

MVA3.r

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```
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
```

```
#Renmaing the dataset
cancer<-wisc_bc_df
library("ggplot2")
library("corrplot")
```

```
## corrplot 0.84 loaded
```

```
library("reshape")
```

```
#number of obsevation and data type
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 ...
```

```
#gives you 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

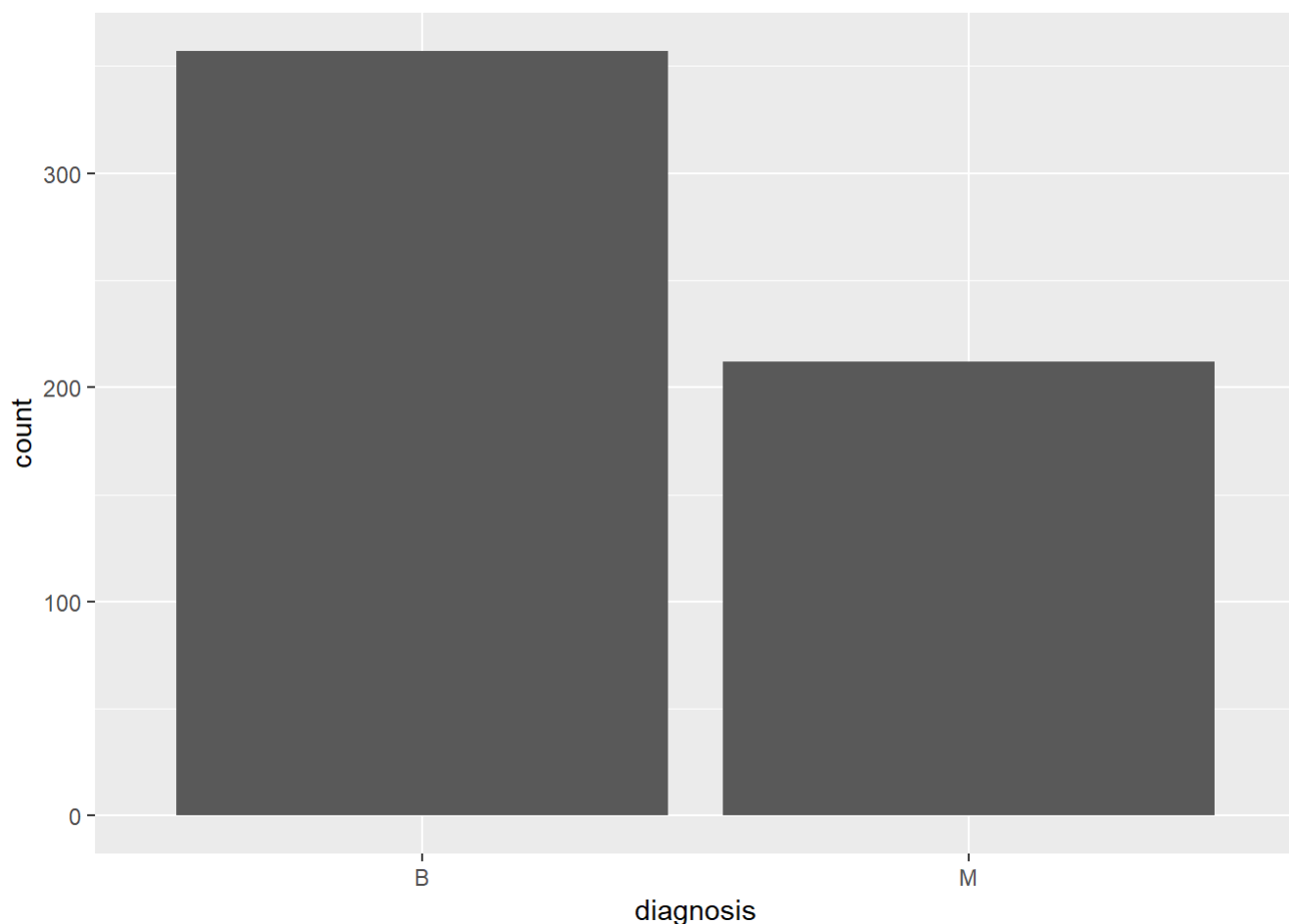
```

```
## 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
```

```
#Gives you frequency table
diagnosis.table <- table(cancer$diagnosis)
diagnosis.table
```

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

```
#Bar plot
ggplot(data=cancer, aes(x=diagnosis)) + geom_bar(stat = "count")
```

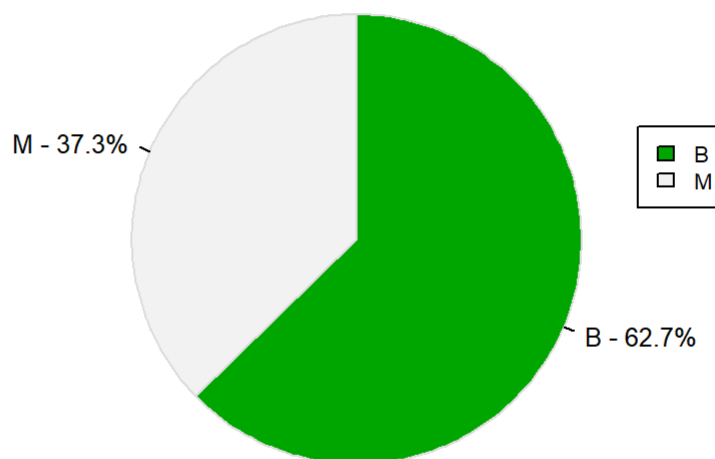


```

#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

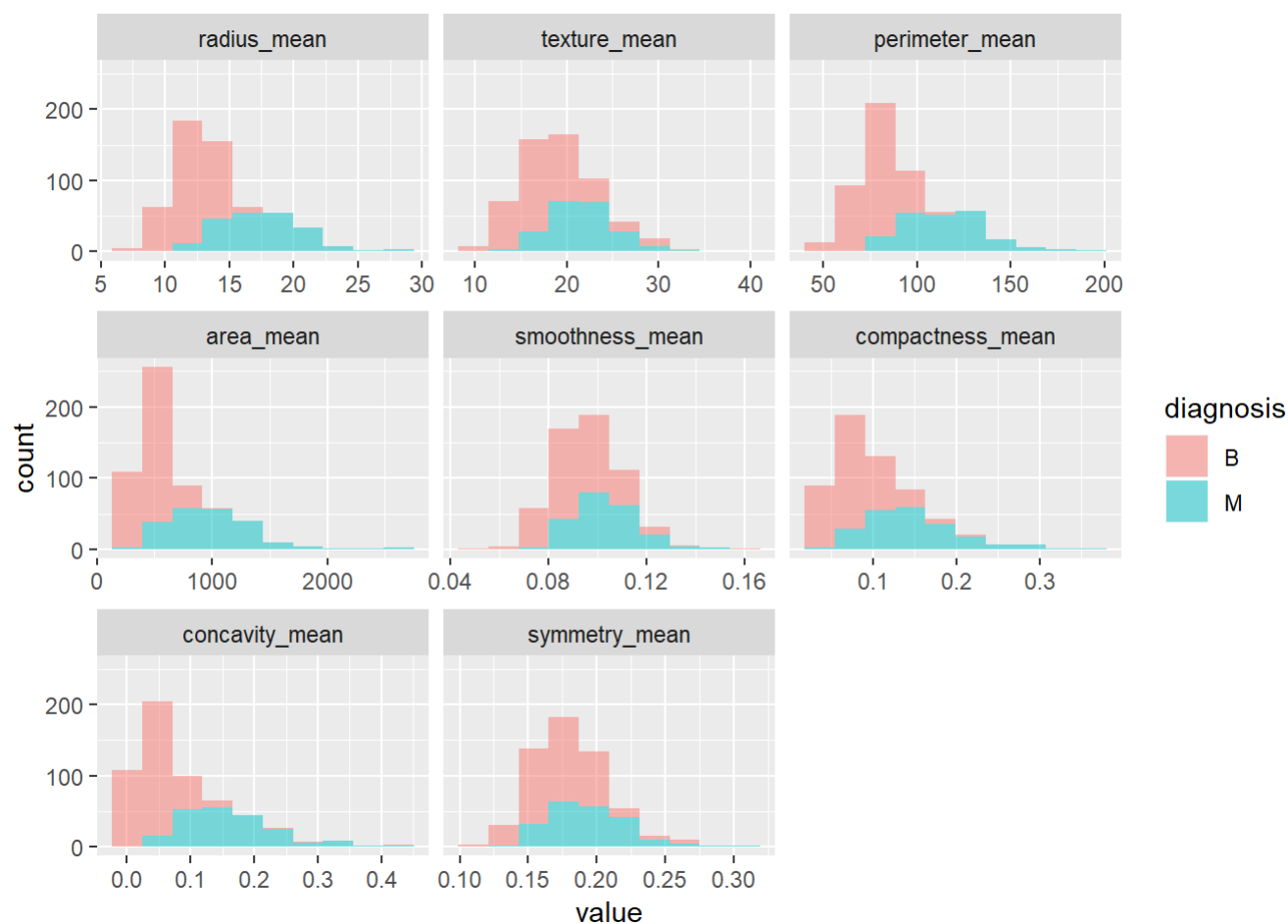


```

#Plot histograms of "mean" variables group by diagnosis
data_mean <- cancer[ ,c("diagnosis", "radius_mean", "texture_mean", "perimeter_mean", "area_mean",
    "smoothness_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')

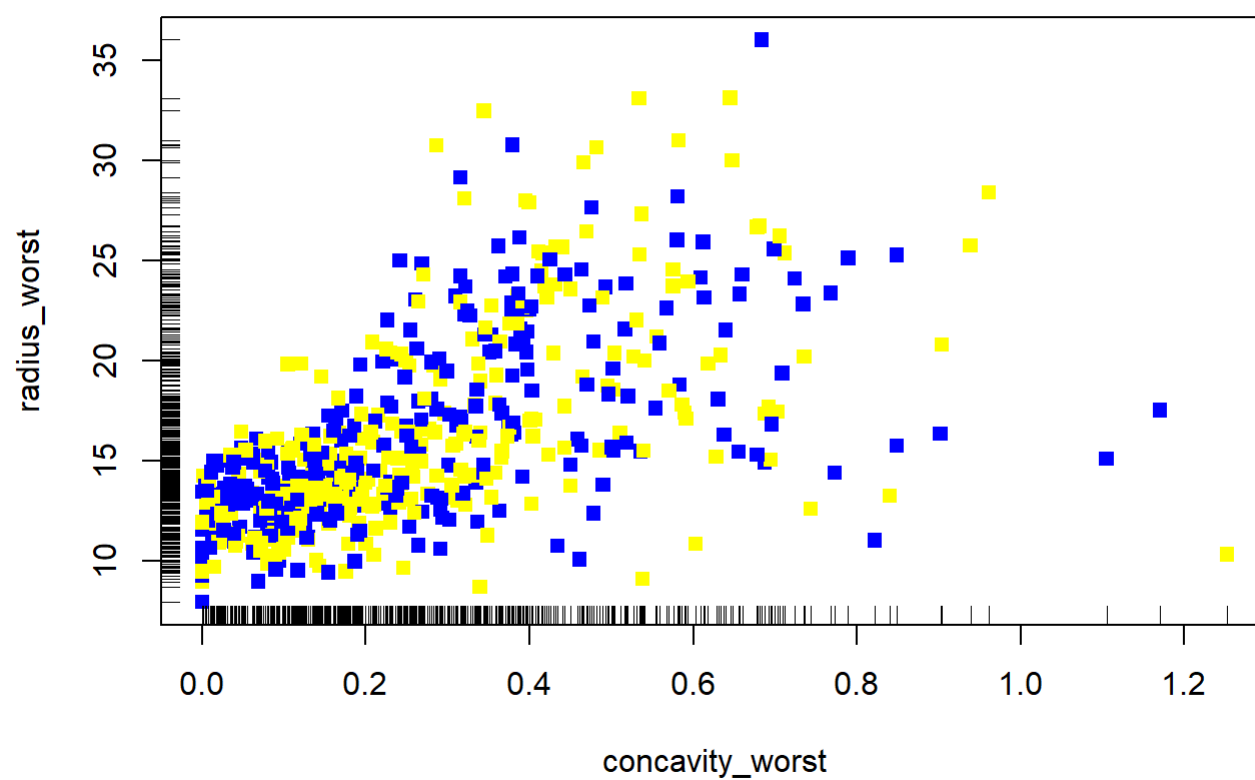
```



