 0.03377
## 458 -2.32e-02  5.01e-03  1.39e-02  1.58e-01 1.036 2.48e-03 0.03096
## 459 -1.17e-02 -2.68e-03 -1.60e-02 -9.73e-02 1.020 9.47e-04 0.01374
## 460  1.92e-04 -4.28e-04  3.10e-04  5.34e-03 1.032 2.86e-06 0.01331
## 461  6.29e-01 -6.70e-02  6.40e-01 -2.38e+00 0.850 5.44e-01 0.19833   *
## 462 -1.80e-02  1.38e-02  1.61e-02  6.35e-02 1.012 4.03e-04 0.00614
## 463 -8.20e-03 -1.31e-02  1.44e-03 -2.55e-02 1.031 6.50e-05 0.01361
## 464  1.32e-02  9.17e-03 -1.04e-03 -2.35e-02 1.031 5.52e-05 0.01300
## 465 -7.79e-02 -9.98e-02 -1.80e-02 -1.55e-01 1.076 2.40e-03 0.06014   *
## 466  5.04e-02  9.98e-03 -1.78e-02 -7.29e-02 1.025 5.31e-04 0.01344
## 467  1.47e-02 -2.42e-03 -5.95e-03 -2.36e-02 1.028 5.57e-05 0.01065
## 468 -5.19e-02 -1.04e-02 -9.61e-03  1.48e-01 0.988 2.18e-03 0.00967
## 469 -4.75e-03  4.09e-03 -2.21e-03 -1.06e-02 1.029 1.13e-05 0.01126
## 470  9.75e-04  1.73e-03  3.96e-03  8.29e-03 1.025 6.89e-06 0.00725
## 471 -2.23e-02 -1.78e-03 -3.91e-02 -6.11e-02 1.018 3.74e-04 0.00794
## 472 -2.32e-02 -6.85e-03 -1.11e-02  4.97e-02 1.021 2.48e-04 0.00850
## 473 -6.03e-03  4.55e-03 -6.05e-03 -1.49e-02 1.030 2.23e-05 0.01147
## 474 -1.57e-02 -2.01e-02 -1.07e-02  6.49e-02 1.047 4.22e-04 0.02966
## 475 -5.80e-03 -6.62e-03  7.59e-03 -2.75e-02 1.035 7.56e-05 0.01744
## 476  2.29e-02  3.00e-03 -4.60e-03  7.68e-02 1.006 5.91e-04 0.00595
## 477 -1.35e-02  3.22e-02 -9.76e-03 -5.33e-02 1.050 2.85e-04 0.03150
## 478  1.09e-01 -6.23e-02  3.73e-02  1.81e-01 1.015 3.27e-03 0.02218
## 479  4.50e-03  4.79e-03 -1.76e-03  1.46e-02 1.024 2.13e-05 0.00598
## 480  2.97e-02 -5.19e-02 -2.83e-02 -1.35e-01 1.009 1.83e-03 0.01392
## 481  1.89e-04 -6.67e-04  2.04e-03  1.91e-02 1.031 3.65e-05 0.01280
## 482 -1.90e-02 -5.00e-03 -1.55e-02 -4.39e-02 1.015 1.93e-04 0.00451
## 483 -3.28e-03 -1.31e-03  3.30e-03 -7.76e-03 1.035 6.03e-06 0.01603
## 484  1.43e-03 -3.91e-02  7.34e-02  1.19e-01 1.038 1.43e-03 0.02787
## 485 -8.15e-03 -4.28e-03  1.76e-04 -2.16e-02 1.025 4.66e-05 0.00819
## 486  3.20e-05  1.39e-04 -7.25e-05  1.40e-03 1.043 1.95e-07 0.02349
## 487 -1.16e-02 -5.19e-02  1.02e-02 -7.27e-02 1.033 5.30e-04 0.01907
## 488  7.60e-02 -5.04e-02  7.19e-02 -2.96e-01 1.035 8.75e-03 0.04700
## 489  1.91e-03 -1.04e-02 -1.39e-02 -3.27e-02 1.026 1.07e-04 0.00951
## 490 -1.34e-01 -4.94e-02 -2.15e-01  5.76e-01 0.841 3.26e-02 0.02633   *
## 491  8.69e-04 -1.32e-02 -6.15e-03 -2.20e-02 1.027 4.86e-05 0.00949
## 492 -4.42e-02  1.99e-02 -6.05e-02  1.95e-01 1.030 3.80e-03 0.03211
## 493 -6.52e-03  2.93e-03 -4.14e-03 -1.82e-02 1.051 3.32e-05 0.03172
## 494  7.92e-04 -3.05e-03 -3.34e-03  6.10e-03 1.027 3.73e-06 0.00877
## 495 -1.71e-02 -6.48e-03 -2.26e-02  4.90e-02 1.063 2.41e-04 0.04303   *
## 496  1.65e-02 -8.15e-02 -7.26e-03  1.96e-01 1.031 3.83e-03 0.03247
## 497 -7.53e-03 -2.75e-03  3.33e-02 -4.52e-02 1.034 2.05e-04 0.01765
## 498  1.97e-02 -9.08e-03 -1.10e-02  3.38e-02 1.022 1.14e-04 0.00676
## 499 -2.72e-01  1.03e-01  1.26e-01 -7.94e-01 0.761 6.11e-02 0.03312   *
## 500 -2.54e-03 -1.72e-02 -5.32e-03 -1.56e-01 1.029 2.43e-03 0.02637
## 501 -8.03e-02  6.91e-02  5.94e-03  1.50e-01 1.015 2.24e-03 0.01821
## 502 -6.09e-03 -9.22e-03  3.65e-02  7.63e-02 1.019 5.83e-04 0.01082
## 503 -2.49e-03 -2.08e-04 -2.03e-03 -6.53e-03 1.034 4.27e-06 0.01506
## 504 -1.04e-02  4.52e-02  1.53e-01  2.90e-01 1.042 8.42e-03 0.05024
## 505  4.47e-03 -7.39e-03 -3.88e-03  3.25e-02 1.025 1.06e-04 0.00897
## 506 -6.64e-03 -2.14e-02 -6.14e-03 -7.74e-02 1.053 6.00e-04 0.03578
## 507 -9.41e-03  8.48e-03  2.24e-02  6.62e-02 1.029 4.38e-04 0.01518
## 508 -2.43e-03  1.29e-03 -8.58e-04  8.34e-03 1.027 6.97e-06 0.00906
## 509 -5.09e-03 -1.58e-02 -1.11e-01 -4.52e-01 0.862 2.01e-02 0.01913   *
## 510 -6.44e-03 -5.00e-03 -4.47e-03 -2.59e-02 1.021 6.71e-05 0.00514
## 511  3.48e-02 -1.10e-02 -8.91e-03 -7.42e-02 1.026 5.52e-04 0.01422
```

