Class 8 Mini project

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It is important to consider scalling your data before anakysis such as PCA

For example:

```
colMeans(mtcars)
```

```
       mpg        cyl       disp         hp       drat         wt       qsec
 20.090625   6.187500 230.721875 146.687500   3.596563   3.217250  17.848750
        vs         am       gear       carb
  0.437500   0.406250   3.687500   2.812500
```

```
apply(mtcars, 2, sd)
```

```
       mpg        cyl       disp         hp       drat         wt
 6.0269481  1.7859216 123.9386938  68.5628685   0.5346787  0.9784574
      qsec         vs         am       gear       carb
 1.7869432  0.5040161   0.4989909   0.7378041  1.6152000
```

```
x<- scale(mtcars)
head(x)
```

```
                         mpg        cyl        disp         hp        drat
Mazda RX4          0.1508848 -0.1049878 -0.57061982 -0.5350928   0.5675137
Mazda RX4 Wag      0.1508848 -0.1049878 -0.57061982 -0.5350928   0.5675137
Datsun 710         0.4495434 -1.2248578 -0.99018209 -0.7830405   0.4739996
Hornet 4 Drive     0.2172534 -0.1049878  0.22009369 -0.5350928  -0.9661175
Hornet Sportabout -0.2307345  1.0148821  1.04308123  0.4129422  -0.8351978
Valiant           -0.3302874 -0.1049878 -0.04616698 -0.6080186  -1.5646078
                           wt       qsec         vs         am        gear
Mazda RX4          -0.610399567 -0.7771651 -0.8680278  1.1899014   0.4235542
```

```
Mazda RX4 Wag      -0.349785269 -0.4637808 -0.8680278  1.1899014  0.4235542
Datsun 710         -0.917004624  0.4260068  1.1160357  1.1899014  0.4235542
Hornet 4 Drive     -0.002299538  0.8904872  1.1160357 -0.8141431 -0.9318192
Hornet Sportabout   0.227654255 -0.4637808 -0.8680278 -0.8141431 -0.9318192
Valiant             0.248094592  1.3269868  1.1160357 -0.8141431 -0.9318192
                         carb
Mazda RX4            0.7352031
Mazda RX4 Wag        0.7352031
Datsun 710          -1.1221521
Hornet 4 Drive      -1.1221521
Hornet Sportabout   -0.5030337
Valiant             -1.1221521
```

```r
round(colMeans(x), 2)
```

```
 mpg  cyl disp   hp drat   wt qsec   vs   am gear carb
   0    0    0    0    0    0    0    0    0    0    0
```

Key point: It is usually always a good idea to scale your data before to PCA

Breast Cancer Biopsy Analysis

```r
# Save your input data file into your Project directory
fna.data <- "WisconsinCancer.csv"

# Complete the following code to input the data and store as wisc.df
wisc.df <- read.csv(fna.data, row.names=1)
```

```r
head(wisc.df)
```

```
         diagnosis radius_mean texture_mean perimeter_mean area_mean
842302           M       17.99        10.38         122.80    1001.0
842517           M       20.57        17.77         132.90    1326.0
84300903         M       19.69        21.25         130.00    1203.0
84348301         M       11.42        20.38          77.58     386.1
84358402         M       20.29        14.34         135.10    1297.0
843786           M       12.45        15.70          82.57     477.1
         smoothness_mean compactness_mean concavity_mean concave.points_mean
```

842302	0.11840	0.27760	0.3001	0.14710
842517	0.08474	0.07864	0.0869	0.07017
84300903	0.10960	0.15990	0.1974	0.12790
84348301	0.14250	0.28390	0.2414	0.10520
84358402	0.10030	0.13280	0.1980	0.10430
843786	0.12780	0.17000	0.1578	0.08089

	symmetry_mean	fractal_dimension_mean	radius_se	texture_se	perimeter_se
842302	0.2419	0.07871	1.0950	0.9053	8.589
842517	0.1812	0.05667	0.5435	0.7339	3.398
84300903	0.2069	0.05999	0.7456	0.7869	4.585
84348301	0.2597	0.09744	0.4956	1.1560	3.445
84358402	0.1809	0.05883	0.7572	0.7813	5.438
843786	0.2087	0.07613	0.3345	0.8902	2.217