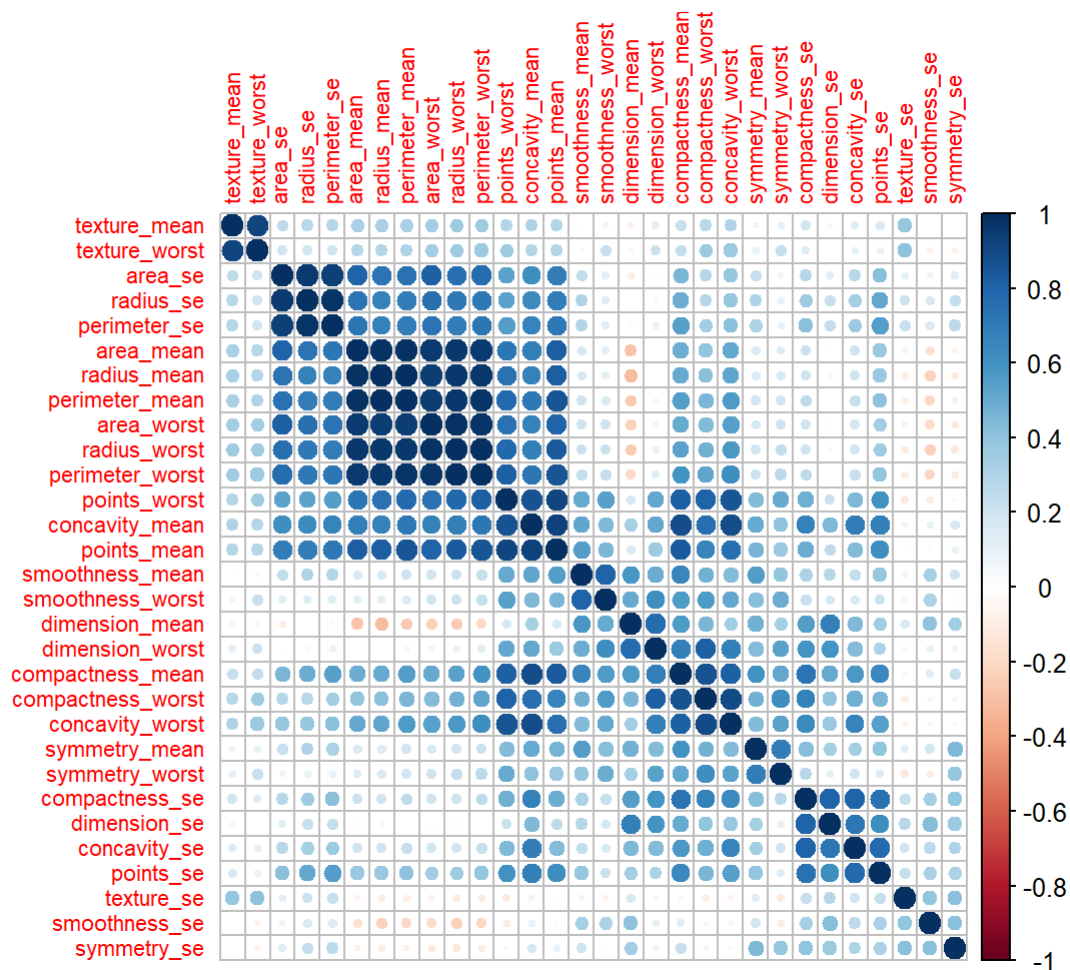
```
#Scatter plot of two variable (concavity again radius)
a <- cancer[,c('concavity_worst','radius_worst')]
plot(x = cancer$concavity_worst,y = cancer$radius_worst,
     xlab = "concavity_worst",
     ylab = "radius_worst",
     main = "Concavity_worst vs radius_worst",
     pch=15,col=c("blue","yellow"))
rug(cancer$concavity_worst, side = 1)

rug(cancer$radius_worst, side = 2)
```


Concavity_worst vs radius_worst



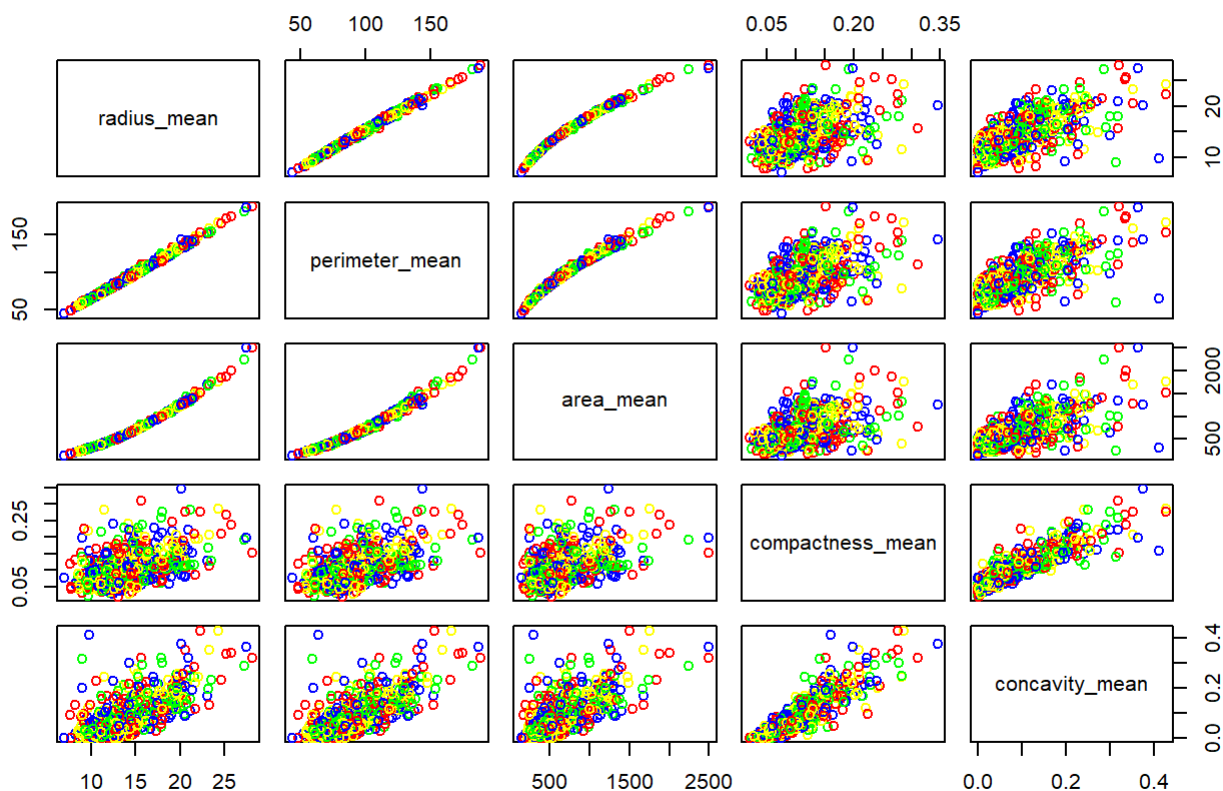
```
#Corelation Matrix of columns  
corMatMy <- cor(cancer[,3:32])  
corrplot(corMatMy, order = "hclust", tl.cex = 0.7)
```



```
#Scatterplot Matrix
```

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

Scatterplot Matrix



```
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"
```

```
#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 + compactness_mean + concavity_mean + points_mean + symmetry_mean + dimension_mean ~ diagn
osis, data=cancer)
# Output of the function hotelling.test is given
cat("T2 statistic =",t2testcan$stat[[1]],"\n")
```

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

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

```
## Levene's tests based on absolute differences around means using t-tests. Standarizing the spa
rows data set with scale()
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
```

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

```
##      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
```

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

```
##      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
```



```
vecmediannosurv <- apply(matnosurv, 2, median)
matabsdevsurv <- abs(matsurv - matrix(rep(vecmediansurv,nrow(matsurv)),nrow=nrow(matsurv), byrow=TRUE))

matabsdevnosurv <- abs(matnosurv - matrix(rep(vecmediannosurv,nrow(matnosurv)),nrow=nrow(matnosurv), byrow=TRUE))

head(matabsdevnosurv)
```

```
##      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(matabsdevsurv,matabsdevnosurv)
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$texture_mean[cancer$diagnosis == "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$perimeter_mean[cancer$diagnosis == "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"], alternative="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$smoothness_mean[cancer$diagnosis == "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$compactness_mean[cancer$diagnosis == "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$concavity_mean[cancer$diagnosis == "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 + compactness_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
# Levene test is used to verify Homoscedasticity. It tests if the variance of two samples are #
#equal. Levene's test is an inferential statistic used to assess the equality of variances for a
#variable calculated for 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 #as
sesses 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 Analysis
```

```
#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
head(cor(cancer[-2]))
```

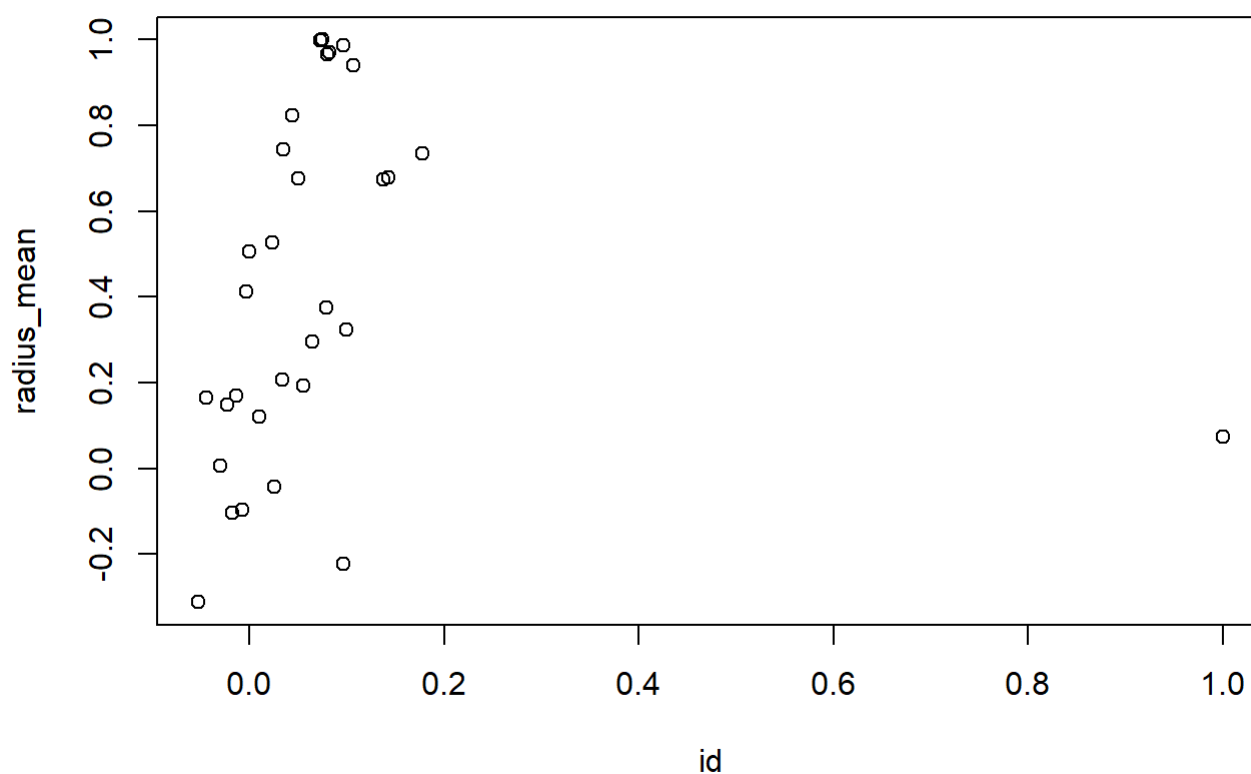
```

##          id radius_mean texture_mean perimeter_mean
## id          1.00000000  0.07462647  0.09976989  0.07315941
## radius_mean  0.07462647  1.00000000  0.32378189  0.99785528
## texture_mean 0.09976989  0.32378189  1.00000000  0.32953306
## perimeter_mean 0.07315941 0.99785528  0.32953306  1.00000000
## area_mean    0.09689282  0.98735717  0.32108570  0.98650680
## smoothness_mean -0.01296820 0.17058119 -0.02338852  0.20727816
##          area_mean smoothness_mean compactness_mean concavity_mean
## id          0.09689282  -0.01296820  0.0000957011  0.05007995
## radius_mean  0.98735717  0.17058119  0.5061235775  0.67676355
## texture_mean 0.32108570  -0.02338852  0.2367022221  0.30241783
## perimeter_mean 0.98650680  0.20727816  0.5569362109  0.71613565
## area_mean    1.00000000  0.17702838  0.4985016822  0.68598283
## smoothness_mean 0.17702838  1.00000000  0.6591232152  0.52198377
##          points_mean symmetry_mean dimension_mean radius_se
## id          0.0441581  -0.02211406  -0.05251145  0.1430476
## radius_mean  0.8225285  0.14774124  -0.31163083  0.6790904
## texture_mean  0.2934641  0.07140098  -0.07643718  0.2758687
## perimeter_mean 0.8509770  0.18302721  -0.26147691  0.6917650
## area_mean    0.8232689  0.15129308  -0.28310981  0.7325622
## smoothness_mean 0.5536952  0.55777479  0.58479200  0.3014671
##          texture_se perimeter_se area_se smoothness_se
## id          -0.00752619  0.1373311  0.1777419  0.096780574
## radius_mean  -0.09731744  0.6741716  0.7358637  -0.222600125
## texture_mean  0.38635762  0.2816731  0.2598450  0.006613777
## perimeter_mean -0.08676108  0.6931349  0.7449827  -0.202694026
## area_mean    -0.06628021  0.7266283  0.8000859  -0.166776667
## smoothness_mean 0.06840645  0.2960919  0.2465524  0.332375443
##          compactness_se concavity_se points_se symmetry_se
## id          0.03396097  0.05523932  0.07876807  -0.017306295
## radius_mean  0.20599998  0.19420362  0.37616896  -0.104320881
## texture_mean  0.19197461  0.14329308  0.16385103  0.009127168
## perimeter_mean 0.25074368  0.22808235  0.40721692  -0.081629327
## area_mean    0.21258255  0.20766006  0.37232028  -0.072496588
## smoothness_mean 0.31894330  0.24839568  0.38067569  0.200774376
##          dimension_se radius_worst texture_worst perimeter_worst
## id          0.025725324  0.08240534  0.06471955  0.07998587
## radius_mean  -0.042641269  0.96953897  0.29700764  0.96513651
## texture_mean  0.054457520  0.35257295  0.91204459  0.35803958
## perimeter_mean -0.005523391  0.96947636  0.30303837  0.97038689
## area_mean    -0.019886963  0.96274609  0.28748863  0.95911957
## smoothness_mean 0.283606699  0.21312014  0.03607180  0.23885263
##          area_worst smoothness_worst compactness_worst
## id          0.1071865  0.01033803  -0.0029681
## radius_mean  0.9410825  0.11961614  0.4134628
## texture_mean  0.3435459  0.07750336  0.2778296
## perimeter_mean 0.9415498  0.15054940  0.4557742
## area_mean    0.9592133  0.12352294  0.3904103
## smoothness_mean 0.2067184  0.80532420  0.4724684
##          concavity_worst points_worst symmetry_worst
## id          0.02320274  0.03517358  -0.04422425
## radius_mean  0.52691146  0.74421420  0.16395333
## texture_mean  0.30102522  0.29531584  0.10500791