```
## 512 -3.31e-02 -1.62e-02  5.76e-02  1.44e-01 1.005 2.08e-03 0.01362
## 513 -6.12e-03  1.89e-02  2.35e-02  4.00e-02 1.032 1.60e-04 0.01503
## 514 -8.65e-03 -1.84e-02  7.40e-03  3.07e-02 1.033 9.45e-05 0.01575
## 515 -1.91e-02 -5.86e-02  2.08e-02 -1.23e-01 1.004 1.52e-03 0.01082
## 516 -1.34e-02  5.87e-03 -2.48e-02  1.02e-01 1.010 1.05e-03 0.01036
## 517 -1.27e-02  7.01e-02  1.43e-01  2.48e-01 1.006 6.12e-03 0.02705
## 518  1.15e-01  1.56e-02 -2.88e-02  1.66e-01 1.004 2.74e-03 0.01613
## 519  7.37e-03  5.87e-03  3.13e-03  2.61e-02 1.027 6.84e-05 0.00995
## 520 -1.92e-02  2.04e-02 -8.17e-02 -1.46e-01 1.007 2.12e-03 0.01453
## 521 -8.94e-03  5.68e-03 -1.61e-03  3.28e-02 1.023 1.08e-04 0.00714
## 522  2.23e-03 -2.20e-03  3.90e-03 -8.62e-03 1.021 7.45e-06 0.00360
## 523 -1.31e-03  2.17e-03  3.57e-04  5.75e-03 1.043 3.31e-06 0.02383
## 524  1.67e-01 -1.18e-02 -1.26e-01  3.64e-01 1.077 1.32e-02 0.08034   *
## 525  8.88e-03 -1.26e-03 -1.22e-02 -7.79e-02 1.058 6.08e-04 0.04059   *
## 526  2.28e-02 -2.28e-02  8.87e-03 -3.89e-02 1.030 1.52e-04 0.01327
## 527  3.20e-03  8.86e-03  2.28e-05 -2.64e-02 1.025 7.00e-05 0.00847
## 528 -1.87e-03  3.50e-01 -5.87e-02  4.60e-01 0.853 2.08e-02 0.01883   *
## 529 -1.11e-02 -2.07e-02  1.95e-03 -3.18e-02 1.027 1.02e-04 0.01065
## 530 -2.64e-03  2.82e-04  5.09e-04 -1.18e-02 1.027 1.40e-05 0.00918
## 531 -4.51e-02  3.41e-02 -3.57e-02 -8.61e-02 1.018 7.42e-04 0.01131
## 532 -1.35e-02  8.06e-02 -1.75e-02  7.36e-01 0.865 5.32e-02 0.04405   *
## 533 -7.65e-03  7.82e-03  4.45e-03 -2.24e-02 1.024 5.04e-05 0.00681
## 534 -3.11e-03  3.82e-03  1.79e-03 -1.15e-02 1.027 1.32e-05 0.00893
## 535 -3.50e-02  1.15e-01  8.28e-03  2.98e-01 0.959 8.85e-03 0.01954
## 536  1.53e-03  2.32e-03  1.07e-02 -2.08e-02 1.022 4.32e-05 0.00513
## 537 -3.92e-03 -1.64e-02  1.12e-02 -3.53e-02 1.023 1.25e-04 0.00750
## 538  5.47e-03 -2.10e-02 -7.97e-03 -3.15e-02 1.023 9.91e-05 0.00749
## 539 -3.71e-05 -1.68e-05  4.99e-05  8.81e-05 1.035 7.77e-10 0.01624
## 540 -5.46e-03  2.31e-03 -3.29e-03 -9.30e-03 1.031 8.66e-06 0.01262
## 541  9.12e-04  4.19e-02 -8.63e-03  6.06e-02 1.025 3.67e-04 0.01201
## 542 -5.62e-03  2.31e-03 -8.45e-05  1.76e-02 1.058 3.12e-05 0.03771   *
## 543  2.00e-02 -1.10e-02 -1.10e-02 -3.81e-02 1.023 1.46e-04 0.00785
## 544 -2.82e-03 -2.99e-03 -1.47e-03 -5.69e-03 1.052 3.25e-06 0.03194
## 545  6.51e-01 -6.53e-01 -1.43e-03 -1.81e+00 0.425 3.00e-01 0.05688   *
## 546 -2.19e-03 -9.61e-04  6.44e-03  1.23e-02 1.025 1.52e-05 0.00691
## 547  1.99e-04  6.23e-03  2.91e-03 -9.31e-03 1.058 8.69e-06 0.03771   *
## 548  2.57e-04 -3.52e-05 -1.38e-05 -4.20e-04 1.024 1.77e-08 0.00613
## 549  1.50e-03 -5.86e-03 -1.25e-03  1.35e-02 1.038 1.82e-05 0.01900
## 550  1.93e-02  1.26e-02  2.97e-02 -4.67e-02 1.028 2.18e-04 0.01276
## 551 -1.55e-02 -9.76e-03  2.08e-03  5.53e-02 1.021 3.06e-04 0.00865
## 552 -6.56e-03 -2.83e-03  2.77e-03 -3.56e-02 1.030 1.27e-04 0.01360
## 553 -4.57e-02 -1.33e-01 -2.48e-02  3.99e-01 0.946 1.58e-02 0.02735   *
## 554 -3.87e-03  4.23e-03 -4.96e-04 -7.34e-03 1.029 5.40e-06 0.01059
## 555 -1.75e-03 -5.34e-04 -1.94e-03  1.45e-02 1.028 2.10e-05 0.00966
## 556  7.70e-02  5.75e-03  1.68e-02  1.65e-01 1.008 2.72e-03 0.01728
## 557 -1.99e-03 -5.60e-03  8.20e-03 -1.83e-02 1.022 3.37e-05 0.00539
## 558  2.09e-02 -7.71e-03 -2.13e-02 -6.35e-02 1.036 4.04e-04 0.02060
## 559 -4.12e-03  3.77e-03 -5.76e-03 -1.12e-02 1.031 1.26e-05 0.01258
## 560  3.52e-02 -1.82e-02 -4.27e-04 -4.92e-02 1.029 2.43e-04 0.01362
## 561  2.03e-02 -9.17e-03  1.62e-02 -8.37e-02 1.010 7.01e-04 0.00795
## 562  7.01e-05  1.84e-03 -2.55e-03 -1.64e-02 1.022 2.71e-05 0.00466
## 563  3.49e-03 -5.85e-03 -2.37e-03 -2.03e-02 1.034 4.14e-05 0.01596
## 564  3.68e-03  1.06e-02 -2.36e-03 -2.24e-02 1.034 5.01e-05 0.01555
## 565  1.09e-02 -9.91e-03 -7.47e-03  2.84e-02 1.027 8.08e-05 0.01044
## 566 -5.27e-03  2.40e-02 -1.34e-02 -5.67e-02 1.021 3.21e-04 0.00916
## 567 -3.45e-02  1.64e-03  3.46e-02  7.61e-02 1.023 5.80e-04 0.01302
## 568  2.17e-02 -1.36e-02  2.16e-03  4.06e-02 1.033 1.65e-04 0.01589
## 569  3.08e-02  7.32e-03  2.65e-02  6.79e-02 1.039 4.61e-04 0.02313
```

```
#View(temp)
#diagnostic plots
# Assessing Outliers
outlierTest(fit)
```
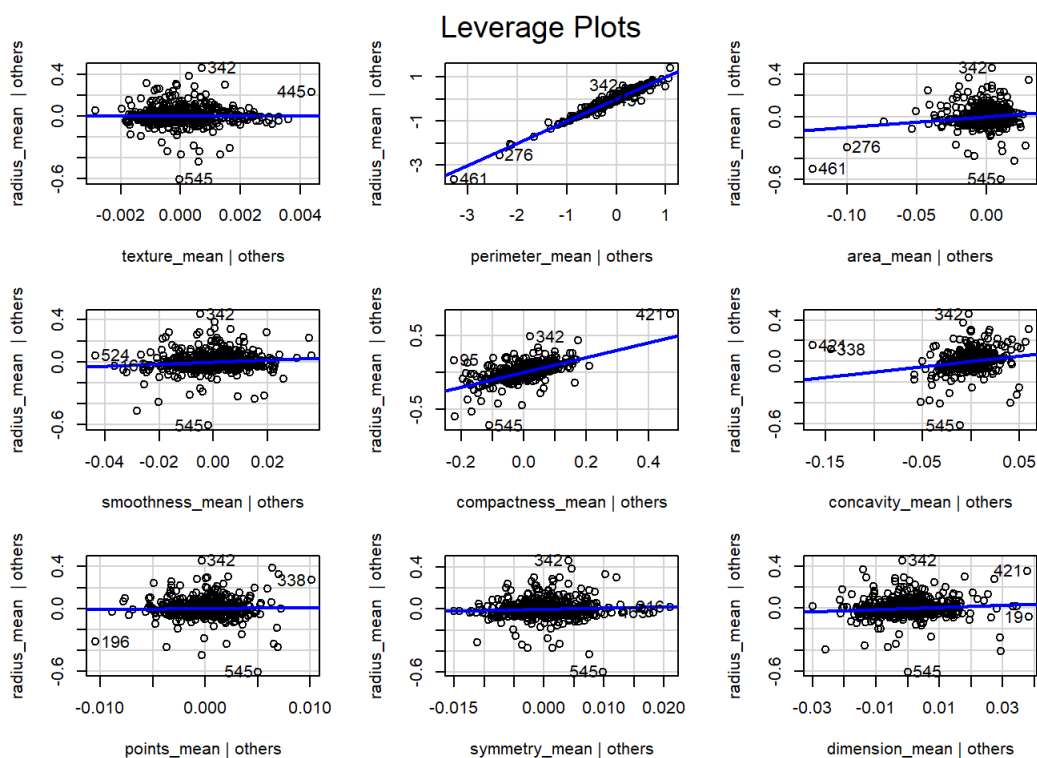
```
##       rstudent unadjusted p-value Bonferonni p
## 545 -7.386899       5.5103e-13   3.1354e-10
## 342  5.328669       1.4379e-07   8.1816e-05
## 272 -5.239786       2.2829e-07   1.2990e-04
## 461 -4.781961       2.2241e-06   1.2655e-03
## 95   4.492512       8.5600e-06   4.8706e-03
## 499 -4.288306       2.1216e-05   1.2072e-02
## 421  4.145027       3.9258e-05   2.2338e-02
## 254 -3.975169       7.9572e-05   4.5277e-02
```
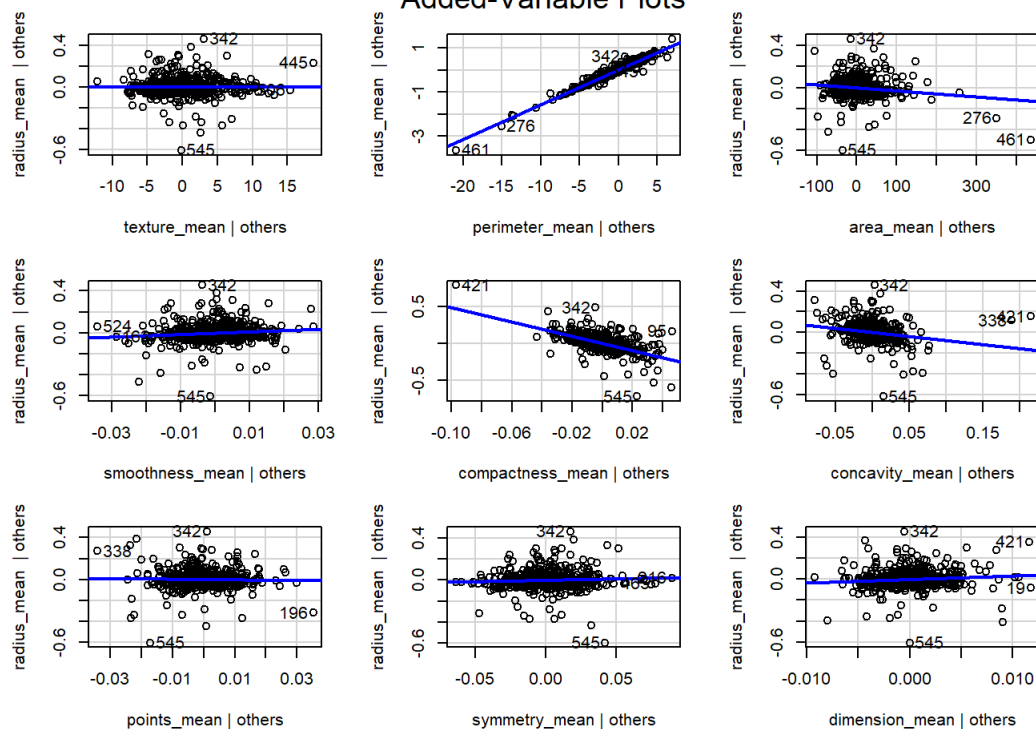
```
qqPlot(fit, main="QQ Plot")
```
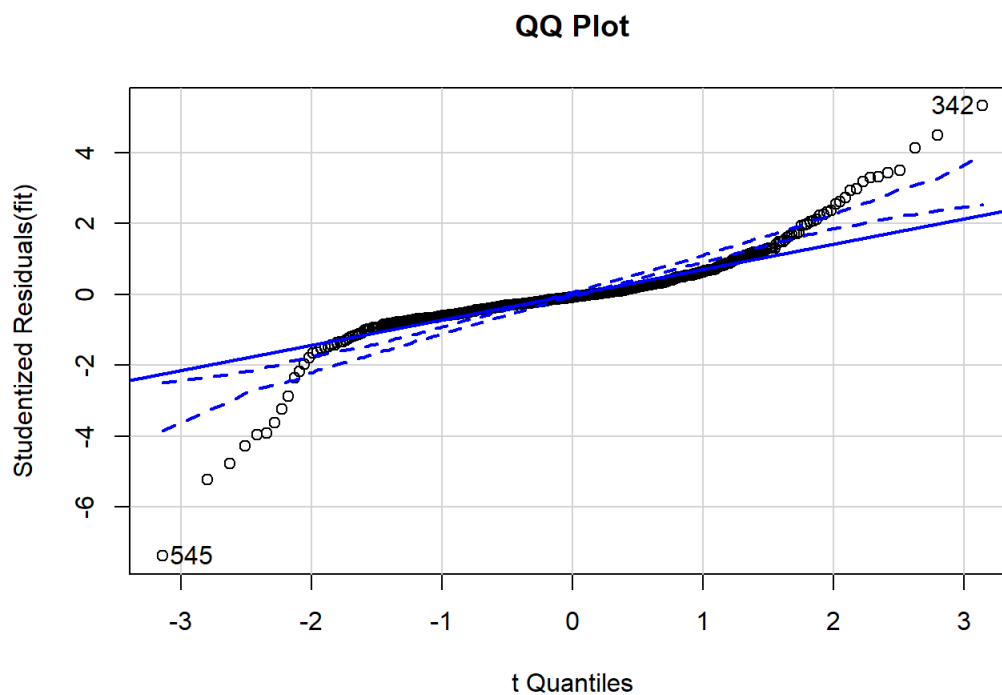