```

```
## perimeter_mean      0.56387926  0.77124079  0.18911504
## area_mean          0.51260592  0.72201663  0.14356991
## smoothness_mean    0.43492571  0.50305335  0.39430948
##                    dimension_worst
## id                    -0.029865636
## radius_mean           0.007065886
## texture_mean          0.119205351
## perimeter_mean        0.051018530
## area_mean             0.003737597
## smoothness_mean       0.499316369
```

```
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)
head(cancer_pca)
```

```
## $sdev
## [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
##
##          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
## 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
##
## $center
##          id      radius_mean      texture_mean      perimeter_mean
## 3.037183e+07  1.412729e+01  1.928965e+01  9.196903e+01

```



```
##      area_mean  smoothness_mean  compactness_mean  concavity_mean
##      6.548891e+02    9.636028e-02    1.043410e-01    8.879932e-02
##      points_mean  symmetry_mean    dimension_mean    radius_se
##      4.891915e-02    1.811619e-01    6.279761e-02    4.051721e-01
##      texture_se    perimeter_se    area_se    smoothness_se
##      1.216853e+00    2.866059e+00    4.033708e+01    7.040979e-03
##      compactness_se  concavity_se    points_se    symmetry_se
##      2.547814e-02    3.189372e-02    1.179614e-02    2.054230e-02
##      dimension_se    radius_worst    texture_worst    perimeter_worst
##      3.794904e-03    1.626919e+01    2.567722e+01    1.072612e+02
##      area_worst  smoothness_worst  compactness_worst  concavity_worst
##      8.805831e+02    1.323686e-01    2.542650e-01    2.721885e-01
##      points_worst  symmetry_worst    dimension_worst
##      1.146062e-01    2.900756e-01    8.394582e-02
##
## $scale
##      id    radius_mean    texture_mean    perimeter_mean
##      1.250206e+08    3.524049e+00    4.301036e+00    2.429898e+01
##      area_mean  smoothness_mean  compactness_mean  concavity_mean
##      3.519141e+02    1.406413e-02    5.281276e-02    7.971981e-02
##      points_mean  symmetry_mean    dimension_mean    radius_se
##      3.880284e-02    2.741428e-02    7.060363e-03    2.773127e-01
##      texture_se    perimeter_se    area_se    smoothness_se
##      5.516484e-01    2.021855e+00    4.549101e+01    3.002518e-03
##      compactness_se  concavity_se    points_se    symmetry_se
##      1.790818e-02    3.018606e-02    6.170285e-03    8.266372e-03
##      dimension_se    radius_worst    texture_worst    perimeter_worst
##      2.646071e-03    4.833242e+00    6.146258e+00    3.360254e+01
##      area_worst  smoothness_worst  compactness_worst  concavity_worst
##      5.693570e+02    2.283243e-02    1.573365e-01    2.086243e-01
##      points_worst  symmetry_worst    dimension_worst
##      6.573234e-02    6.186747e-02    1.806127e-02
##
## $x
##      PC1      PC2      PC3      PC4      PC5
##      [1,]  2.50194550 -0.096948052 -0.4489597008  2.334117555  0.697715477
##      [2,]  1.46743888 -1.686300588  1.1542038774  0.336210935  0.459625382
##      [3,]  2.92902790 -0.383199241 -0.8955890691 -0.116482776  0.984413772
##      [4,]  1.99534236 -1.330465924  1.1172875551  2.050276131  0.253038461
##      [5,]  2.50025164  2.010350968 -0.7584034865  1.986216853 -1.135370958
##      [6,]  2.01830827 -0.782420945  0.1125197163 -0.653227961  0.018415769
##      [7,]  1.09348444 -1.293936715  1.4189069050 -3.356740242 -0.951965047
##      [8,] -4.54183732 -3.099372405 -2.2612175075 -2.200950296  3.459973177
##      [9,]  2.69412302 -1.421092569  0.9516155379  0.007476733  1.250335936
##      [10,]  2.08173487 -1.812218651 -1.1720406658  1.137014305  0.414757427
##      [11,] -5.08416948  2.000137924 -0.7512306390 -0.076186113 -0.385543991
##      [12,]  2.42030088 -0.010337119 -0.8066693631 -0.070644793  0.075814497
##      [13,]  0.42109190 -0.121776139 -0.5410059634 -0.365041743 -1.511092195
##      [14,]  3.72127373  1.784296564  1.2485358731  0.129289545  0.520260616
##      [15,] -2.50683608  2.519115720  0.7679362671 -0.814023090  0.426551810
##      [16,]  0.10377563  0.205899348  0.3621314863 -1.000054021 -2.991100602
##      [17,]  0.71352261  1.556166034 -0.7062636839  1.691564007 -0.340941385
##      [18,]  2.87310984  0.482741343 -0.4233003513  0.743662891  0.860313171
##      [19,] -7.18617681 -0.044244030  2.0258549210  0.087485348  0.664035557
```

##	[20,]	1.88203558	-1.429919420	-1.0832586631	1.705943528	0.884175937
##	[21,]	2.83789903	0.393325503	-0.3614479874	0.812880484	0.040063252
##	[22,]	-0.33608363	-3.535859467	0.0806908813	-1.552997026	1.956881414
##	[23,]	2.34862913	-0.683708564	1.1197182845	-0.295906284	0.539770064
##	[24,]	-1.40123647	-1.312422336	0.6099807955	1.894731466	0.034197398
##	[25,]	1.35378261	-3.553367632	1.7257338713	-0.038167893	0.343071810
##	[26,]	0.36757240	-0.131511726	-2.0517854155	1.050460940	-0.752865683
##	[27,]	1.96773313	0.957849703	-0.1042456721	-0.088392018	0.547006886
##	[28,]	-3.99611352	-0.554685751	-2.7691318844	-1.904122982	0.524809460
##	[29,]	1.94377603	-2.549019049	-1.0010501923	0.023504095	-1.204979082
##	[30,]	3.14007439	1.481392013	-1.2100992985	0.450805086	-0.839570619
##	[31,]	4.02708469	2.536551854	0.3201023892	1.521284235	-0.668651573
##	[32,]	1.97963602	0.413646828	-0.3874100402	-1.737038268	0.307044021
##	[33,]	-5.92051113	-1.235591140	1.6913474333	-0.457479353	-2.884900796
##	[34,]	1.97245619	0.170054921	0.3939115987	-0.773371688	0.853191162
##	[35,]	1.13538658	1.400448882	-0.5969586419	1.997234324	-0.528505811
##	[36,]	1.60653102	-0.299793694	-1.5936523874	0.905026936	-1.233932411
##	[37,]	-2.69844100	4.420137831	0.2529603192	0.501660080	-0.376615080
##	[38,]	0.73892075	-3.702602060	0.6503933965	2.236743562	0.337401750
##	[39,]	-1.20949419	2.030094176	0.9393311840	0.254246634	-0.091939830
##	[40,]	-2.62903181	-0.590514951	-2.0090573484	0.268426633	-1.194710401
##	[41,]	-3.37008639	3.350976309	-1.7985794564	-2.074346194	0.594049060
##	[42,]	-6.13756604	1.994599998	-1.6150397012	0.976403193	0.332878874
##	[43,]	-7.11812078	-10.263194605	-3.1473916044	0.121405084	2.965445913
##	[44,]	2.39686919	-0.995805736	-0.7705310186	1.553017799	-1.428655251
##	[45,]	3.17370620	2.079136566	-1.0061465196	0.391506420	-1.421225837
##	[46,]	-1.27212896	2.434528242	2.4069357804	-0.101418611	-2.164134739
##	[47,]	4.64234140	0.803512818	0.2422677400	0.480313638	-0.529696031
##	[48,]	-10.91746308	3.672587536	-0.9712242881	2.355734704	0.483077938
##	[49,]	0.48966745	-0.091895060	-0.9743219974	-0.323695888	-0.131359549
##	[50,]	1.45902605	-0.595347371	1.1194916680	0.093040615	-1.092491404
##	[51,]	-1.31071031	-2.163284902	-1.7896139702	-0.014878073	-0.166863596
##	[52,]	0.37899113	0.625986823	-1.3115137359	1.157684780	-1.781580029
##	[53,]	2.71068202	0.214197953	-0.3290871583	0.057868635	0.046815390
##	[54,]	0.68520263	1.130602189	1.2114889784	-3.846059245	-1.434177469
##	[55,]	-9.02109721	0.634635478	0.1673933507	-0.747308053	-0.571766253
##	[56,]	-1.16002006	-2.522911903	-1.9063958530	0.630738306	-0.234081020
##	[57,]	1.89187412	-1.675750393	0.1045973919	1.222231193	-2.566361316
##	[58,]	3.88962340	-0.814349374	1.0112433799	0.825915255	2.132628805
##	[59,]	-12.87573436	-2.324575387	6.2450981501	1.985364374	3.143767328
##	[60,]	-3.77524767	1.881732616	-1.7830011567	0.394615080	0.336620919
##	[61,]	-9.07163621	-2.032511308	2.0795521059	-1.035032956	-0.814114250
##	[62,]	-5.06161345	1.774290825	1.1401674892	-0.682053867	-0.650295434
##	[63,]	-3.52696866	-2.336951122	7.7489267037	-0.523555170	-2.691800431
##	[64,]	2.15342402	1.913412787	-1.2005079052	-1.109606651	-0.451361168
##	[65,]	-4.72102980	-3.317643560	-1.4912712243	2.043051365	0.022275985
##	[66,]	1.32751070	-1.468128570	0.8509474426	-1.139782681	0.048274411
##	[67,]	2.47879771	1.413541128	-0.3300293450	0.329186462	-0.661062602
##	[68,]	3.28383340	3.154081348	0.1797972729	0.733291311	-0.390150526
##	[69,]	1.86854679	0.894248748	-0.8926930624	1.030400589	0.229769428
##	[70,]	1.76125095	-0.787484445	-1.9530764794	-0.715597778	0.626092114
##	[71,]	-0.75772517	-0.898784355	-2.7028656356	-0.287112874	-0.805196696
##	[72,]	3.07004076	-1.137654329	0.3645176409	-0.621084533	1.439458140
##	[73,]	-1.56317061	-6.506081229	2.1551984163	0.046802299	-1.059106630

##	[74,]	1.63922138	4.568310634	0.7665801344	1.643167615	-1.397621661
##	[75,]	0.75307340	3.062757775	1.3999768264	-0.929764763	-0.901643353
##	[76,]	0.93888949	-0.932974158	-0.0515719454	-1.346989022	-0.068349941
##	[77,]	-0.35976583	3.555468206	-2.2591684707	0.223134444	-0.779394631
##	[78,]	3.51923913	0.655941140	0.5770684508	-0.005683076	-0.021764084
##	[79,]	2.12321200	0.022804183	-0.0079139450	1.771500671	-1.291026449
##	[80,]	-2.77132199	1.087548931	-1.1390502599	0.396154946	0.171847035
##	[81,]	1.97882278	1.835388762	-0.3024160196	0.554071039	0.204874318
##	[82,]	3.35841683	1.098081357	0.1255485894	0.835385947	-0.736585457
##	[83,]	2.48784540	1.182801959	0.3238305432	-1.244671309	0.123510536
##	[84,]	-1.25193513	-1.025145982	-0.1126310289	2.057308860	-0.140038831
##	[85,]	0.93178328	-2.309906917	-1.6003994900	1.667412705	1.428669764
##	[86,]	4.31206406	1.971577569	-0.2802141590	1.579424140	-1.982828702
##	[87,]	3.14232842	0.885778200	-2.1383772174	1.422536047	-0.420519084
##	[88,]	1.85744292	1.568886080	0.8181346387	-3.918373504	0.215618482
##	[89,]	-4.20063730	5.106542143	-0.8039110546	-0.852966939	0.466182541
##	[90,]	0.62500097	-0.643566700	-0.5024130627	-0.013864636	0.105817554
##	[91,]	4.06387726	1.242978608	0.5530591326	1.708039317	-0.613862590
##	[92,]	2.55604475	0.754405572	-1.6220992846	0.057008703	-0.505254685
##	[93,]	1.91095867	3.109332934	-1.0918757059	-1.056248694	-0.960001763
##	[94,]	3.17353516	2.072192725	0.0653368157	-1.864627331	0.206783972
##	[95,]	-6.50582706	-8.018131761	-0.3314399120	-2.757528828	-1.607920461
##	[96,]	-1.77786660	0.254481260	-1.7460651293	1.030151031	-1.183314722
##	[97,]	2.00452164	0.287116039	0.5844453196	-0.335501280	-1.172587586
##	[98,]	2.87272100	0.263011629	-0.4821301150	-0.243167336	0.555534181
##	[99,]	2.97732093	-1.810950696	-0.2218200555	0.389630689	1.528248268
##	[100,]	-10.75407134	2.235395747	-0.0150317513	-0.376563477	-1.189667182
##	[101,]	0.74369721	-3.149394191	1.4666856924	-0.306471973	-0.948920976
##	[102,]	5.56419667	0.480329489	4.0666384040	-2.307360378	1.030819908
##	[103,]	3.15974344	-0.414099653	-1.1126449042	1.963719390	0.062114722
##	[104,]	-0.22502189	1.553242547	-0.8230668033	-0.648931048	0.493406049
##	[105,]	3.22993309	1.166555416	0.2405502778	-0.991857082	-0.898922810
##	[106,]	2.20667901	-1.291744626	-0.8964793212	0.699329128	-0.179330561
##	[107,]	0.98492738	-0.795767487	2.3452665725	0.173830356	-1.549954277
##	[108,]	1.23832538	-1.577605200	-1.2869771554	0.101176628	-0.013222090
##	[109,]	2.55333527	-0.229205082	1.3975774444	-1.955998009	1.447903371
##	[110,]	3.34331455	0.019535956	0.4886576929	-1.133840406	1.558965743
##	[111,]	0.75467299	-1.802314504	-0.5675651783	-0.563776953	0.934046866
##	[112,]	-0.23405551	-6.909577147	0.6432228540	-1.991372884	-0.657265287
##	[113,]	-3.32563601	1.312453602	0.6822569181	1.015191328	0.928825573
##	[114,]	-4.34396173	-4.850419127	-2.7395300114	-1.482475038	-1.279040206
##	[115,]	3.54319152	1.279452421	0.9941661042	-0.596285222	0.214662584
##	[116,]	-2.46541768	1.489076147	0.5631340431	-2.254085759	-1.409238648
##	[117,]	-1.24815169	-0.399600312	-3.8408229784	-0.729563054	0.651902115
##	[118,]	-4.13838217	-0.780943254	-0.9077267332	-0.008248176	0.604476357
##	[119,]	-4.93583227	2.834367243	0.8654055442	0.349982907	0.477256185
##	[120,]	-0.35258994	-2.130394017	0.6917292948	0.193867619	0.098333135
##	[121,]	3.14475887	1.868857446	-0.6929978118	0.305619965	-0.408682352
##	[122,]	-4.96178269	3.255662851	3.3541117097	0.126932945	-0.125838022
##	[123,]	3.07589792	0.303342578	1.2318930380	-2.188096474	0.594856428
##	[124,]	-5.30134864	6.705490137	1.4169226015	1.792384917	1.068659622
##	[125,]	3.32800427	-0.479244890	-0.8989743659	0.806462957	0.588303101
##	[126,]	3.05868796	0.176163451	0.6036047514	0.267996089	-0.897428969
##	[127,]	-3.20194758	-4.058183169	-2.7060133717	1.310403583	0.229486669

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## [128,] 0.54660499 1.310515958 0.9688659512 -1.471547838 -0.207680931
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## [537,]	2.84469305	-0.133127057	0.4745695745	0.472207485	1.512816534
## [538,]	3.34962817	0.063488601	-0.2871035394	-0.621116699	1.119876959
## [539,]	1.66922234	0.207833811	-0.1631375423	-0.194091500	-0.556458267
## [540,]	2.82110178	-0.374649303	-1.3592772183	1.730834304	-0.280572137
## [541,]	-0.44201240	2.775367202	0.3966928739	0.486732332	0.522352684
## [542,]	1.29865971	-4.962105055	0.3526022459	2.234331114	3.840065291
## [543,]	4.13725536	1.375072291	0.8551058344	-0.048917995	0.592027695
## [544,]	-7.22128200	0.010718318	-2.8799687746	0.040062109	2.446911017
## [545,]	-11.64894933	-4.761813536	1.9451698825	0.350864750	3.370483386
## [546,]	1.42496615	-1.399869981	-0.8450435069	1.102039048	0.365230708
## [547,]	2.09990574	-3.657502132	3.6257113913	1.551381636	-2.233469867
## [548,]	2.39991037	0.246681497	-0.3378671702	-0.274970968	0.352897453
## [549,]	0.48590718	0.173477406	1.0135793621	-1.997904671	-0.331200038
## [550,]	2.13997388	-0.103944360	-1.5001858808	1.113655093	0.071153309
## [551,]	1.35404318	-0.370549656	2.4529396180	-1.116387394	-1.913508379
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## [553,]	-6.34937295	-7.716748627	-4.2345641977	-3.414140485	-1.695312257
## [554,]	1.53390730	-0.409744080	0.5850370461	-0.339481767	0.782786302
## [555,]	2.80247498	1.662304949	-0.2002936463	-2.229008377	0.202865323
## [556,]	-7.65724966	0.835800511	-2.1970463290	0.257856262	0.232863640
## [557,]	3.01791604	0.668841737	0.3570566166	0.567682198	0.737429477
## [558,]	-1.97984933	-2.321801686	1.2034762501	1.781761087	-0.147789993
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## [560,] 1.55955384 1.028960265 -1.3197775498 0.621701342 0.376933156
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## [563,] 2.55960867 2.489030874 0.1537135592 -2.100294779 -0.982931938
## [564,] 1.81436070 -0.403841548 -1.2387230231 1.269441800 -0.002995888
## [565,] 2.59208254 2.033925156 -0.0683395784 -0.169487840 -1.199669593
## [566,] 2.43449839 -3.439805597 3.4401454793 0.511458026 1.040071996
## [567,] 0.39541303 0.975171322 -2.5944480530 -0.791160326 -0.732682392
## [568,] 1.17806944 0.465701673 -0.5094579617 2.144876827 0.243326085
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##
## PC6 PC7 PC8 PC9 PC10
## [1,] -0.243005836 0.5092014591 -1.114233e+00 0.2840243356 0.324631968
## [2,] 1.230824782 0.2937433944 1.000046e-01 -0.0668399016 0.426121795
## [3,] -0.258787224 -0.3303384517 3.599041e-02 0.8734350372 0.022221919
## [4,] -1.553963404 -0.9692185222 -1.318521e+00 0.6254396236 0.056664698
## [5,] 0.594036057 0.1198200600 -4.827970e-01 -0.2727816446 -0.294394853
## [6,] 0.691445258 0.1454025895 6.214539e-02 0.2342453501 0.736812390
## [7,] -1.418752354 -1.2388811831 -2.165076e-01 0.9315565326 -0.268145770
## [8,] -1.081225510 -0.4658149824 3.804442e-02 0.2385509971 0.541705535
## [9,] 0.972459383 0.0819567466 1.751165e-01 0.6908540096 0.288307896
## [10,] 0.095284975 0.0625272462 -1.062398e-01 -0.1778243252 0.115976898
## [11,] -1.203709368 -1.0330083689 -4.662867e-01 0.4201199428 -0.605111938
## [12,] 0.812108515 0.3060748681 8.738049e-02 0.2419410388 0.365639712
## [13,] -0.539258610 -0.0996748214 -2.485447e-01 -0.6655039982 0.802021236
## [14,] 0.758438841 0.0317275218 4.888299e-01 -0.3406210411 -0.058962380
## [15,] -1.573412378 -1.0849024065 -2.361521e+00 -0.9159464767 0.102473556
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## [22,] -2.125361510 -1.0205658953 -4.133036e-01 0.4584351566 -0.241614991
## [23,] -1.227651735 -0.7812871502 1.186259e-01 0.0772507569 0.091978458
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## [151,] -0.726141010 -0.4315726584 2.792403e-01 -0.2139559591 -0.221249071
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## [152,] 0.575695205 0.0906253907 6.823949e-01 0.1838087904 0.732243903
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## [18,] -0.070022741 8.093517e-02 -7.033761e-02 -8.395862e-02
## [19,] -0.569253541 1.036564e-01 2.835675e-01 -9.017732e-02
## [20,] 0.094090139 3.112346e-02 1.817905e-01 -1.864672e-02
## [21,] 0.082523144 -1.237892e-01 1.579260e-02 5.933084e-02
## [22,] -0.298916941 1.844051e-01 2.587069e-01 -2.211982e-01
## [23,] -0.212830498 -6.229868e-02 -2.717846e-02 1.218820e-01
## [24,] 0.052680902 -1.495457e-01 3.095900e-02 -6.934114e-02
## [25,] -0.592719681 3.595383e-01 2.336257e-01 2.706467e-01
## [26,] 0.059778364 2.323086e-01 -1.084881e-01 -4.270176e-02
## [27,] -0.101721236 -6.246379e-02 3.644114e-02 4.855680e-02
## [28,] -0.174272716 -3.466604e-01 -1.891704e-01 5.124000e-01
## [29,] -0.210233550 1.329305e-01 -1.594789e-01 -1.715399e-01
## [30,] -0.035264653 -5.636630e-02 2.947379e-02 -2.661072e-01
## [31,] 0.216369579 5.541341e-03 -8.719242e-02 2.221158e-01
## [32,] -0.025354521 -1.495302e-01 1.596027e-01 -1.733590e-01
## [33,] 0.292036732 -1.729689e-01 -3.171784e-02 2.893805e-02
## [34,] 0.008156900 -4.414144e-01 6.028979e-02 -1.211665e-01
## [35,] 0.166555572 -3.037006e-02 -1.028303e-01 2.777077e-01
## [36,] 0.427685230 -3.470538e-03 2.101913e-01 -2.076874e-01
## [37,] -0.289484970 -6.548585e-02 -3.232965e-01 3.558403e-01