```
## [1] 342 545
```

```
leveragePlots(fit) # leverage plots
```
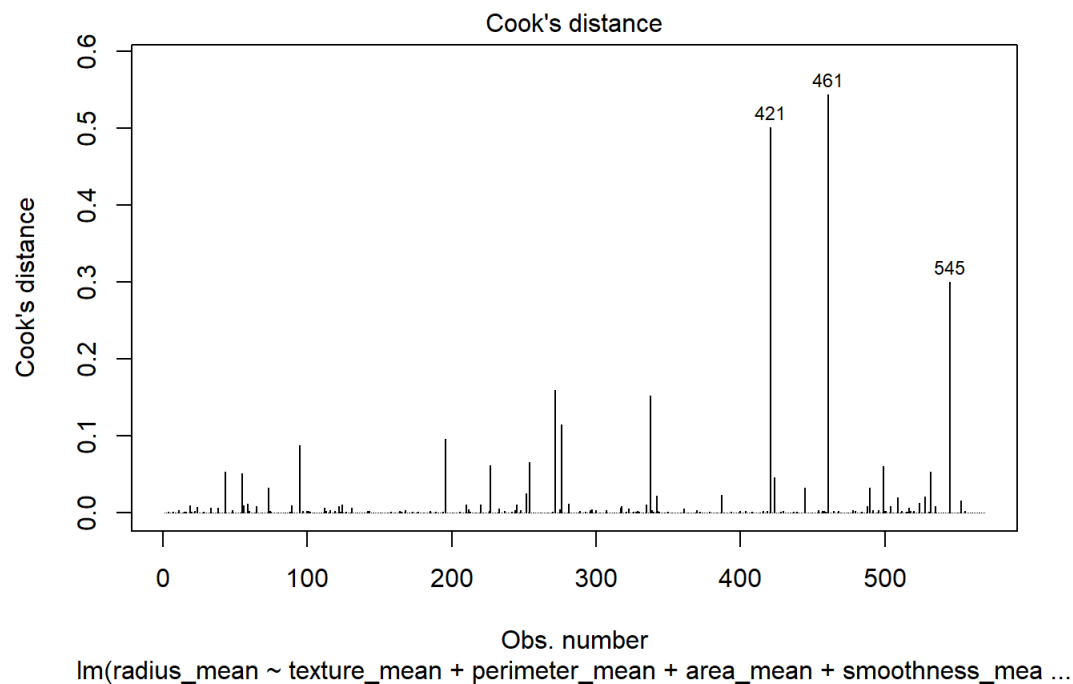
```
# Influential Observations
# added variable plots
avPlots(fit)
```

Added-Variable Plots


```
# Cook's D plot
# identify D values > 4/(n-k-1)
cutoff <- 4/((nrow(mtcars)-length(fit$coefficients)-2))
plot(fit, which=4, cook.levels=cutoff)
```


Cook's distance

lm(radius_mean ~ texture_mean + perimeter_mean + area_mean + smoothness_mea ...

```
# Influence Plot
#influencePlot(fit, id.method="identify", main="Influence Plot", sub="Circle size is proportial to Cook's Di
stance" )
# Normality of Residuals
# qq plot for studentized resid
qqPlot(fit, main="QQ Plot")
```
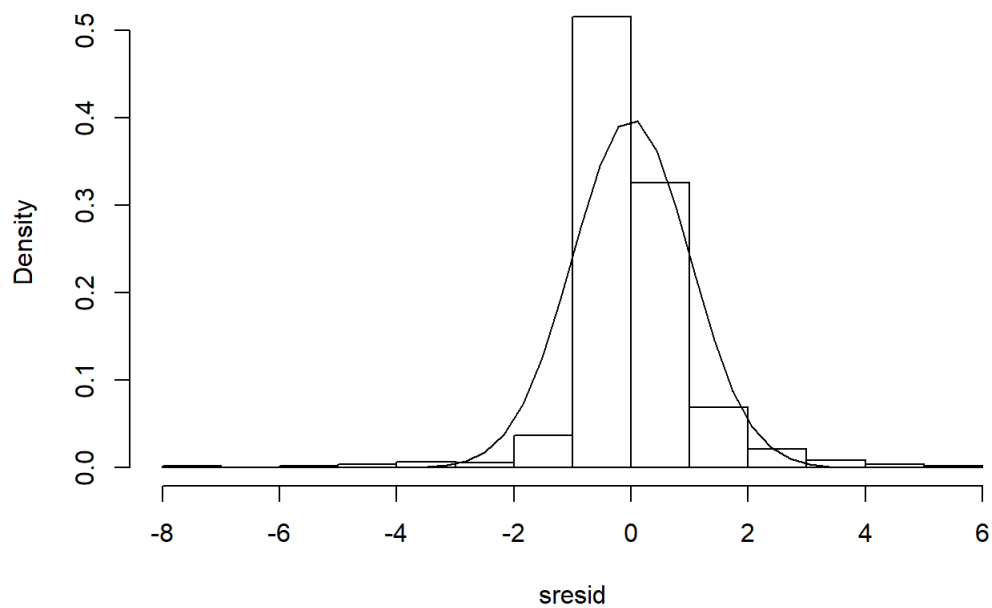
QQ Plot
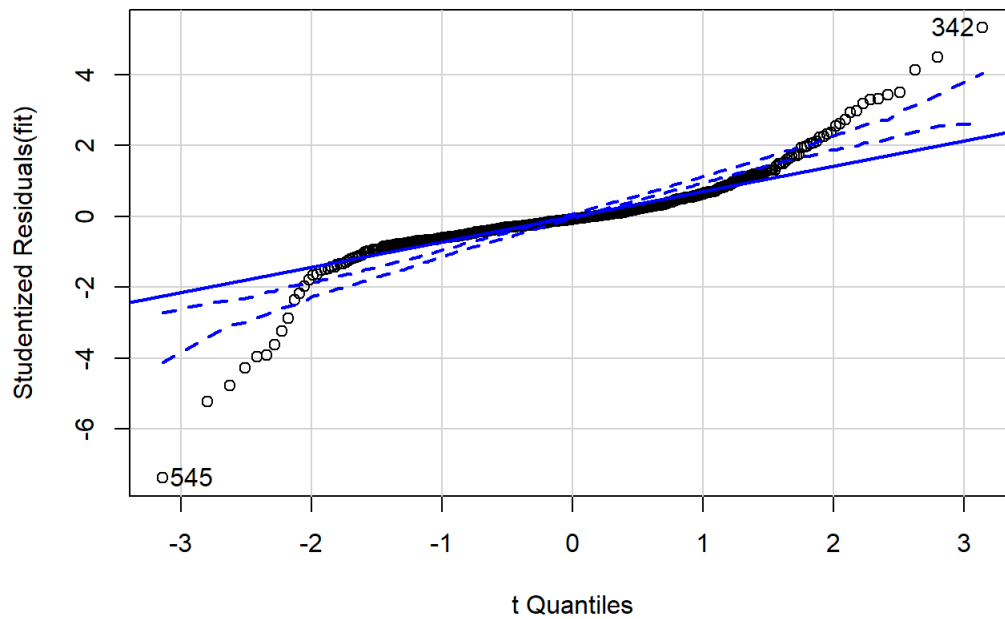

```
## [1] 342 545
```

```
# distribution of studentized residuals
library(MASS)
sresid <- studres(fit)
hist(sresid, freq=FALSE,
     main="Distribution of Studentized Residuals")
xfit<-seq(min(sresid),max(sresid),length=40)
yfit<-dnorm(xfit)
lines(xfit, yfit)
```
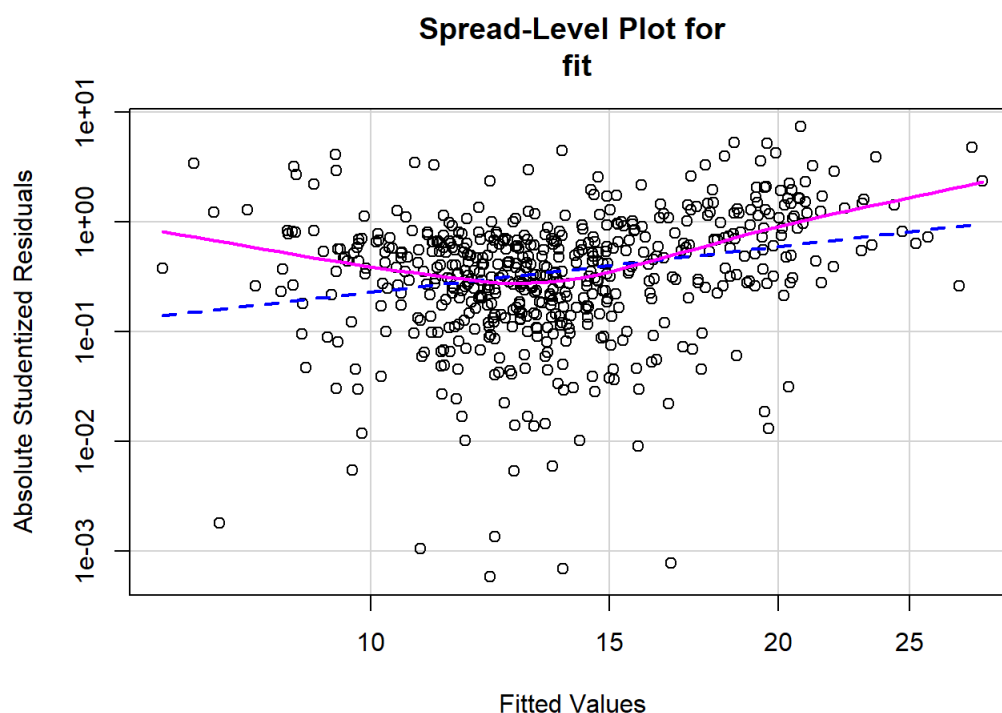
Distribution of Studentized Residuals


```
#Non-constant Error Variance
# Evaluate homoscedasticity
# non-constant error variance test
ncvTest(fit)
```

```
## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 185.2798, Df = 1, p = < 2.22e-16
```

```
# plot studentized residuals vs. fitted values
spreadLevelPlot(fit)
```


Spread-Level Plot for fit

```
##
## Suggested power transformation:  -0.3800782
```

```
#Multi-collinearity
# Evaluate Collinearity
vif(fit) # variance inflation factors
```
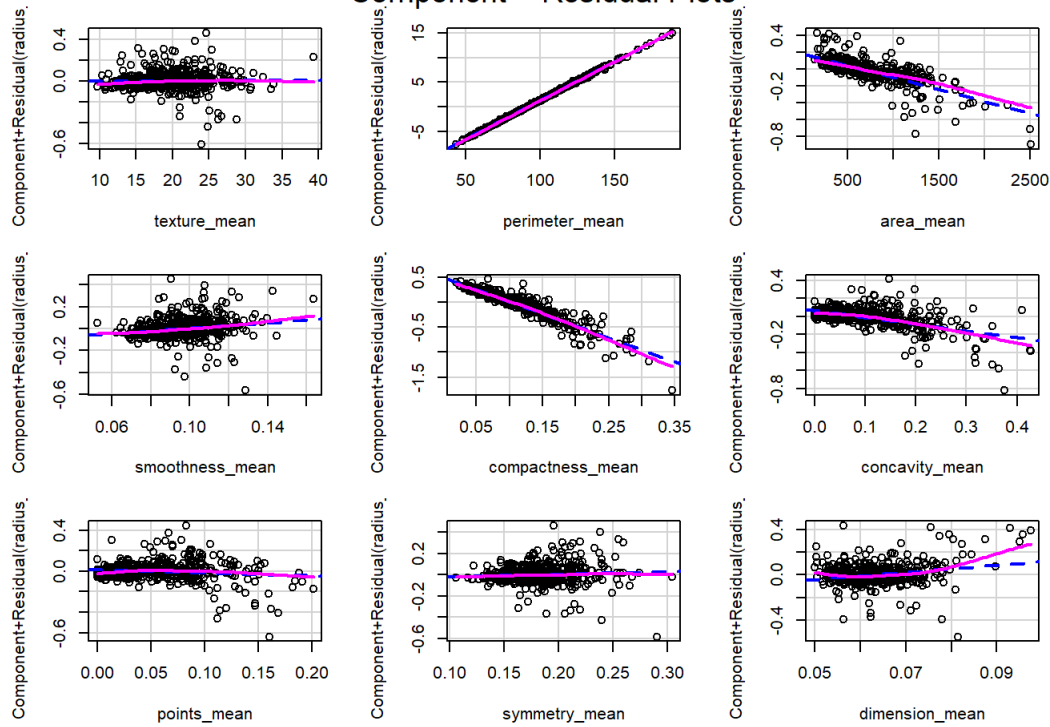
```
##     texture_mean    perimeter_mean      area_mean  smoothness_mean
##         1.186846         76.368376       54.975875         2.915555
## compactness_mean  concavity_mean    points_mean    symmetry_mean
##        14.209579         11.240791       21.694730         1.773078
##   dimension_mean
##         6.404651
```

```
sqrt(vif(fit)) > 2 # problem?
```

```
##     texture_mean    perimeter_mean      area_mean  smoothness_mean
##            FALSE              TRUE           TRUE            FALSE
## compactness_mean  concavity_mean    points_mean    symmetry_mean
##             TRUE              TRUE           TRUE            FALSE
##   dimension_mean
##             TRUE
```
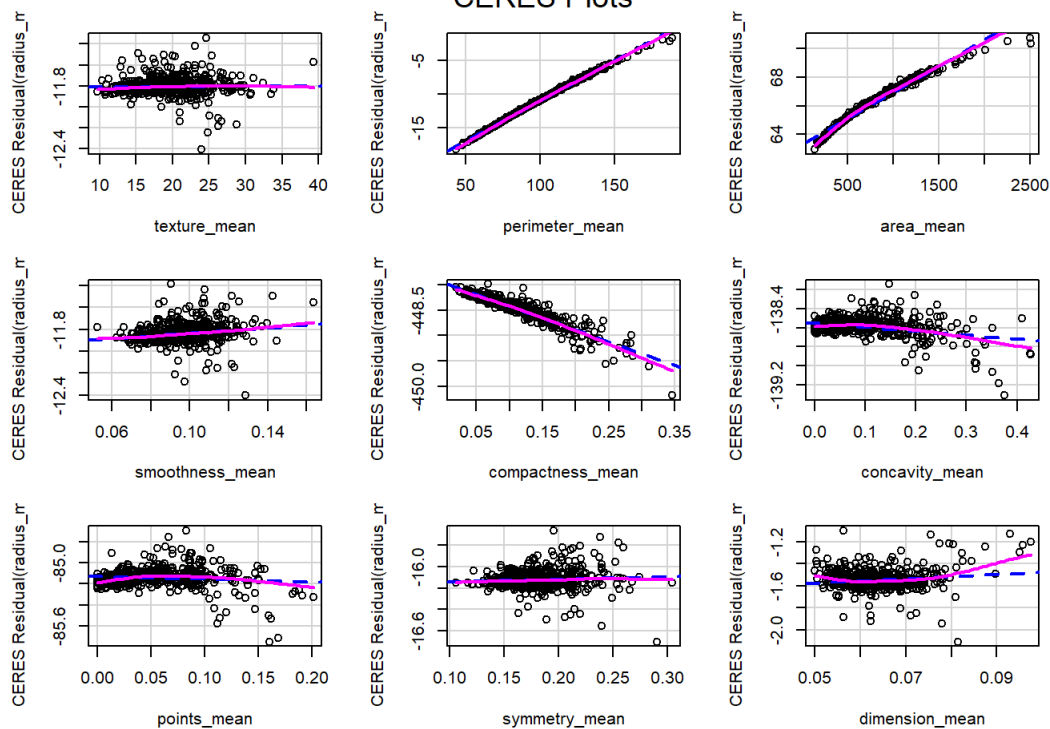
```
#Nonlinearity
# component + residual plot
crPlots(fit)
```

Component + Residual Plots

```
# Ceres plots
ceresPlots(fit)
```

CERES Plots


```
#Non-independence of Errors
# Test for Autocorrelated Errors
durbinWatsonTest(fit)
```

```
##  lag Autocorrelation D-W Statistic p-value
##    1     -0.05203636      2.103706   0.192
##  Alternative hypothesis: rho != 0
```

```
# Global test of model assumptions
library(gvlma)
#install.packages("gvlma", lib="/Library/Frameworks/R.framework/Versions/3.5/Resources/library")
library(gvlma)
gvmodel <- gvlma(fit)
summary(gvmodel)
```

```
##
## Call:
## lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean + points_mean +
##     symmetry_mean + dimension_mean, data = cancer)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.60730 -0.03619 -0.00712  0.02849  0.45917
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      9.941e-02  1.342e-01   0.741  0.45915
## texture_mean     2.343e-04  9.418e-04   0.249  0.80360
## perimeter_mean   1.569e-01  1.337e-03 117.301  < 2e-16 ***
## area_mean       -2.857e-04  7.834e-05  -3.647  0.00029 ***
## smoothness_mean  1.274e+00  4.514e-01   2.822  0.00495 **
## compactness_mean -4.827e+00  2.654e-01 -18.189  < 2e-16 ***
## concavity_mean  -7.596e-01  1.564e-01  -4.857 1.55e-06 ***
## points_mean     -2.975e-01  4.463e-01  -0.667  0.50529
## symmetry_mean    2.351e-01  1.806e-01   1.302  0.19362
## dimension_mean   3.252e+00  1.333e+00   2.440  0.01501 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08862 on 559 degrees of freedom
## Multiple R-squared:  0.9994, Adjusted R-squared:  0.9994
## F-statistic: 9.974e+04 on 9 and 559 DF,  p-value: < 2.2e-16
##
##
## ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
## USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
## Level of Significance =  0.05
##
## Call:
##  gvlma(x = fit)
##
##                     Value  p-value                   Decision
## Global Stat        2133.190 0.000000 Assumptions NOT satisfied!
## Skewness              9.689 0.001853 Assumptions NOT satisfied!
## Kurtosis           2008.128 0.000000 Assumptions NOT satisfied!
## Link Function       104.728 0.000000 Assumptions NOT satisfied!
## Heteroscedasticity   10.645 0.001104 Assumptions NOT satisfied!
```