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## [38,] -0.108652538 2.852529e-01 -2.966173e-01 -1.116214e-01
## [39,] 0.213031719 -3.190089e-02 -1.007190e-01 2.525017e-03
## [40,] 0.213901668 9.520973e-02 -1.633312e-02 7.186205e-02
## [41,] -0.128650796 -8.231716e-02 -1.097702e-02 -1.979734e-01
## [42,] 0.081202851 -1.972840e-01 -3.179374e-01 7.591987e-01
## [43,] -0.172079352 -6.241070e-02 4.630782e-01 3.452129e-02
## [44,] -0.333009658 4.986805e-01 2.761034e-01 -6.990563e-02
## [45,] 0.095351175 1.721466e-01 -9.280238e-03 -1.272046e-01
## [46,] 0.027241062 -4.783811e-02 3.647888e-02 -1.705672e-01
## [47,] 0.026833779 -4.734618e-02 5.843090e-02 4.947846e-02
## [48,] -0.555953043 -4.066040e-01 -1.211012e-01 3.671663e-01
## [49,] 0.102861102 -1.282732e-01 -9.936293e-03 -1.110597e-01
## [50,] -0.010018401 3.911403e-02 -1.016924e-01 -2.008620e-02
## [51,] -0.123075581 1.368015e-01 2.252240e-01 -1.368558e-01
## [52,] -0.026895711 1.735375e-01 -1.285103e-02 -5.023757e-02
## [53,] 0.069750673 -7.866944e-02 1.405715e-02 3.218193e-02
## [54,] -0.218941828 -2.562217e-01 1.920552e-01 1.194130e-01
## [55,] 0.207821187 6.344923e-02 2.959831e-01 -3.884609e-01
## [56,] 0.153030859 -1.522467e-01 4.169582e-02 8.696207e-02
## [57,] 0.199017477 2.379359e-02 1.181418e-01 9.812868e-05
## [58,] 0.127131332 -2.752838e-01 -1.006724e-01 2.038471e-01
## [59,] 0.172469710 -8.647610e-01 7.262622e-01 1.956888e-02
## [60,] -0.343578522 -3.229187e-01 1.379908e-01 2.472202e-02
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## [62,] 0.223477206 -3.303582e-01 -2.896124e-01 5.510999e-01
## [63,] -0.283067579 2.803105e-01 1.197289e+00 1.344579e+00
## [64,] -0.004249728 -8.430511e-02 1.516885e-02 1.168719e-01
## [65,] -0.179295547 -8.150818e-02 3.797931e-02 1.439501e-01
## [66,] -0.136527933 1.425655e-01 9.787605e-02 -4.806061e-02
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## [71,] 0.668556185 2.521189e-01 -3.799022e-01 -3.964538e-01
## [72,] -0.079199196 -2.068270e-01 3.099509e-02 -9.146318e-02
## [73,] -1.116351100 1.154812e-01 -1.258013e-01 -1.205257e-01
## [74,] -0.167898657 5.790013e-02 1.517053e-02 1.333051e-02
## [75,] -0.386612906 2.223152e-01 2.137822e-01 -8.725618e-02
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## [80,] 0.111005160 3.943212e-02 5.985223e-03 -7.554262e-02
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## [92,] -0.194657396 -3.040978e-01 1.749788e-01 -4.769003e-05
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## [97,] -0.307271309 -1.855001e-01 4.826845e-02 -1.295130e-01
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## [111,] 0.109170941 -2.455506e-02 4.445504e-02 -1.904603e-01
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## [114,] 0.501030094 1.536523e-01 1.527529e-01 -2.196078e-01
## [115,] 0.041412675 6.233098e-02 -6.961252e-02 1.498783e-01
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## [117,] -0.209278525 -4.937788e-01 5.749773e-01 4.020940e-01
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## [128,] 0.521981738 -2.438699e-01 5.268949e-03 -1.352151e-01
## [129,] 0.059396119 4.126106e-01 -8.728869e-02 3.473966e-02
## [130,] 0.382658056 -1.505340e-01 3.043896e-02 -7.379857e-02
## [131,] 0.520403647 1.734497e-01 -3.462492e-01 -3.649636e-02
## [132,] 0.290047022 3.434603e-02 -5.264320e-02 -8.671717e-04
## [133,] -0.118462619 -1.227311e-01 1.859024e-01 3.728351e-02
## [134,] 0.654516751 -1.417697e-01 3.629542e-01 1.913907e-01
## [135,] 0.222896409 4.414003e-01 1.946630e-01 -1.851684e-01
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## [154,] -0.024492577 -7.340752e-03 3.375487e-02 -1.696552e-02
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## [156,] -0.372822318 -1.104207e-01 -2.575758e-01 3.619148e-01
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## [158,] 0.130122293 -4.111523e-01 -1.754924e-01 -3.508902e-01
## [159,] 0.344231223 2.232965e-01 2.066830e-01 2.601489e-01
## [160,] 0.058911342 -1.743389e-01 5.795462e-02 -4.883182e-02
## [161,] -0.013617606 -3.410433e-01 -2.253278e-01 1.971972e-01
## [162,] -0.374326537 -1.724632e-02 5.449744e-02 -1.838220e-01
## [163,] -0.211051607 -8.809421e-02 2.617836e-01 1.638992e-02
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## [167,] 0.179994044 5.417862e-03 -2.378199e-01 1.312368e-01
## [168,] 0.243757379 -2.150256e-01 -1.002714e-01 -9.076299e-02
## [169,] 0.073219124 -2.096709e-01 1.977582e-01 -3.676455e-04
## [170,] -0.041909581 7.849588e-02 4.078843e-02 1.431406e-01
## [171,] 0.646219434 3.471970e-02 1.389356e-01 -1.533832e-01
## [172,] 0.189290414 -1.776043e-01 9.217565e-02 -2.483075e-02
## [173,] -0.188764595 3.337944e-01 1.662036e-01 4.113868e-02
## [174,] -0.266994528 1.947080e-02 7.554220e-02 3.169527e-05
## [175,] -0.089442781 -3.018320e-01 -3.120110e-01 2.038555e-01
## [176,] 0.020777979 5.705901e-02 9.869446e-02 5.902616e-02
## [177,] -0.596695797 1.686586e-02 -2.696835e-01 4.406408e-02
## [178,] 0.156166497 -6.320437e-03 4.653165e-02 4.947341e-02
## [179,] 0.269850604 5.694780e-02 -3.119842e-01 7.252457e-03
## [180,] 0.021383635 -3.175475e-01 1.707156e-01 -1.194288e-01
## [181,] 0.298889684 -1.967352e-01 -2.155974e-01 -2.286554e-01
## [182,] 0.081924891 -1.864879e-01 -2.334583e-01 -1.484778e-02
## [183,] -0.169542495 3.460192e-02 1.513143e-01 -6.512446e-02
## [184,] 0.079596558 7.957722e-02 1.396697e-01 -1.108148e-01
## [185,] 0.023624644 3.273827e-01 -1.564256e-01 3.088299e-02
## [186,] 0.276111244 6.046096e-02 -3.602096e-01 -7.154936e-02
## [187,] 0.433286646 -2.802339e-01 -3.292672e-01 -3.840022e-01
## [188,] -0.238341625 -4.490292e-02 -1.498768e-02 -9.804595e-03
## [189,] 0.063604878 1.153640e-01 -4.422867e-03 -1.421138e-01
## [190,] 0.275013247 -7.166472e-02 1.190678e-02 -8.404817e-02
## [191,] -0.187431094 1.202845e-01 -1.148853e-01 1.424007e-01
## [192,] 0.095414298 -3.716180e-01 -1.583732e-01 -1.393171e-01
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## [195,] -0.045745025 -2.264059e-01 1.697125e-01 2.677639e-01
## [196,] 0.561831020 -9.039943e-01 5.083163e-02 -2.752302e-01
## [197,] 0.271582196 2.398050e-01 -2.361568e-01 -1.729211e-01
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## [199,] -0.254622312 -1.831581e-01 2.196529e-01 -1.365678e-01
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## [200,] 0.274556338 9.177930e-03 2.771621e-02 8.595676e-02
## [201,] 0.404209736 5.865478e-01 7.557826e-01 6.356041e-01
## [202,] -0.025514733 -6.617383e-02 -1.532354e-01 -1.743620e-01
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## [226,] 0.480123885 7.192897e-01 -6.574233e-01 3.078245e-01
## [227,] -0.696515349 -1.060124e-01 1.507905e-01 -2.037321e-01
## [228,] 0.339768688 -1.143257e-01 5.505415e-02 -3.466093e-01
## [229,] 0.150104370 -3.349342e-01 -1.184740e-02 -2.692893e-02
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## [236,] 0.133965667 9.184280e-02 -7.540586e-02 4.454720e-02
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## [252,] -0.853221633 -7.833246e-01 1.205321e-01 2.446040e-01
## [253,] -0.035676897 -1.883865e-01 1.561197e-01 1.104227e-01
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## [453,] 0.214432386 6.462198e-01 4.572245e-01 -1.856783e-01
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## [457,] 0.591158273 -5.824376e-02 -1.919702e-01 3.868300e-01
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## [459,] 0.101701285 -8.905947e-03 -1.834538e-01 1.857571e-01
## [460,] -0.027289191 -1.938181e-01 1.048415e-01 3.829356e-02
## [461,] -0.232007751 -1.040052e-01 1.123264e+00 -9.171639e-01
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## [466,] -0.387817362 3.272425e-01 3.568318e-02 -2.214587e-01
## [467,] -0.002403087 2.411783e-01 2.350863e-01 -5.933900e-02
## [468,] -0.007050347 2.245577e-01 -2.302748e-02 -1.105619e-01
## [469,] 0.135831371 -1.488714e-01 -7.360296e-02 -1.879613e-04
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## [472,] 0.027946365 2.598719e-02 1.712958e-01 4.211271e-03
## [473,] 0.147895534 4.808134e-01 -3.842855e-02 -8.438951e-02
## [474,] -0.793888072 9.113932e-02 -6.231881e-01 1.802401e-01
## [475,] 0.490390249 4.206388e-02 1.444518e-03 3.732401e-01
## [476,] 0.194558951 1.065368e-01 -2.703042e-01 -1.832076e-01
## [477,] 0.104406066 -2.029487e-01 9.143765e-03 -8.764407e-02
## [478,] -0.131892905 -1.728015e-01 -3.374861e-01 -2.453675e-02
## [479,] 0.237160597 -7.589834e-02 1.284184e-01 -3.049761e-01
## [480,] 0.278073334 7.642517e-02 7.834827e-02 -4.114467e-01
## [481,] 0.035489310 7.554027e-02 1.064340e-01 2.369870e-02
## [482,] 0.075341273 -2.679651e-02 7.012865e-02 -2.191363e-01
## [483,] 0.378214785 -2.994907e-01 -1.718938e-01 1.884331e-01
## [484,] 0.207366238 -5.127782e-01 -3.057416e-01 -5.080697e-02
## [485,] 0.267661517 -1.475477e-01 -5.880012e-02 2.418804e-01
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## [487,] 0.135816514 -4.255877e-02 1.036395e-02 6.282936e-03
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## [565,] 0.058856156 -4.695702e-01 -4.501508e-01 -3.471412e-01
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## [569,] 0.231756423 -3.548587e-05 2.473740e-01 -2.592611e-01
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## [2,] -5.262226e-02 -5.987170e-02 5.868642e-02 0.0709786126
## [3,] -1.380489e-01 -1.348974e-01 1.008003e-01 0.0539090082
## [4,] -4.001824e-01 -1.030209e-01 -2.882171e-01 0.1820459068
## [5,] 8.515543e-02 -8.500541e-02 -6.332008e-02 0.0435910301
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## [7,] -2.937883e-02 -1.475160e-01 -1.731877e-02 -0.0108743761

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## [16,] 5.353835e-02 -5.469285e-02 -1.008057e-01 -0.0522950385
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## [18,] 1.634152e-01 -3.505539e-02 -1.464825e-01 -0.0039775402
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## [20,] 4.683065e-02 6.678614e-02 6.078671e-03 0.1437547933
## [21,] -2.227016e-01 5.752789e-02 -2.271678e-02 -0.0993528734
## [22,] -1.446453e-03 -1.498505e-01 -2.707121e-01 -0.1656619655
## [23,] -5.508613e-02 1.981001e-01 1.483337e-01 -0.0618197083
## [24,] -4.532253e-02 -2.759078e-01 -3.047715e-01 0.2331576854
## [25,] -1.764213e-01 6.727165e-03 -2.542099e-01 -0.2043585353
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## [34,] -1.495394e-01 -6.830546e-02 8.381920e-02 0.0983623254
## [35,] 1.261303e-01 -1.181033e-02 -9.847136e-03 0.0919067189
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## [37,] -4.197287e-02 2.687950e-02 -5.888385e-02 -0.0859464734
## [38,] 1.940495e-02 1.230285e-01 3.737305e-01 -0.1400014645
## [39,] -1.021625e-01 -8.007357e-02 1.273240e-01 0.0428784496
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## [41,] -7.182280e-02 9.492884e-02 2.480937e-01 0.1557606094
## [42,] -3.661367e-01 -2.251888e-02 -4.545154e-02 0.0014049365
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## [44,] -4.464008e-02 -1.383938e-02 1.263177e-02 0.0731473296
## [45,] 3.368770e-02 -9.491693e-02 1.219370e-01 0.1056865731
## [46,] -6.757124e-02 5.126289e-01 1.365662e-02 0.1544413525
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## [51,] -5.049758e-02 -2.459290e-01 1.174748e-01 -0.1628544758
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## [87,] -1.136738e-01 -3.576620e-02 1.752846e-03 -0.0789253084
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## [513,] 1.179215e-01 2.366203e-01 1.204413e-01 -0.2021077023
## [514,] 1.208629e-01 5.672705e-02 -1.135186e-01 0.1094581728
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## [546,] -4.077239e-02 1.146042e-01 -1.222713e-01 0.0329535421
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## [3,] 8.548436e-02 0.0382776645 -4.151896e-02 -3.554641e-02
## [4,] 2.228481e-01 -0.1157200651 -3.676948e-02 -1.481717e-01
## [5,] 8.165322e-03 0.0027380524 5.983731e-02 4.616773e-02
## [6,] -3.133835e-02 0.0427842226 -8.646068e-02 -3.094469e-02
## [7,] 3.634293e-02 -0.0074700186 -3.691957e-02 -5.978630e-02
## [8,] 2.939741e-02 0.0004695672 3.573416e-01 5.216734e-02
## [9,] -6.923093e-02 0.0497355910 7.027952e-03 -2.066589e-02
## [10,] -7.627162e-02 0.0756044146 -6.937821e-02 -1.796520e-02
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## [372,] 7.734288e-02 -0.1789792161 6.575644e-02 -3.370480e-02
## [373,] 1.046839e-01 -0.0566251575 7.211925e-02 9.285333e-02
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## [12,] 0.0313667590 0.0214758148 -5.815388e-03 2.101407e-03
## [13,] -0.0115189160 -0.0236487859 -1.336927e-02 -9.541018e-04
## [14,] -0.0001342391 0.0262774321 -4.354456e-03 -6.766971e-03
## [15,] 0.0526092277 -0.0106431857 1.382817e-02 -1.138219e-02
## [16,] -0.0395565231 -0.0113053550 -3.940202e-03 6.933750e-03
## [17,] 0.0118991338 -0.0219583607 1.264325e-02 4.760172e-03
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## [19,] 0.2263597091 0.0319045180 -5.109774e-02 1.888498e-02
## [20,] 0.0030067774 -0.0211027308 -1.938230e-02 9.852988e-04
## [21,] -0.0198932675 -0.0136803305 -8.551012e-03 -1.325546e-03
## [22,] 0.0187612193 -0.0216819855 2.411236e-02 -8.858584e-03
## [23,] -0.0246700231 -0.0128612569 -4.467560e-03 3.629728e-03
## [24,] 0.0901569755 -0.0098411879 2.301966e-02 -2.374885e-02
## [25,] 0.0109952266 -0.0379124107 4.791318e-03 8.663743e-03
## [26,] 0.0315139751 -0.0401102951 4.734871e-02 9.919702e-03
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## [42,] -0.0446278063 0.0911078308 -1.362661e-03 1.313363e-02
## [43,] -0.1841875377 0.0424279229 6.857974e-02 -1.998307e-02
## [44,] 0.0855229177 -0.0160270811 -2.834893e-02 1.060561e-02
## [45,] 0.0328784540 -0.0146923196 -7.281896e-03 -5.593681e-03
## [46,] 0.0511279444 -0.0069384905 -1.819427e-03 -7.746198e-03
## [47,] 0.0547823196 -0.0023206355 -8.758586e-03 3.372264e-03
## [48,] -0.2137482100 -0.0381373067 -2.763514e-02 4.146805e-03
## [49,] 0.0329035277 0.0020957473 -3.598031e-03 5.861108e-04
## [50,] 0.0129741769 0.0087123575 -7.947914e-03 -1.263665e-02
## [51,] 0.0815819893 0.0152921924 -6.954635e-03 -2.622044e-03
## [52,] 0.0297321325 -0.0331236455 -1.219745e-02 -1.497444e-02
## [53,] -0.0402841172 0.0107722059 -1.137519e-02 3.710160e-03
## [54,] 0.0411842454 -0.0065017458 2.731969e-03 -7.122045e-03
## [55,] -0.3121274609 -0.1007394701 1.109937e-03 3.822175e-02

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## [56,] 0.1271426338 0.0718062109 7.998705e-02 -8.613806e-03
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## [63,] 0.0773552872 -0.0035421174 1.873981e-02 2.154060e-02
## [64,] -0.0695511185 0.0115904549 2.266887e-02 1.568908e-02
## [65,] 0.0225291261 0.0010160584 1.636328e-02 -1.872231e-02
## [66,] 0.0155835137 0.0132711018 -4.069241e-03 3.713134e-03
## [67,] 0.0063615856 -0.0200441666 -7.372887e-03 -4.932517e-03
## [68,] 0.0090042996 0.0268352584 1.231880e-02 -1.881063e-03
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## [70,] 0.0355147201 0.0043148745 -4.507685e-03 1.070424e-03
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## [74,] -0.0235123863 0.0065685994 4.674044e-03 -1.181389e-02
## [75,] -0.1048133481 -0.0187357842 -2.052335e-02 -1.339569e-02
## [76,] 0.0058851872 -0.0156305323 -1.011894e-02 -6.699865e-03
## [77,] -0.0431265122 0.0255737824 -3.463985e-03 -4.223548e-03
## [78,] 0.0099252444 0.0360829529 -1.616924e-02 -3.198251e-03
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## [83,] 0.0582247814 0.0209370866 -2.321229e-02 -5.350306e-03
## [84,] 0.0117268178 0.0200736766 -2.732546e-02 -7.409999e-03
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## [89,] -0.1463380961 0.0686806867 -1.759236e-02 -1.384178e-02
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## [94,] 0.0074520198 0.0193216886 2.805047e-03 -6.017928e-03
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## [137,] -0.1693512189 0.0191597416 -6.064920e-03 2.892406e-03
## [138,] -0.0510039159 0.0015462011 -1.578328e-02 3.669325e-03
## [139,] 0.1548661527 -0.0396956918 -2.163775e-02 -5.416209e-03
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## [148,] 0.0855603625 0.0163266005 2.975207e-03 -6.193694e-03
## [149,] 0.1056232897 -0.0076881080 5.237851e-03 -4.690007e-03
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## [181,] 0.0409088669 0.0165848011 2.757407e-02 6.055236e-03
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## [192,] -0.0316711822 0.0243156430 1.458648e-02 1.203914e-02
## [193,] 0.0161883160 0.0264481006 2.716071e-02 6.924193e-03
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## [201,] -0.1600935990 0.0538812276 -1.838841e-01 -1.986860e-02
## [202,] -0.0486704254 -0.0396450877 4.095781e-02 7.788287e-03
## [203,] -0.0607609902 0.0155759941 -2.345218e-02 9.257839e-03
## [204,] 0.1302058140 0.0023842517 -4.912041e-03 -1.550811e-02
## [205,] -0.0076333583 0.0069129307 -1.597288e-03 6.070265e-03
## [206,] -0.1350441358 0.0406781538 -5.025907e-02 -2.024723e-04
## [207,] -0.0473031822 0.0076293215 -2.290028e-02 -5.435989e-03
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## [210,] -0.0110996987 0.1370702906 -1.603930e-02 4.133387e-03
## [211,] -0.0381426451 0.0171359015 6.290327e-03 1.075495e-02
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## [213,] -0.0143132559 0.0881507588 3.588076e-02 2.149344e-02
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## [218,] -0.0705155682 -0.0476980872 7.135127e-03 9.321918e-04
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## [233,] -0.1518435602 0.0725043604 8.010253e-03 5.647265e-04
## [234,] 0.0745509311 -0.0094078612 1.904012e-02 -8.444384e-03
## [235,] 0.0107607612 0.0006052507 -1.213857e-02 7.212550e-03
## [236,] -0.0905729854 -0.0043891798 -4.527487e-03 6.241986e-03
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## [243,] 0.0151957175 -0.0335511891 -5.262922e-03 -4.738478e-03
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## [252,] -0.0938360569 0.0276283929 -4.792438e-02 4.690659e-03
## [253,] -0.0089108922 0.0372166818 -1.267774e-02 4.188595e-03
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## [263,] 0.0162646958 0.0460053592 3.654914e-02 7.332564e-03
## [264,] -0.0282880859 0.0015013125 2.555840e-02 5.773789e-03
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## [269,] 0.0210645417 -0.0301629168 -4.466482e-03 4.588415e-03
## [270,] -0.2342551012 0.0464761088 1.644698e-02 -9.618505e-04
## [271,] 0.0227891490 0.0023902638 -1.098851e-02 -9.766745e-05
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## [276,] 0.0237200715 0.1123767205 1.558175e-01 -6.337401e-03
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## [279,] 0.0113965718 0.0277135446 -1.781950e-02 -8.246944e-03
## [280,] -0.0721306829 -0.0087386448 1.192190e-02 -9.252677e-03
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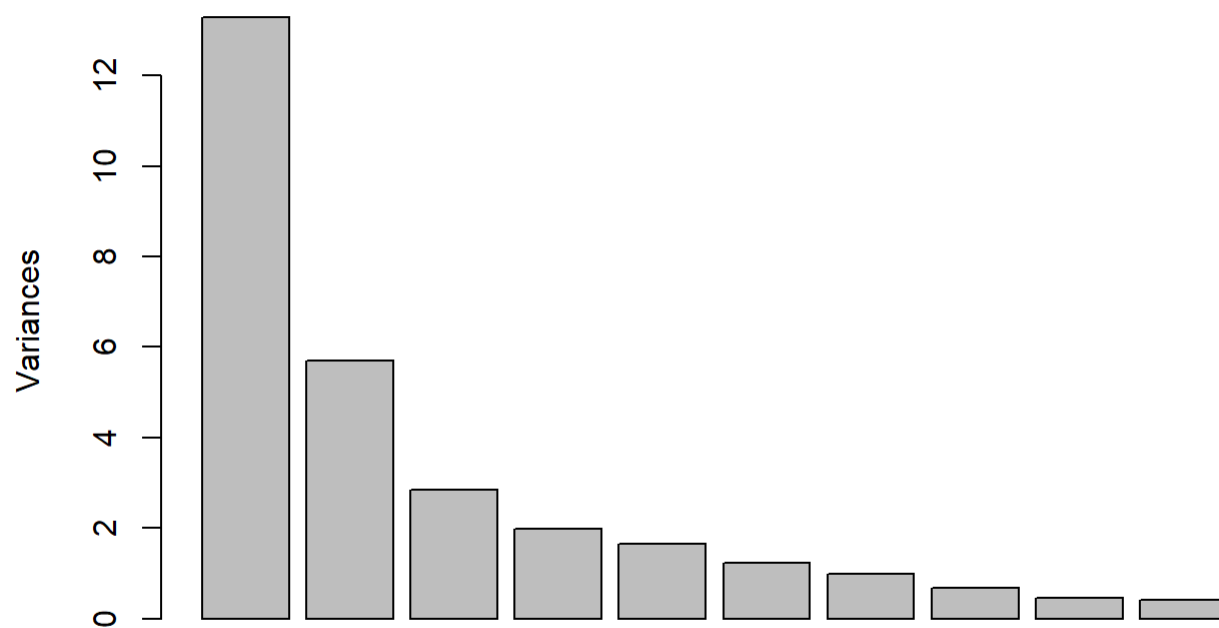


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## [450,] 0.0997344857 -0.0631799343 2.005276e-03 -1.180672e-02
## [451,] -0.1023705503 -0.0167752280 2.192633e-02 1.449200e-03
## [452,] -0.0113897420 0.0078013184 2.964486e-02 1.696583e-02
## [453,] 0.0295149019 -0.0140034566 5.639098e-02 -7.523633e-03
## [454,] -0.0106002592 0.0265833751 9.392628e-05 -9.942180e-03
## [455,] -0.0123625079 0.0064421088 -2.338543e-02 4.479801e-03
## [456,] 0.0250653194 -0.0323661340 -1.288361e-02 -4.932915e-03
## [457,] 0.1731726298 0.0567668257 -3.945065e-02 -2.635609e-04
## [458,] 0.1122419264 0.0928558859 -1.494124e-01 -2.460544e-02
## [459,] -0.0706313591 0.0057360028 -6.830642e-03 4.327957e-03
## [460,] 0.0377633229 0.0151558628 5.822948e-03 -7.239153e-03
## [461,] 0.1548050138 -0.0798835029 -1.416941e-02 1.570558e-02
## [462,] 0.0285530316 -0.0432694777 3.240388e-04 1.347570e-02
## [463,] 0.0603150184 -0.0112962893 1.065499e-02 1.170937e-03
## [464,] -0.0347133203 -0.0029773356 7.425218e-03 3.459640e-03
## [465,] 0.0417058316 -0.0295098362 1.664518e-02 3.187039e-03
## [466,] 0.0669804663 0.0247731421 -2.384961e-02 -1.136713e-02
## [467,] -0.0537566841 0.0014715952 -7.879551e-03 -1.122062e-03
## [468,] -0.0036705130 0.0044647944 -4.907562e-03 -1.931371e-02
## [469,] -0.0462464219 -0.0870265468 -9.578580e-03 1.446233e-02
## [470,] 0.0696740942 0.0086360351 -1.657304e-02 -3.880822e-03
## [471,] 0.0101882986 0.0099682420 -4.864309e-02 1.219165e-03
## [472,] -0.0217680090 0.0146804137 6.548298e-03 -1.147811e-02
## [473,] 0.1652006122 -0.0321987677 1.615000e-02 -5.160398e-04
## [474,] 0.0404867349 0.1042476923 -1.801906e-02 1.798879e-02
## [475,] -0.0600300369 0.0132322290 -5.067542e-03 9.467318e-04
## [476,] 0.0411966404 0.0372092199 1.049049e-02 -3.297660e-03
## [477,] 0.0087345724 -0.0066951686 6.261255e-03 -7.853052e-03
## [478,] -0.0290854323 0.0314593832 -1.688671e-02 -2.796787e-03
## [479,] -0.0687275509 -0.0070471310 -5.146066e-02 -7.753824e-03
## [480,] -0.0902827784 -0.0231176989 -3.365654e-02 1.531822e-02
## [481,] 0.0285956655 -0.0159264328 -1.763929e-02 -5.580673e-03
## [482,] 0.0569252374 0.0009415398 -1.306305e-02 7.644811e-03
## [483,] 0.2129481507 -0.0985963944 -2.112252e-02 -1.606756e-02
## [484,] -0.0090227346 0.0248997990 3.734145e-02 1.790719e-03
## [485,] -0.0125412778 0.0127037430 1.009832e-02 4.256908e-03
## [486,] 0.0636391030 -0.0323824607 -2.607947e-02 -4.951705e-03
## [487,] -0.1397578741 0.0088616024 -6.041273e-04 1.252251e-02
```

```
## [488,] -0.0747773145 -0.0420757978 -5.595981e-03 -1.960175e-02
## [489,] 0.0802388777 -0.0138229184 -2.376301e-02 -2.479727e-03
## [490,] -0.0657399357 0.0605750522 -3.704814e-03 -3.061750e-02
## [491,] 0.0989654491 -0.0140864165 4.367477e-03 2.171240e-03
## [492,] 0.0282618964 -0.0680236124 8.422818e-02 -2.374215e-02
## [493,] 0.2172752231 0.0082839891 1.938583e-02 1.442880e-03
## [494,] -0.0123190204 -0.0095134802 -9.186819e-03 3.113970e-03
## [495,] -0.2199572217 -0.0294567698 1.576101e-02 -5.252938e-03
## [496,] 0.0634010466 -0.0082540868 1.922416e-02 -1.087247e-02
## [497,] -0.0533707600 -0.0089322195 3.592632e-03 -3.646989e-03
## [498,] 0.0480566608 0.0142425925 7.108301e-02 1.083214e-02
## [499,] 0.1442753476 -0.0422424796 -1.782818e-02 4.751815e-02
## [500,] 0.0165308656 -0.0083255759 -2.727051e-02 5.957476e-03
## [501,] -0.0100329601 -0.0372407659 2.363354e-02 -9.646078e-03
## [502,] 0.0171915088 -0.0178647571 1.050801e-03 -8.568039e-03
## [503,] 0.0756534229 0.0607336581 9.157892e-03 1.261060e-02
## [504,] 0.0297769033 0.0973985283 3.350919e-02 -2.700494e-02
## [505,] 0.0350448873 0.0275088283 1.063655e-02 2.760851e-05
## [506,] -0.0285875298 -0.0016575587 -1.182673e-03 -4.053176e-03
## [507,] 0.0189829021 0.0207446755 -7.102198e-03 -1.406710e-02
## [508,] -0.0172826029 0.0125580405 -9.707108e-03 -9.199495e-03
## [509,] -0.1441724544 -0.0394471024 -6.987832e-02 -7.615465e-03
## [510,] 0.0875496770 -0.0391355476 8.573809e-03 8.449619e-03
## [511,] 0.0981611536 -0.0150404803 1.875760e-02 1.130911e-02
## [512,] 0.0260553682 -0.0198184704 2.964767e-02 -1.229652e-02
## [513,] 0.2306612233 -0.1768569002 7.487201e-02 1.145739e-03
## [514,] 0.0443660379 -0.0127577223 1.385273e-02 5.862815e-04
## [515,] 0.0244686942 0.0136171599 -3.015268e-02 3.004115e-02
## [516,] -0.0464406428 -0.0461814081 7.006575e-03 -2.118240e-02
## [517,] -0.1804905504 0.0326011719 5.896892e-03 -1.843209e-03
## [518,] -0.0498431167 0.0469805320 -3.286808e-03 7.346996e-04
## [519,] 0.0216068656 -0.0476515075 -3.416270e-02 -1.304970e-02
## [520,] 0.1523810055 -0.0451309386 -3.033061e-02 1.749013e-02
## [521,] -0.0591849335 -0.0255713138 1.596715e-02 -1.397577e-04
## [522,] -0.0395616001 0.0091315682 3.740507e-02 1.008395e-02
## [523,] 0.0513025394 0.0081396144 -1.686257e-03 -1.284561e-03
## [524,] -0.1277410469 -0.0095049270 6.099755e-02 -1.943908e-02
## [525,] -0.1521848402 -0.0408818910 4.394310e-02 1.438141e-03
## [526,] -0.0241695923 0.0197707678 -2.631440e-02 4.108005e-03
## [527,] -0.0502031636 0.0248580682 -2.886409e-02 1.869812e-02
## [528,] -0.0157216742 0.0417373451 6.411718e-03 -3.945196e-02
## [529,] 0.0226840232 -0.0011725978 1.220802e-02 2.561845e-04
## [530,] -0.0128800796 0.0008940912 4.154574e-04 -2.483717e-03
## [531,] 0.0142770079 0.0250853629 -3.624568e-03 -3.363374e-03
## [532,] -0.0065668831 0.0016770508 5.785196e-02 -3.674048e-02
## [533,] 0.0776102509 0.0225164413 -5.199929e-03 -1.656424e-03
## [534,] 0.0328960130 -0.0287557957 -4.530040e-02 -6.688662e-03
## [535,] -0.0730291458 0.0153900883 -5.554195e-03 -3.353871e-02
## [536,] 0.1253022047 0.0006555599 1.231382e-03 4.937076e-03
## [537,] -0.0282099570 0.0141624831 -2.623194e-03 1.917073e-03
## [538,] 0.0033372312 -0.0091753971 -4.953264e-03 6.203430e-04
## [539,] 0.0828029895 -0.0089573807 -1.291559e-02 -4.762266e-03
## [540,] 0.1346756425 0.0092818155 -4.752541e-03 3.466008e-03
## [541,] 0.0686944450 -0.0043570810 1.903166e-02 -1.182699e-02
```