```
fit
```

```
##
## Call:
## lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean + points_mean +
##     symmetry_mean + dimension_mean, data = cancer)
##
## Coefficients:
##      (Intercept)      texture_mean    perimeter_mean         area_mean
##        0.0994138         0.0002343         0.1568643        -0.0002857
##  smoothness_mean  compactness_mean    concavity_mean       points_mean
##        1.2738109        -4.8274443        -0.7595884        -0.2975420
##    symmetry_mean    dimension_mean
##        0.2350661         3.2515870
```

```
summary(fit)
```

```
##
## Call:
## lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean + points_mean +
##     symmetry_mean + dimension_mean, data = cancer)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.60730 -0.03619 -0.00712  0.02849  0.45917
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       9.941e-02  1.342e-01   0.741  0.45915
## texture_mean      2.343e-04  9.418e-04   0.249  0.80360
## perimeter_mean    1.569e-01  1.337e-03 117.301  < 2e-16 ***
## area_mean        -2.857e-04  7.834e-05  -3.647  0.00029 ***
## smoothness_mean   1.274e+00  4.514e-01   2.822  0.00495 **
## compactness_mean -4.827e+00  2.654e-01 -18.189  < 2e-16 ***
## concavity_mean   -7.596e-01  1.564e-01  -4.857 1.55e-06 ***
## points_mean      -2.975e-01  4.463e-01  -0.667  0.50529
## symmetry_mean     2.351e-01  1.806e-01   1.302  0.19362
## dimension_mean    3.252e+00  1.333e+00   2.440  0.01501 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08862 on 559 degrees of freedom
## Multiple R-squared:  0.9994, Adjusted R-squared:  0.9994
## F-statistic: 9.974e+04 on 9 and 559 DF,  p-value: < 2.2e-16
```

```
fit1 <- fit
fit2 <- lm(mpg ~ disp + hp + wt, data = mtcars)
# compare models
anova(fit1, fit2)
```

```
## Warning in anova.lmlist(object, ...): models with response '"mpg"' removed
## because response differs from model 1
```

```
## Analysis of Variance Table
##
## Response: radius_mean
##                   Df Sum Sq Mean Sq    F value      Pr(>F)
## texture_mean       1  739.5   739.5 9.4163e+04 < 2.2e-16 ***
## perimeter_mean     1 6284.4  6284.4 8.0022e+05 < 2.2e-16 ***
## area_mean          1    2.3     2.3 2.9053e+02 < 2.2e-16 ***
## smoothness_mean    1    8.7     8.7 1.1111e+03 < 2.2e-16 ***
## compactness_mean   1   14.3    14.3 1.8156e+03 < 2.2e-16 ***
## concavity_mean     1    0.3     0.3 3.8966e+01 8.533e-10 ***
## points_mean        1    0.0     0.0 4.8960e-01   0.48439
## symmetry_mean      1    0.0     0.0 1.4625e+00   0.22705
## dimension_mean     1    0.0     0.0 5.9517e+00   0.01501 *
## Residuals        559    4.4     0.0
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
step <- stepAIC(fit, direction="both")
```

```
## Start:  AIC=-2747.92
## radius_mean ~ texture_mean + perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + points_mean + symmetry_mean +
##     dimension_mean
##
##                    Df Sum of Sq     RSS      AIC
## - texture_mean      1     0.000   4.391 -2749.86
## - points_mean       1     0.003   4.394 -2749.47
## - symmetry_mean     1     0.013   4.403 -2748.20
## <none>                            4.390 -2747.92
## - dimension_mean    1     0.047   4.437 -2743.90
## - smoothness_mean   1     0.063   4.453 -2741.88
## - area_mean         1     0.104   4.495 -2736.54
## - concavity_mean    1     0.185   4.575 -2726.40
## - compactness_mean  1     2.598   6.988 -2485.40
## - perimeter_mean    1   108.059 112.449  -904.57
##
## Step:  AIC=-2749.86
## radius_mean ~ perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + points_mean + symmetry_mean +
##     dimension_mean
##
##                    Df Sum of Sq     RSS      AIC
## - points_mean       1     0.004   4.394 -2751.4
## - symmetry_mean     1     0.013   4.404 -2750.1
## <none>                            4.391 -2749.9
## + texture_mean      1     0.000   4.390 -2747.9
## - dimension_mean    1     0.046   4.437 -2745.9
## - smoothness_mean   1     0.062   4.453 -2743.9
## - area_mean         1     0.104   4.495 -2738.5
## - concavity_mean    1     0.185   4.575 -2728.4
## - compactness_mean  1     2.617   7.007 -2485.9
## - perimeter_mean    1   108.111 112.502  -906.3
##
## Step:  AIC=-2751.4
## radius_mean ~ perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + symmetry_mean + dimension_mean
##
##                    Df Sum of Sq     RSS      AIC
## - symmetry_mean     1     0.012   4.406 -2751.84
## <none>                            4.394 -2751.40
## + points_mean       1     0.004   4.391 -2749.86
## + texture_mean      1     0.001   4.394 -2749.47
## - dimension_mean    1     0.048   4.442 -2747.23
## - smoothness_mean   1     0.065   4.459 -2745.09
## - area_mean         1     0.107   4.501 -2739.76
## - concavity_mean    1     0.327   4.721 -2712.54
## - compactness_mean  1     2.681   7.075 -2482.40
## - perimeter_mean    1   111.885 116.279  -889.51
##
## Step:  AIC=-2751.84
## radius_mean ~ perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + dimension_mean
##
##                    Df Sum of Sq     RSS      AIC
## <none>                            4.406 -2751.84
## + symmetry_mean     1     0.012   4.394 -2751.40
## + points_mean       1     0.002   4.404 -2750.14
## + texture_mean      1     0.001   4.406 -2749.90
## - dimension_mean    1     0.046   4.452 -2747.93
## - smoothness_mean   1     0.082   4.488 -2743.36
## - area_mean         1     0.104   4.510 -2740.55
## - concavity_mean    1     0.321   4.727 -2713.88
## - compactness_mean  1     2.713   7.119 -2480.84
## - perimeter_mean    1   112.363 116.769  -889.11
```

```
step$anova # display results
```

```
## Stepwise Model Path
## Analysis of Deviance Table
##
## Initial Model:
## radius_mean ~ texture_mean + perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + points_mean + symmetry_mean +
##     dimension_mean
##
## Final Model:
## radius_mean ~ perimeter_mean + area_mean + smoothness_mean +
##     compactness_mean + concavity_mean + dimension_mean
##
##
##            Step Df     Deviance Resid. Df Resid. Dev      AIC
## 1                                     559   4.390043 -2747.924
## 2  - texture_mean  1 0.0004861662      560   4.390529 -2749.861
## 3   - points_mean  1 0.0035279695      561   4.394057 -2751.404
## 4 - symmetry_mean  1 0.0121227535      562   4.406180 -2751.836
```

```
summary(fit)
```

```
##
## Call:
## lm(formula = radius_mean ~ texture_mean + perimeter_mean + area_mean +
##     smoothness_mean + compactness_mean + concavity_mean + points_mean +
##     symmetry_mean + dimension_mean, data = cancer)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.60730 -0.03619 -0.00712  0.02849  0.45917
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       9.941e-02  1.342e-01   0.741  0.45915
## texture_mean      2.343e-04  9.418e-04   0.249  0.80360
## perimeter_mean    1.569e-01  1.337e-03 117.301  < 2e-16 ***
## area_mean        -2.857e-04  7.834e-05  -3.647  0.00029 ***
## smoothness_mean   1.274e+00  4.514e-01   2.822  0.00495 **
## compactness_mean -4.827e+00  2.654e-01 -18.189  < 2e-16 ***
## concavity_mean   -7.596e-01  1.564e-01  -4.857 1.55e-06 ***
## points_mean      -2.975e-01  4.463e-01  -0.667  0.50529
## symmetry_mean     2.351e-01  1.806e-01   1.302  0.19362
## dimension_mean    3.252e+00  1.333e+00   2.440  0.01501 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08862 on 559 degrees of freedom
## Multiple R-squared:  0.9994, Adjusted R-squared:  0.9994
## F-statistic: 9.974e+04 on 9 and 559 DF,  p-value: < 2.2e-16
```

```
predict.lm(fit, data.frame(wt =3.2 ,drat=3.9,hp=130,disp=150) )
```

```
## Warning: 'newdata' had 1 row but variables found have 569 rows
```

```
##         1         2         3         4         5         6         7
## 12.330796 10.642003 11.097924 11.233164 15.170675 11.567838 11.453923
##         8         9        10        11        12        13        14
## 13.760271 10.531795 11.118149 20.733918 12.250051 13.162461 13.051487
##        15        16        17        18        19        20        21
## 19.513196 14.647787 15.705885 12.673868 20.212847 12.278214 11.721279
##        22        23        24        25        26        27        28
## 11.620070 11.011240 14.950736 10.529627 13.810144 13.451282 15.381638
##        29        30        31        32        33        34        35
##  9.563629 13.383655 13.058871 12.806841 17.729902 12.261681 14.548721
##        36        37        38        39        40        41        42
## 13.718672 18.897047 12.017636 16.806422 16.293030 20.267835 19.614021
##        43        44        45        46        47        48        49
## 11.137628 13.023973 13.920216 18.018794 11.188343 25.792861 13.504247
##        50        51        52        53        54        55        56
```

```
## 12.388114 13.787234 14.947070 11.813153 14.182581 23.627714 13.078543
##         57         58         59         60         61         62         63
## 11.784277 10.140061 24.374095 19.250052 19.044811 17.443693 17.444516
##         64         65         66         67         68         69         70
## 13.468937 15.187222 12.343554 13.262009 14.571310 13.839425 11.671497
##         71         72         73         74         75         76         77
## 13.487120 10.118895  8.806259 17.748382 16.769998 12.338536 18.246198
##         78         79         80         81         82         83         84
## 11.315963 12.794134 17.928671 14.940325 12.272111 13.316477 14.596785
##         85         86         87         88         89         90         91
## 11.285241 12.901529 12.359722 13.447163 20.956363 13.679625 12.860670
##         92         93         94         95         96         97         98
## 12.529420 15.575301 12.978901 13.837036 16.055512 13.070238 11.866384
##         99        100        101        102        103        104        105
## 10.204178 25.274779 10.612917  9.771597 11.292373 14.706011 13.201215
##        106        107        108        109        110        111        112
## 11.538973 12.571711 12.229696 10.831818 11.194120 11.622124  8.106041
##        113        114        115        116        117        118        119
## 18.554052 13.772018 11.784096 17.144074 14.434849 15.441815 19.695601
##        120        121        122        123        124        125        126
## 12.982999 13.839291 20.382521 11.668319 21.560908 11.492851 11.479781
##        127        128        129        130        131        132        133
## 13.067226 14.580673 18.975461 14.319441 15.013201 13.691013 13.239078
##        134        135        136        137        138        139        140
## 21.535518 11.072082 16.650069  8.757531 12.101903 17.105958 11.954320
##        141        142        143        144        145        146        147
## 18.639370 17.930570 20.034337 14.304244 14.576573 11.853722 15.777377
##        148        149        150        151        152        153        154
## 16.458655 12.426253 12.352359 12.518888  9.745966 12.942271 10.370930
##        155        156        157        158        159        160        161
## 14.435225  9.485643 13.571299 11.017004 10.601156 13.499586 13.260433
##        162        163        164        165        166        167        168
## 11.264164 13.872597  9.072477 23.042581 27.198008 14.357770 17.410391
##        169        170        171        172        173        174        175
## 13.204129 13.742966 13.146899 13.961528 13.650624 13.510821 13.386639
##        176        177        178        179        180        181        182
## 12.873179 19.095214 11.107772 18.587852 12.195465 12.222128 16.033680
##        183        184        185        186        187        188        189
## 13.782232 15.206463 11.320783 10.941291 17.101286 18.421949 20.093960
##        190        191        192        193        194        195        196
##  9.797758 16.090201 11.971754 14.898998 14.604071 15.610233 19.405955
##        197        198        199        200        201        202        203
## 15.067836 14.647200 13.454749 12.233419 14.953264 10.837405 14.993348
##        204        205        206        207        208        209        210
## 12.568171 11.766150 15.519792 11.595947 11.798423 13.503961 20.957234
##        211        212        213        214        215        216        217
## 12.913620 14.536059 17.110585 13.270607 10.880093 10.173402 12.735993
##        218        219        220        221        222        223        224
## 14.185480 12.413859 23.130126 12.729717 12.696396 19.480556 11.485750
##        225        226        227        228        229        230        231
## 10.733768  8.670037  9.427180 20.198664 17.536010 11.316807 11.619784
##        232        233        234        235        236        237        238
## 12.340120 14.333302 16.265109 12.822970 11.731134 14.941807  8.603776
##        239        240        241        242        243        244        245
## 10.675824 10.526020 13.949781  8.796888  9.428327 17.235765 19.550249
##        246        247        248        249        250        251        252
##  9.683485 10.087674 14.627653  8.218990 12.018023 15.046638 15.848232
##        253        254        255        256        257        258        259
## 11.264181 18.250523 13.947197  9.454737 14.576008 11.419258 12.781230
##        260        261        262        263        264        265        266
## 13.559422 12.082122 10.243628 15.490241 13.885013 17.013639 13.037594
##        267        268        269        270        271        272        273
## 10.237655  8.903503 12.302196 19.464311 12.814601 19.610526 14.047615
##        274        275        276        277        278        279        280
## 12.378348 19.312631 28.300059 14.861959 16.598054 10.871268  7.729156
##        281        282        283        284        285        286        287
## 17.878059 11.312171 12.053927 13.623029 17.172147 14.637487 14.146359
##        288        289        290        291        292        293        294
## 19.836114 20.855280 12.614561  9.425671 13.717608 13.836310 12.220737
##        295        296        297        298        299        300        301
## 21.975570 24.700739 20.695773 19.838411 12.106094 16.378705 19.213069
##        302        303        304        305        306        307        308
## 14.260896 10.905228 13.435188 15.674339 20.482838 15.308358 12.915666
```

```
## 14.260896 10.905228 15.435188 15.074339 20.482838 15.308338 12.915666
##       309       310       311       312       313       314       315
## 14.967491 13.575471 20.426746 17.293851 13.644130 11.911396 13.258970
##       316       317       318       319       320       321       322
## 13.493917 20.463621 23.081491 11.154481 14.713486 12.510447 16.712445
##       323       324       325       326       327       328       329
## 20.090099 11.939316 12.447205 18.528669 14.005747 15.860510 13.059781
##       330       331       332       333       334       335       336
## 23.456415  9.799514 12.892559 10.848668 12.245084 14.726324 15.255470
##       337       338       339       340       341       342       343
## 12.590043  8.768101 18.655429 15.656495 16.122398 18.560830 16.356188
##       344       345       346       347       348       349       350
## 11.243513 16.187029  9.779642  8.886397 11.456620 15.021587 12.051075
##       351       352       353       354       355       356       357
## 14.010561 17.578485 12.891255 11.357411 14.767135  9.457941  9.909236
##       358       359       360       361       362       363       364
## 11.814859 18.283519  9.352239 20.335461 15.897062 12.285710 10.322908
##       365       366       367       368       369       370       371
## 12.202361 11.488471 17.657614  9.793510 11.600403 19.266664 12.541987
##       372       373       374       375       376       377       378
##  9.219852 12.311869 12.203883 12.658638 12.454957 14.714298 12.330108
##       379       380       381       382       383       384       385
## 11.416341 11.529731 13.854454 10.525373 14.469700 16.170221 11.335644
##       386       387       388       389       390       391       392
## 10.282036 22.000278 10.536570 13.610527 16.257226 17.797695 11.208554
##       393       394       395       396       397       398       399
## 13.631540 19.077559 13.692732 13.848824 11.580808 15.362675 19.678855
##       400       401       402       403       404       405       406
##  9.885539  9.848037 13.341115 19.225149 20.540699 13.252570 20.415222
##       407       408       409       410       411       412       413
## 16.178124 11.491300 14.849233  9.605722 12.873510 11.366488 10.758543
##       414       415       416       417       418       419       420
## 11.732596 11.739111 19.339206 11.435819 14.443274 20.123881 11.843433
##       421       422       423       424       425       426       427
##  9.413430 15.104045 11.208913  9.079563 11.419607 12.620161 11.918528
##       428       429       430       431       432       433       434
## 14.756366 10.175104 15.235975 13.637797 18.376042 12.030947 18.439389
##       435       436       437       438       439       440       441
## 10.993764 14.107290 18.704320 12.934587  8.687036 11.703050 12.985477
##       442       443       444       445       446       447       448
## 13.608030 15.111169 13.420938 17.235043  9.544859 13.774576 12.048991
##       449       450       451       452       453       454       455
## 11.862941 17.024098 10.463613 12.352649 19.548341 11.776449 11.921888
##       456       457       458       459       460       461       462
## 14.452065 13.591839 20.653110  8.743534 13.005946 27.792221 18.748633
##       463       464       465       466       467       468       469
## 11.059101 13.798022 17.192588 12.454970 13.220041 17.898250 10.258778
##       470       471       472       473       474       475       476
## 14.031429 12.830340 14.922566 13.042222 19.497573 12.058126 18.132271
##       477       478       479       480       481       482       483
## 12.075817 20.994703 14.943392 13.920304 14.485221 14.477683 18.635346
##       484       485       486       487       488       489       490
##  9.842350 11.680963 15.749211  9.712819 22.385237 13.189419 10.776610
##       491       492       493       494       495       496       497
## 18.029867 20.506722 15.468774 10.954275  8.577949 12.786878  9.905631
##       498       499       500       501       502       503       504
## 13.133849 19.918001 15.612849 16.593408 15.955677 16.134650 10.461069
##       505       506       507       508       509       510       511
## 11.589802 11.254999 14.243101 14.802300 21.201838 15.531859 13.134412
##       512       513       514       515       516       517       518
## 17.821994 11.811511 13.628630 16.454032 12.741866 20.440264 19.576431
##       519       520       521       522       523       524       525
## 18.196992 13.215368 10.445775 12.482701 15.126776  7.655483  7.013920
##       526       527       528       529       530       531       532
## 12.899589 12.645259 17.661343 11.397083  9.678853 12.010972  7.396690
##       533       534       535       536       537       538       539
## 12.743932 16.470690 19.605065 12.855586 11.555852 11.731998 13.869940
##       540       541       542       543       544       545       546
## 11.607248 16.961566  9.287247 12.617860 20.342736 20.787300 12.936930
##       547       548       549       550       551       552       553
##  8.954094 12.760473 14.041482 12.086192 12.797706 11.166680 12.253060
##       554       555       556       557       558       559       560
## 11.756259 13.197059 21.500697 11.522043 14.728413 11.088746 14.836915
```

```
##      561      562      563      564      565      566      567
## 14.332544 12.221265 14.414045 12.875661 13.145596 10.312021 15.221633
##      568      569
## 14.501868 21.331349
```