```
## [542,] -0.0958839897 -0.0266441447 3.100822e-02 5.635812e-03
## [543,] 0.0391931001 0.0061086959 -2.330714e-03 -6.398906e-06
## [544,] -0.0884505800 0.0230539154 -5.910469e-02 -6.112608e-03
## [545,] 0.0461121057 0.0512587241 -3.534171e-02 7.330315e-02
## [546,] -0.0181344013 -0.0079308291 -5.151052e-02 -9.360687e-03
## [547,] -0.1284012027 0.0731570237 2.171499e-02 3.565962e-03
## [548,] -0.0652554774 0.0267267995 -1.453407e-02 1.372139e-03
## [549,] 0.0144803135 0.0290173096 -1.418995e-03 -4.295967e-03
## [550,] 0.0020030080 0.0038173956 1.280350e-02 8.471746e-04
## [551,] -0.0460309869 -0.0698233075 2.414560e-04 1.845563e-03
## [552,] -0.0306835658 0.0147021330 -5.820844e-03 -1.138799e-03
## [553,] 0.0013530758 0.1356038629 -3.808346e-02 3.787346e-03
## [554,] -0.0092761156 -0.0162335677 -6.313714e-03 8.823042e-04
## [555,] 0.0583525074 0.0104867651 -7.650307e-03 -7.688319e-03
## [556,] 0.0365396314 0.1285384513 -1.926274e-02 -3.420722e-03
## [557,] -0.0825366557 0.0120057039 -9.118959e-04 2.230323e-03
## [558,] 0.0596863336 0.0432872298 -3.428184e-03 -7.399596e-03
## [559,] 0.2118838404 -0.0181142975 3.600294e-02 2.217638e-04
## [560,] -0.0265311428 0.0214659480 -5.356050e-03 9.112897e-03
## [561,] 0.0612930701 -0.1122543797 -6.714921e-02 -1.368662e-02
## [562,] 0.0536497985 -0.0177312339 -1.023821e-02 -3.139075e-03
## [563,] 0.0572798895 0.0130302469 -1.209907e-02 -5.552985e-03
## [564,] -0.0318972163 -0.0229019521 -3.253642e-02 -9.340876e-04
## [565,] 0.0048045501 0.0281111851 4.728344e-03 -5.899725e-04
## [566,] 0.0068911201 -0.0175118860 -2.580188e-04 5.826148e-03
## [567,] 0.0471706437 0.0507946253 1.250840e-03 3.425887e-03
## [568,] 0.1477176175 0.0013794388 -1.939084e-03 -1.131610e-02
## [569,] -0.0426995400 -0.0728970801 3.245528e-02 -6.532395e-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 cancer_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")
# 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			

```
head(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
```

```
head(cancer_pca$rotation)
```

##	PC1	PC2	PC3	PC4
## id	-0.02291216	0.03406849	0.09693844	-0.02659805
## radius_mean	-0.21891302	0.23327140	-0.01139379	0.04218795
## texture_mean	-0.10384388	0.06004420	0.06689234	-0.60295431
## perimeter_mean	-0.22753491	0.21458900	-0.01212479	0.04275280
## area_mean	-0.22104577	0.23066882	0.02629315	0.05411472
## smoothness_mean	-0.14241471	-0.18642221	-0.10318240	0.15809818
##	PC5	PC6	PC7	PC8
## id	0.01132759	-0.316733438	0.90711563	-0.096362415
## radius_mean	-0.03812986	0.029588521	-0.04229878	-0.116427419
## texture_mean	0.04909145	-0.031394323	0.01499356	0.001875482
## perimeter_mean	-0.03771559	0.028394008	-0.04358882	-0.106272097
## area_mean	-0.01056223	0.006113155	-0.02892567	-0.047414568
## smoothness_mean	0.36575006	-0.262508993	-0.14034036	-0.123541189
##	PC9	PC10	PC11	PC12
## id	0.14911564	-0.16926751	0.05818900	-0.006721252
## radius_mean	-0.04627083	-0.22402704	-0.07946608	-0.042213788
## texture_mean	-0.08872717	0.11945674	-0.25325809	0.304032359
## perimeter_mean	-0.03623074	-0.22634517	-0.06986593	-0.017573055
## area_mean	-0.08064986	-0.18600385	-0.06279537	-0.110760120
## smoothness_mean	0.27899640	-0.06133822	0.08466155	0.135321954
##	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
##	PC17	PC18	PC19	PC20
## id	-0.007779983	-0.01970737	0.005442248	0.02045491
## radius_mean	0.150008977	0.20990800	-0.156773206	0.21182139
## texture_mean	0.159152972	-0.03416176	0.040048687	0.02993171
## perimeter_mean	0.113792993	0.20123366	-0.168413120	0.22707927
## area_mean	0.130173978	0.25146046	-0.269145594	-0.04549963
## smoothness_mean	0.203117911	0.16817161	0.354463321	-0.16035826
##	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
##	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
##	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
```

```
#print(cancer_pca)
# 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

```
# 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))
```

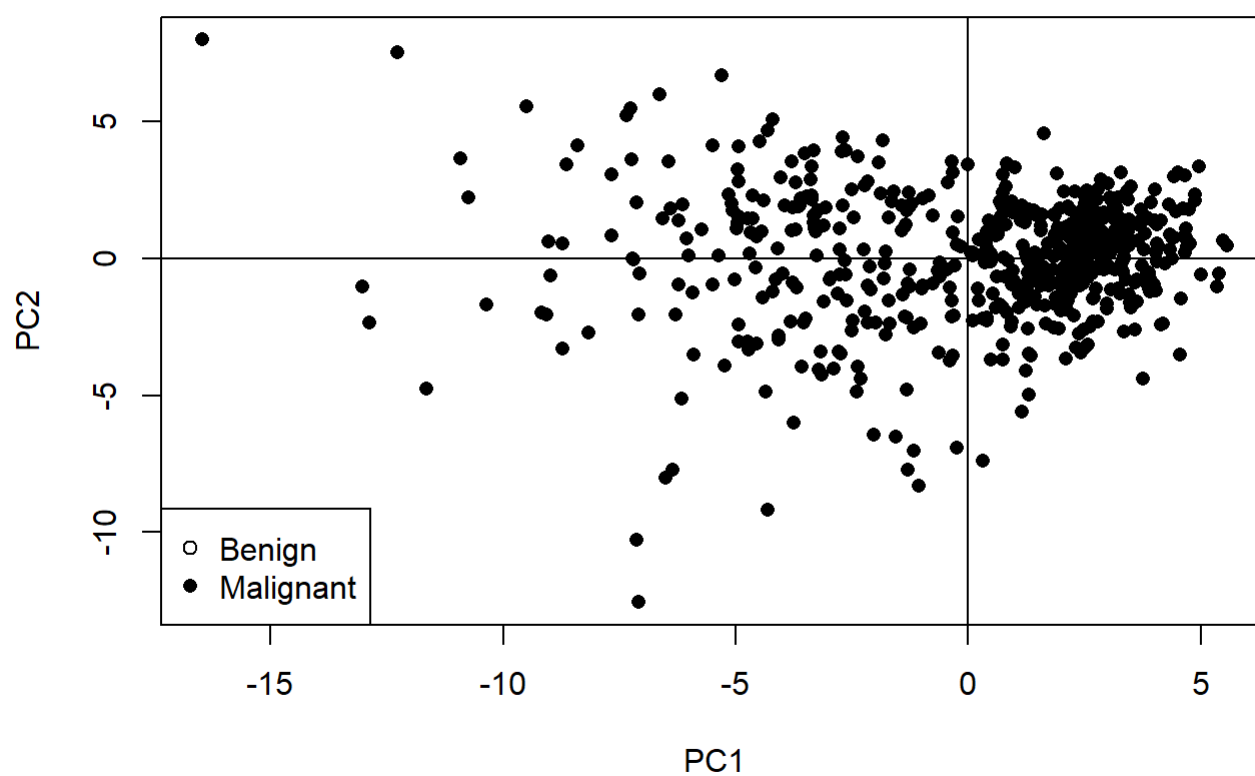
```
## Levene's Test for Homogeneity of Variance (center = median)
##           Df F value    Pr(>F)
## group    1  6.8535 0.009083 **
##           567
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

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

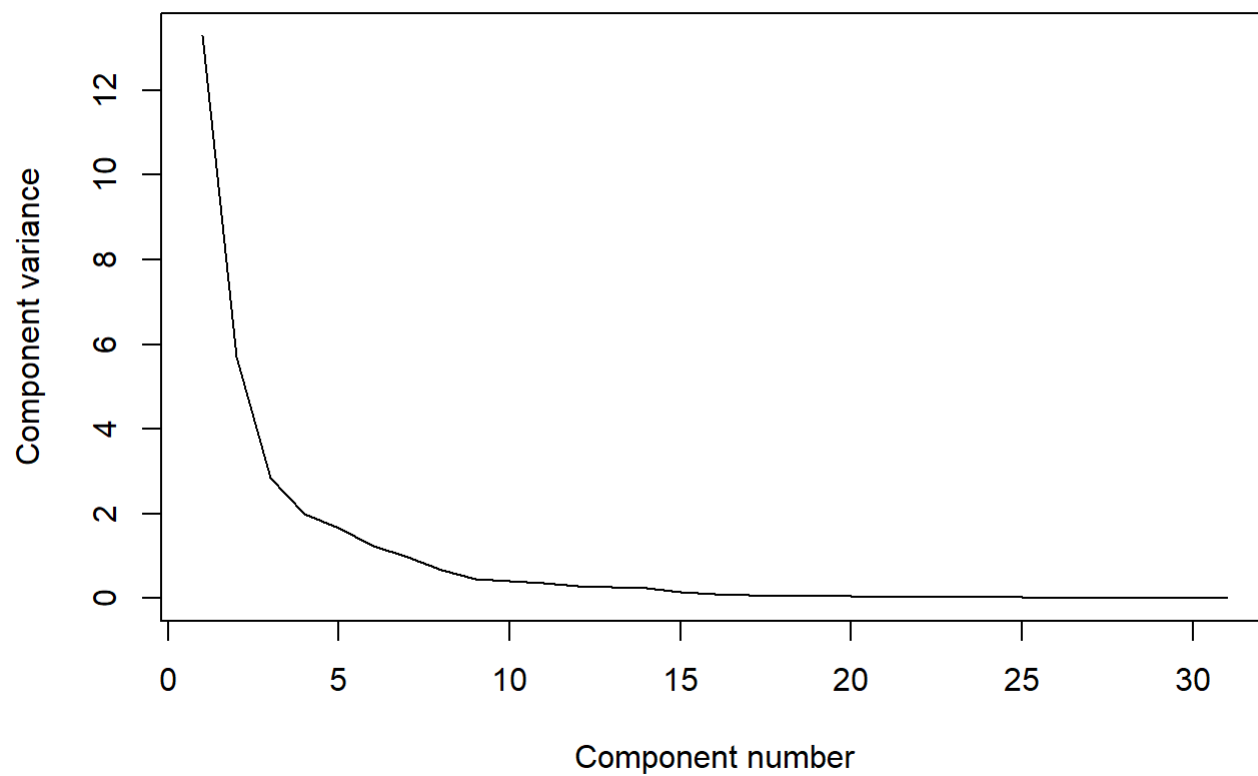
```
# Plotting the scores for the first and second components
plot(diag_pca$PC1, diag_pca$PC2,pch=ifelse(diag_pca$diagnosis == "S",1,16),xlab="PC1", ylab="PC
2", main="569 entries against values for PC1 & PC2")
abline(h=0)
abline(v=0)
legend("bottomleft", legend=c("Benign","Malignant"), pch=c(1,16))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