```r
#LDA
library(MASS)
features <- c("radius", "texture", "perimeter", "area", "smoothness", "compactness", "concavity", "concave_p
oints", "symmetry", "fractal_dimension")
names(cancer) <- c("id", "diagnosis", paste0(features,"_mean"), paste0(features,"_se"), paste0(features,"_wo
rst"))
head(cancer)
```

```
##         id diagnosis radius_mean texture_mean perimeter_mean area_mean
## 1 87139402         B       12.32        12.39          78.85     464.1
## 2  8910251         B       10.60        18.95          69.28     346.4
## 3   905520         B       11.04        16.83          70.92     373.2
## 4   868871         B       11.28        13.39          73.00     384.8
## 5  9012568         B       15.19        13.21          97.65     711.8
## 6   906539         B       11.57        19.04          74.20     409.7
##   smoothness_mean compactness_mean concavity_mean concave_points_mean
## 1         0.10280          0.06981        0.03987             0.03700
## 2         0.09688          0.11470        0.06387             0.02642
## 3         0.10770          0.07804        0.03046             0.02480
## 4         0.11640          0.11360        0.04635             0.04796
## 5         0.07963          0.06934        0.03393             0.02657
## 6         0.08546          0.07722        0.05485             0.01428
##   symmetry_mean fractal_dimension_mean radius_se texture_se perimeter_se
## 1        0.1959                0.05955    0.2360     0.6656        1.670
## 2        0.1922                0.06491    0.4505     1.1970        3.430
## 3        0.1714                0.06340    0.1967     1.3870        1.342
## 4        0.1771                0.06072    0.3384     1.3430        1.851
## 5        0.1721                0.05544    0.1783     0.4125        1.338
## 6        0.2031                0.06267    0.2864     1.4400        2.206
##   area_se smoothness_se compactness_se concavity_se concave_points_se
## 1   17.43      0.008045       0.011800      0.01683          0.012410
## 2   27.10      0.007470       0.035810      0.03354          0.013650
## 3   13.54      0.005158       0.009355      0.01056          0.007483
## 4   26.33      0.011270       0.034980      0.02187          0.019650
## 5   17.72      0.005012       0.014850      0.01551          0.009155
## 6   20.30      0.007278       0.020470      0.04447          0.008799
##   symmetry_se fractal_dimension_se radius_worst texture_worst
## 1     0.01924             0.002248        13.50         15.64
## 2     0.03504             0.003318        11.88         22.94
## 3     0.01718             0.002198        12.41         26.44
## 4     0.01580             0.003442        11.92         15.77
## 5     0.01647             0.001767        16.20         15.73
## 6     0.01868             0.003339        13.07         26.98
##   perimeter_worst area_worst smoothness_worst compactness_worst
## 1           86.97      549.1           0.1385            0.1266
## 2           78.28      424.8           0.1213            0.2515
## 3           79.93      471.4           0.1369            0.1482
## 4           76.53      434.0           0.1367            0.1822
## 5          104.50      819.1           0.1126            0.1737
## 6           86.43      520.5           0.1249            0.1937
##   concavity_worst concave_points_worst symmetry_worst
## 1         0.12420              0.09391         0.2827
## 2         0.19160              0.07926         0.2940
## 3         0.10670              0.07431         0.2998
## 4         0.08669              0.08611         0.2102
## 5         0.13620              0.08178         0.2487
## 6         0.25600              0.06664         0.3035
##   fractal_dimension_worst
## 1                 0.06771
## 2                 0.07587
## 3                 0.07881
## 4                 0.06784
## 5                 0.06766
## 6                 0.08284
```

```
dim(cancer)
```

```
## [1] 569  32
```

```
#The mean, standard error, and "worst" or largest (mean of the three largest values) of these features were
computed for each image, resulting in 30 features. For instance, field 3 is Mean Radius, field 13 is Radius
SE, field 23 is Worst Radius.
#we need to convert to matrix to facilitate distance measurement
cancer.data <- as.matrix(cancer[,c(3:32)])
row.names(cancer.data) <- cancer$id
dim(cancer.data)
```

```
## [1] 569  30
```

```
dim(cancer)
```

```
## [1] 569  32
```

```
cancer_raw <- cbind(cancer.data, as.numeric(cancer$diagnosis)-1)
dim(cancer_raw)
```

```
## [1] 569  31
```

```
colnames(cancer_raw)[31] <- "diagnosis"
#What this does is it simply removes ID as a variable and defines our data as a matrix instead of a datafram
e while still retaining the ID but in the column-names instead.
# Lets cut the data into two parts
smp_size_raw <- floor(0.75 * nrow(cancer_raw))
train_ind_raw <- sample(nrow(cancer_raw), size = smp_size_raw)
train_raw.df <- as.data.frame(cancer_raw[train_ind_raw, ])
test_raw.df <- as.data.frame(cancer_raw[-train_ind_raw, ])
# We now have a training and a test set. Training is 75% and test is 25%
cancer_raw.lda <- lda(formula = train_raw.df$diagnosis ~ ., data = train_raw.df)
cancer_raw.lda
```

```
## Call:
## lda(train_raw.df$diagnosis ~ ., data = train_raw.df)
##
## Prior probabilities of groups:
##         0         1
## 0.6079812 0.3920188
##
## Group means:
##   radius_mean texture_mean perimeter_mean area_mean smoothness_mean
## 0    12.20931     17.73842       78.51649  467.5602      0.09252054
## 1    17.45683     21.49192      115.26341  976.8533      0.10300790
##   compactness_mean concavity_mean concave_points_mean symmetry_mean
## 0       0.08133633     0.04691021          0.02641657     0.1755290
## 1       0.14393503     0.15999168          0.08834940     0.1931976
##   fractal_dimension_mean radius_se texture_se perimeter_se  area_se
## 0             0.06273788 0.2866185   1.215833     2.024590 21.31406
## 1             0.06267856 0.6133072   1.238501     4.326784 72.55156
##   smoothness_se compactness_se concavity_se concave_points_se symmetry_se
## 0   0.007122780     0.02172185   0.02644435       0.009974378  0.02085096
## 1   0.006843862     0.03200765   0.04182880       0.015166796  0.02078420
##   fractal_dimension_se radius_worst texture_worst perimeter_worst
## 0          0.003619425     13.45977      23.29000        87.63591
## 1          0.004047186     21.17383      29.28886       141.47641
##   area_worst smoothness_worst compactness_worst concavity_worst
## 0   565.5143        0.1247011         0.1871725       0.1716166
## 1  1428.2581        0.1446251         0.3633264       0.4424442
##   concave_points_worst symmetry_worst fractal_dimension_worst
## 0           0.07642857      0.2732938              0.07943371
## 1           0.18148317      0.3235341              0.09015832
##
## Coefficients of linear discriminants:
##                                 LD1
## radius_mean             -2.015117609
## texture_mean             0.017205002
## perimeter_mean           0.281753013
## area_mean                0.000693878
## smoothness_mean         -0.440334270
## compactness_mean       -29.974802092
## concavity_mean           7.558451765
## concave_points_mean      7.839926608
## symmetry_mean            0.759610666
## fractal_dimension_mean   2.389051030
## radius_se                3.834592657
## texture_se              -0.012272622
## perimeter_se            -0.246278342
## area_se                 -0.005017335
## smoothness_se           52.081546082
## compactness_se           0.002455225
## concavity_se           -23.330252325
## concave_points_se       57.266225155
## symmetry_se             15.222864633
## fractal_dimension_se    35.653120109
## radius_worst             1.188410854
## texture_worst            0.041255513
## perimeter_worst         -0.046902775
## area_worst              -0.005452222
## smoothness_worst         7.300495981
## compactness_worst        1.904638957
## concavity_worst          2.457550682
## concave_points_worst     2.197198183
## symmetry_worst           2.017611697
## fractal_dimension_worst 14.039056444
```

```
summary(cancer_raw.lda)
```

```
##         Length Class  Mode
## prior   2      -none- numeric
## counts  2      -none- numeric
## means   60     -none- numeric
## scaling 30     -none- numeric
## lev     2      -none- character
## svd     1      -none- numeric
## N       1      -none- numeric
## call    3      -none- call
## terms   3      terms  call
## xlevels 0      -none- list
```

```
print(cancer_raw.lda)
```

```
##         Length Class  Mode
## prior   2      -none- numeric
## counts  2      -none- numeric
## means   60     -none- numeric
## scaling 30     -none- numeric
## lev     2      -none- character
## svd     1      -none- numeric
## N       1      -none- numeric
## call    3      -none- call
## terms   3      terms  call
## xlevels 0      -none- list
```

```
## Call:
## lda(train_raw.df$diagnosis ~ ., data = train_raw.df)
##
## Prior probabilities of groups:
##         0         1
## 0.6079812 0.3920188
##
## Group means:
##   radius_mean texture_mean perimeter_mean area_mean smoothness_mean
## 0    12.20931     17.73842       78.51649  467.5602      0.09252054
## 1    17.45683     21.49192      115.26341  976.8533      0.10300790
##   compactness_mean concavity_mean concave_points_mean symmetry_mean
## 0       0.08133633     0.04691021          0.02641657     0.1755290
## 1       0.14393503     0.15999168          0.08834940     0.1931976
##   fractal_dimension_mean radius_se texture_se perimeter_se  area_se
## 0             0.06273788 0.2866185   1.215833     2.024590 21.31406
## 1             0.06267856 0.6133072   1.238501     4.326784 72.55156
##   smoothness_se compactness_se concavity_se concave_points_se symmetry_se
## 0   0.007122780     0.02172185   0.02644435       0.009974378  0.02085096
## 1   0.006843862     0.03200765   0.04182880       0.015166796  0.02078420
##   fractal_dimension_se radius_worst texture_worst perimeter_worst
## 0          0.003619425     13.45977      23.29000        87.63591
## 1          0.004047186     21.17383      29.28886       141.47641
##   area_worst smoothness_worst compactness_worst concavity_worst
## 0   565.5143        0.1247011         0.1871725       0.1716166
## 1  1428.2581        0.1446251         0.3633264       0.4424442
##   concave_points_worst symmetry_worst fractal_dimension_worst
## 0           0.07642857      0.2732938              0.07943371
## 1           0.18148317      0.3235341              0.09015832
##
## Coefficients of linear discriminants:
##                                 LD1
## radius_mean              -2.015117609
## texture_mean              0.017205002
## perimeter_mean            0.281753013
## area_mean                 0.000693878
## smoothness_mean          -0.440334270
## compactness_mean        -29.974802092
## concavity_mean            7.558451765
## concave_points_mean       7.839926608
## symmetry_mean             0.759610666
## fractal_dimension_mean    2.389051030
## radius_se                 3.834592657
## texture_se               -0.012272622
## perimeter_se             -0.246278342
## area_se                  -0.005017335
## smoothness_se            52.081546082
## compactness_se            0.002455225
## concavity_se            -23.330252325
## concave_points_se        57.266225155
## symmetry_se              15.222864633
## fractal_dimension_se     35.653120109
## radius_worst              1.188410854
## texture_worst             0.041255513
## perimeter_worst          -0.046902775
## area_worst               -0.005452222
## smoothness_worst          7.300495981
## compactness_worst         1.904638957
## concavity_worst           2.457550682
## concave_points_worst      2.197198183
## symmetry_worst            2.017611697
## fractal_dimension_worst  14.039056444
```

```
plot(cancer_raw.lda)
```

group 0

group 1
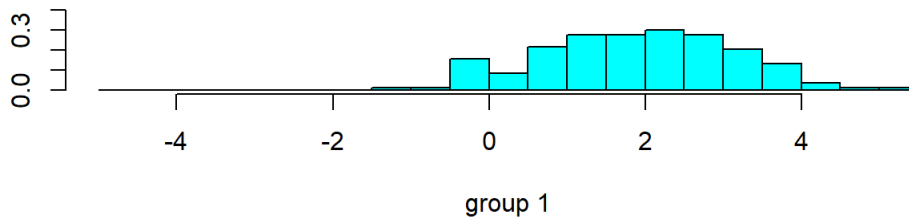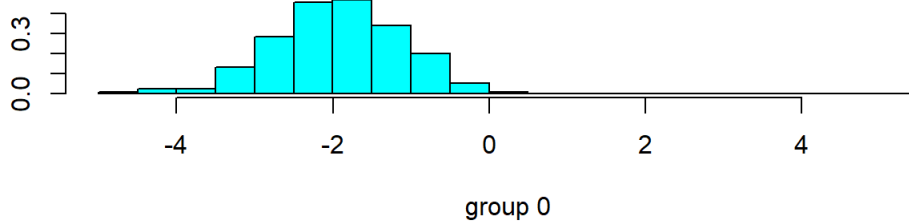
```
cancer_raw.lda.predict <- predict(cancer_raw.lda, newdata = test_raw.df)
cancer_raw.lda.predict$class
```

```
##   [1] 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 1 1 1 1 0 0 0 0 0 1 0 0 0 1 1 1 1 0
##  [36] 0 0 0 1 0 0 0 0 0 0 0 1 0 0 0 1 0 1 1 0 1 1 0 0 0 0 0 0 1 0 0 1 0 0 1
##  [71] 0 0 1 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1 0 0 0 1
## [106] 1 1 0 0 0 0 0 1 0 1 0 0 0 0 0 1 1 0 0 0 1 1 0 1 0 1 0 1 1 1 0 0 0 0 0 0 0
## [141] 0 1 0
## Levels: 0 1
```

```
#View(cancer_raw.lda.predict)
#cancer_raw.lda.predict$x
# Get the posteriors as a dataframe.
cancer_raw.lda.predict.posteriors <- as.data.frame(cancer_raw.lda.predict$posterior)
#create ROC/AUC curve
#install.packages("ROCR")
library(ROCR)
```

```
## Loading required package: gplots
```

```
##
## Attaching package: 'gplots'
```

```
## The following object is masked from 'package:stats':
##
##     lowess
```

```
pred <- prediction(cancer_raw.lda.predict.posteriors[,2], test_raw.df$diagnosis)
roc.perf = performance(pred, measure = "tpr", x.measure = "fpr")
auc.train <- performance(pred, measure = "auc")
auc.train <- auc.train@y.values
plot(roc.perf)
abline(a=0, b= 1)
text(x = .25, y = .65 ,paste("AUC = ", round(auc.train[[1]],3), sep = ""))
```
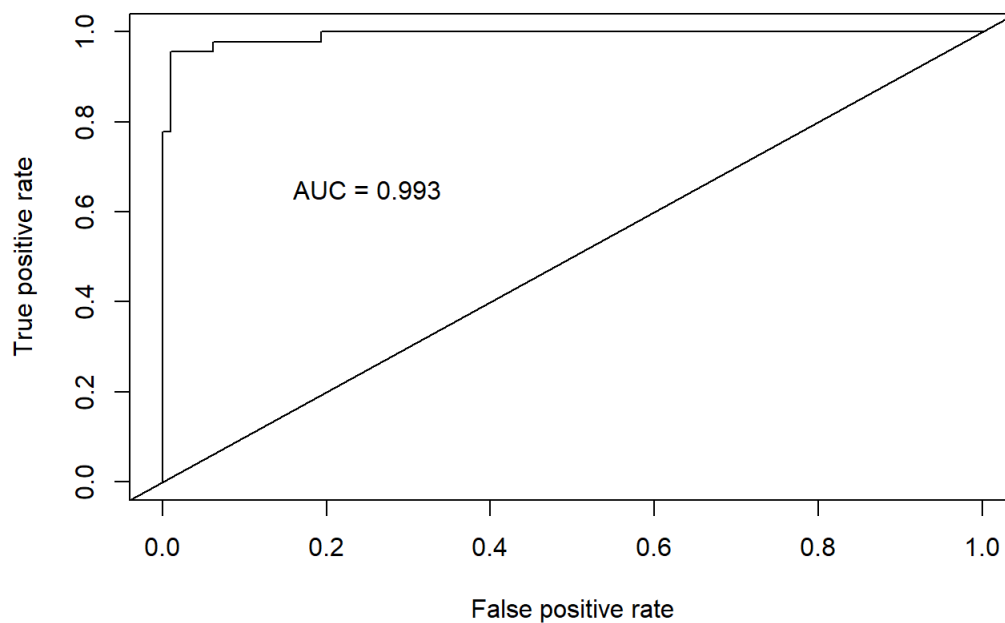
```r
#kNN
library(class)
```

```
## 
## Attaching package: 'class'
```

```
## The following object is masked from 'package:reshape':
## 
##     condense
```

```r
normalize <- function(x) {
  y <- (x - min(x))/(max(x) - min(x))
  y
}

wbcd_n_L <- lapply(cancer[, 3:32], normalize)
wbcd_n <- data.frame(wbcd_n_L)
wbcd_n[1:3, 1:4]
```

```
##   radius_mean texture_mean perimeter_mean  area_mean
## 1   0.2526859    0.0906324      0.2422777 0.13599152
## 2   0.1712812    0.3124789      0.1761454 0.08606575
## 3   0.1921056    0.2407846      0.1874784 0.09743372
```

```r
rownames(wbcd_n) <- cancer$id
BM_class <- cancer[, 2]
names(BM_class) <- wisc_bc_df$id
BM_class[1:3]
```

```
## 87139402  8910251   905520
##        B        B        B
## Levels: B M
```

```r
nrow(cancer)
```

```
## [1] 569
```

```
rand_permute <- sample(x = 1:569, size = 569)
rand_permute[1:5]
```

```
## [1] 454   6 336 251 285
```

```
# save(rand_permute, file='rand_permute.RData')

all_id_random <- cancer[rand_permute, "id"]
569/3
```

```
## [1] 189.6667
```

```
validate_id <- as.character(all_id_random[1:189])
training_id <- as.character(all_id_random[190:569])

wbcd_train <- wbcd_n[training_id, ]
wbcd_val <- wbcd_n[validate_id, ]
BM_class_train <- BM_class[training_id]
BM_class_val <- BM_class[validate_id]
table(BM_class_train)
```

```
## BM_class_train
##   B   M
## 234 146
```

```
table(BM_class_val)
```

```
## BM_class_val
##   B   M
## 123  66
```

```
sqrt(nrow(wbcd_train))
```

```
## [1] 19.49359
```

```
knn_predict <- knn(wbcd_train, wbcd_val, BM_class_train, k = 19)
knn_predict[1:3]
```

```
## [1] B B B
## Levels: B M
```

```
table(knn_predict, BM_class_val)
```

```
##            BM_class_val
## knn_predict   B   M
##           B 122   5
##           M   1  61
```

```
prop.table(table(knn_predict, BM_class_val))
```

```
##            BM_class_val
## knn_predict           B           M
##           B 0.645502646 0.026455026
##           M 0.005291005 0.322751323
```

```
knn_predict_3 <- knn(wbcd_train, wbcd_val, BM_class_train, k = 3)
knn_predict_7 <- knn(wbcd_train, wbcd_val, BM_class_train, k = 7)
knn_predict_11 <- knn(wbcd_train, wbcd_val, BM_class_train, k = 11)
knn_predict_31 <- knn(wbcd_train, wbcd_val, BM_class_train, k = 31)

table(knn_predict_3, BM_class_val)
```

```
##                BM_class_val
## knn_predict_3   B    M
##              B 120    5
##              M   3   61
```

```
table(knn_predict_7, BM_class_val)
```

```
##                BM_class_val
## knn_predict_7   B    M
##              B 122    4
##              M   1   62
```

```
table(knn_predict_11, BM_class_val)
```

```
##                 BM_class_val
## knn_predict_11   B    M
##               B 121    5
##               M   2   61
```

```
table(knn_predict_31, BM_class_val)
```

```
##                 BM_class_val
## knn_predict_31   B    M
##               B 121    6
##               M   2   60
```