569 entries against values for PC1 & PC2



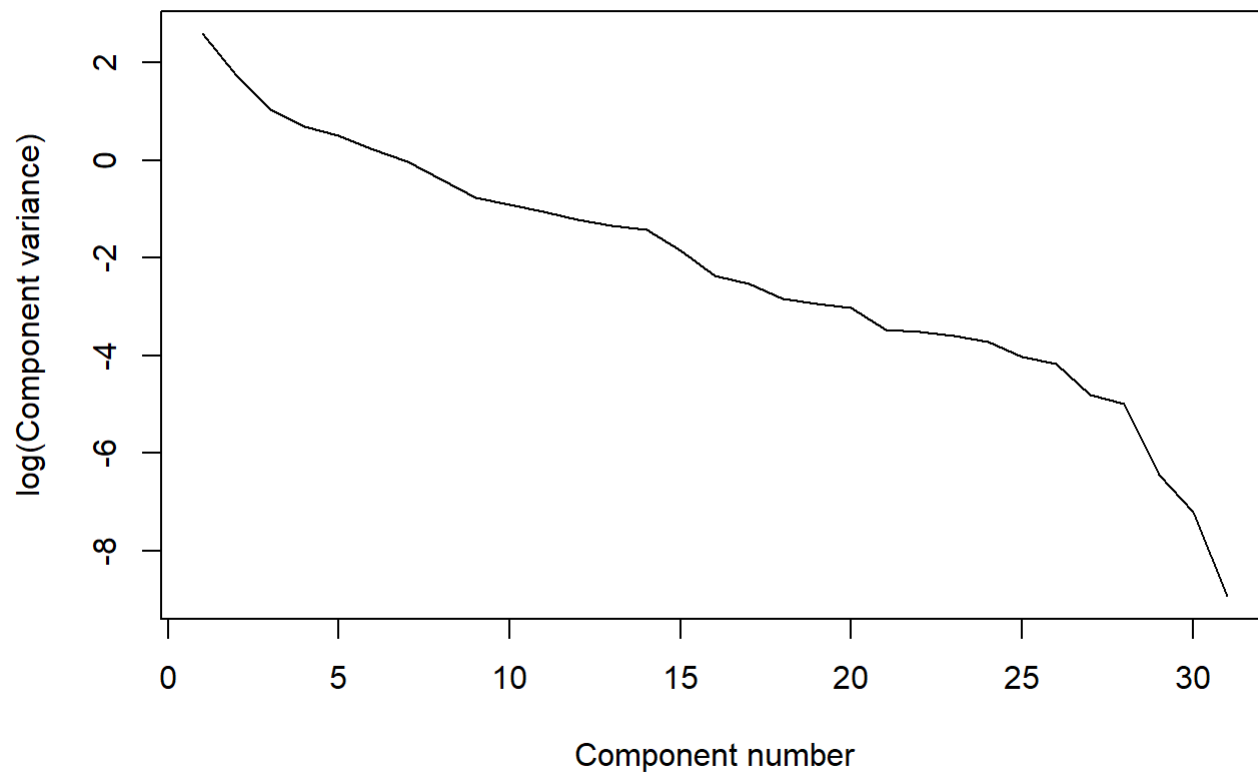
```
plot(eigen_cancer, xlab = "Component number", ylab = "Component variance", type = "l", main = "Scree diagram")
```

Scree diagram



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

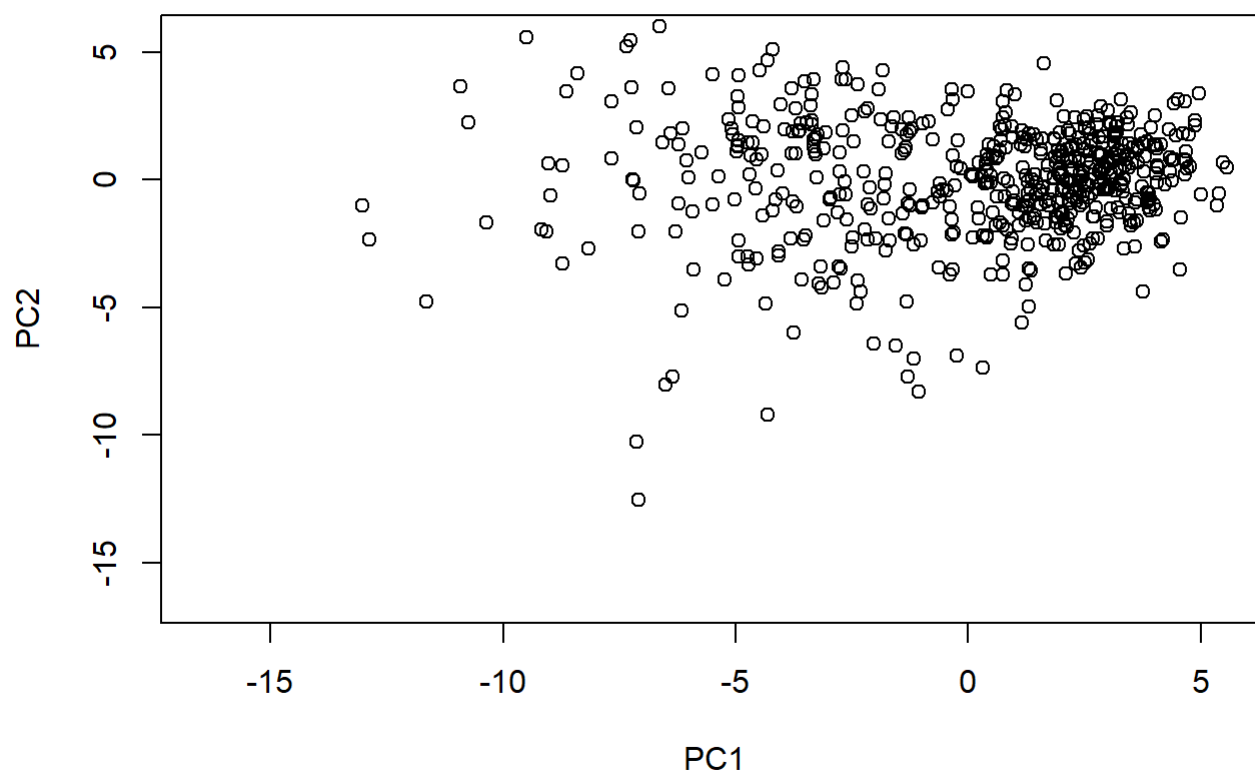
```
xlim <- range(cancer_pca$x[,1])
head(cancer_pca$x[,1])
```

```
## [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
library(psych)
```

```
##
```

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

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

```
##
```

```
##      logit
```

```
## The following objects are masked from 'package:ggplot2':
```

```
##
```

```
##      %+%, alpha
```

```
#install.packages("psych", Lib="/Library/Frameworks/R.framework/Versions/3.5/Resources/Library")
```

```
library(psych)
```

```
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
```

```
# 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
```

```
# 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
```

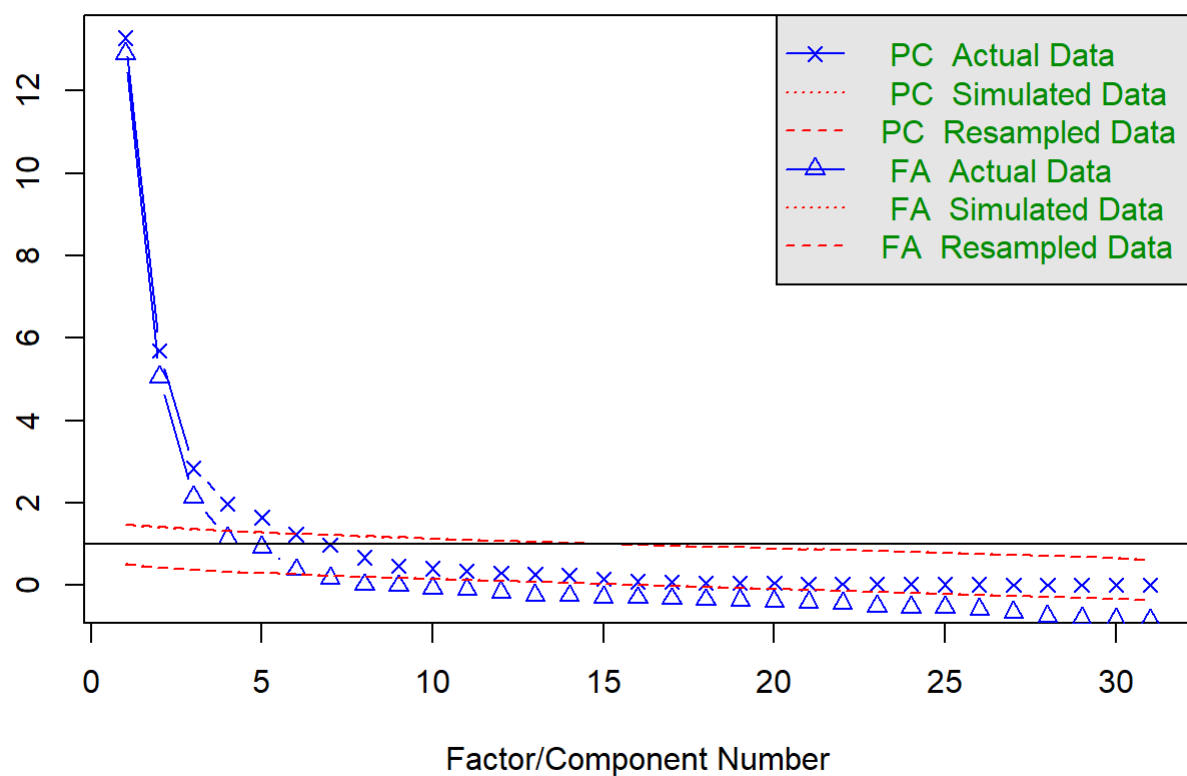
```
# Play with FA utilities
```

```
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.
```

eigenvalues of principal components and factor analysis

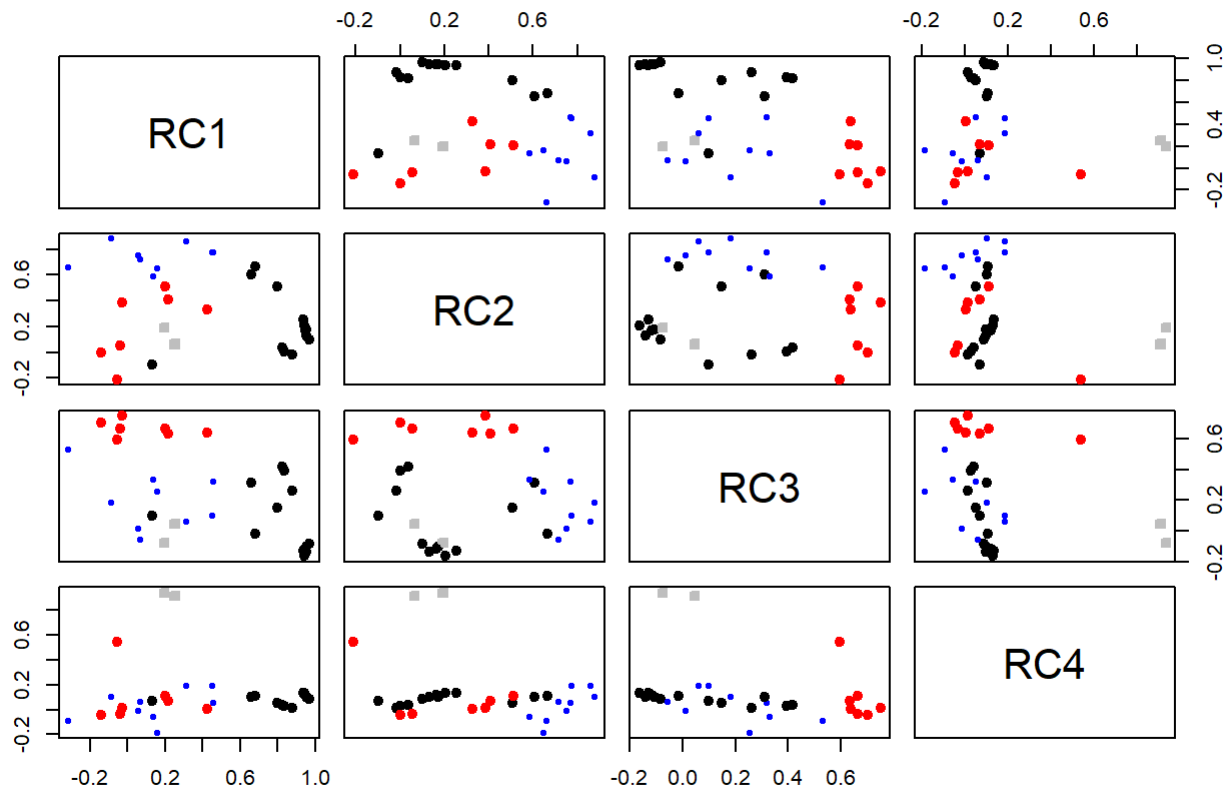
Parallel Analysis Scree Plots



```
## 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