	area_se	smoothness_se	compactness_se	concavity_se	concave.points_se
842302	153.40	0.006399	0.04904	0.05373	0.01587
842517	74.08	0.005225	0.01308	0.01860	0.01340
84300903	94.03	0.006150	0.04006	0.03832	0.02058
84348301	27.23	0.009110	0.07458	0.05661	0.01867
84358402	94.44	0.011490	0.02461	0.05688	0.01885
843786	27.19	0.007510	0.03345	0.03672	0.01137

	symmetry_se	fractal_dimension_se	radius_worst	texture_worst
842302	0.03003	0.006193	25.38	17.33
842517	0.01389	0.003532	24.99	23.41
84300903	0.02250	0.004571	23.57	25.53
84348301	0.05963	0.009208	14.91	26.50
84358402	0.01756	0.005115	22.54	16.67
843786	0.02165	0.005082	15.47	23.75

	perimeter_worst	area_worst	smoothness_worst	compactness_worst
842302	184.60	2019.0	0.1622	0.6656
842517	158.80	1956.0	0.1238	0.1866
84300903	152.50	1709.0	0.1444	0.4245
84348301	98.87	567.7	0.2098	0.8663
84358402	152.20	1575.0	0.1374	0.2050
843786	103.40	741.6	0.1791	0.5249

	concavity_worst	concave.points_worst	symmetry_worst
842302	0.7119	0.2654	0.4601
842517	0.2416	0.1860	0.2750
84300903	0.4504	0.2430	0.3613
84348301	0.6869	0.2575	0.6638
84358402	0.4000	0.1625	0.2364
843786	0.5355	0.1741	0.3985

	fractal_dimension_worst
842302	0.11890

```
842517                    0.08902
84300903                  0.08758
84348301                  0.17300
84358402                  0.07678
843786                    0.12440
```

```
diagnosis <- wisc.df[,1]
table (diagnosis)
```

```
diagnosis
  B   M
357 212
```

Remove this first 'diagnosis' column from the data set as I dont want to pass this to PCA etc. It is essentially the expert "answer" that we will compare our analysis result to

```
# We can use -1 here to remove the first column
wisc.data <- wisc.df[,-1]
head(wisc.data)
```

```
         radius_mean texture_mean perimeter_mean area_mean smoothness_mean
842302         17.99        10.38         122.80    1001.0         0.11840
842517         20.57        17.77         132.90    1326.0         0.08474
84300903       19.69        21.25         130.00    1203.0         0.10960
84348301       11.42        20.38          77.58     386.1         0.14250
84358402       20.29        14.34         135.10    1297.0         0.10030
843786         12.45        15.70          82.57     477.1         0.12780
         compactness_mean concavity_mean concave.points_mean symmetry_mean
842302            0.27760         0.3001             0.14710        0.2419
842517            0.07864         0.0869             0.07017        0.1812
84300903          0.15990         0.1974             0.12790        0.2069
84348301          0.28390         0.2414             0.10520        0.2597
84358402          0.13280         0.1980             0.10430        0.1809
843786            0.17000         0.1578             0.08089        0.2087
         fractal_dimension_mean radius_se texture_se perimeter_se area_se
842302                  0.07871    1.0950     0.9053        8.589  153.40
842517                  0.05667    0.5435     0.7339        3.398   74.08
84300903                0.05999    0.7456     0.7869        4.585   94.03
84348301                0.09744    0.4956     1.1560        3.445   27.23
84358402                0.05883    0.7572     0.7813        5.438   94.44
843786                  0.07613    0.3345     0.8902        2.217   27.19
```

```
        smoothness_se compactness_se concavity_se concave.points_se
842302       0.006399         0.04904      0.05373           0.01587
842517       0.005225         0.01308      0.01860           0.01340
84300903     0.006150         0.04006      0.03832           0.02058
84348301     0.009110         0.07458      0.05661           0.01867
84358402     0.011490         0.02461      0.05688           0.01885
843786       0.007510         0.03345      0.03672           0.01137
        symmetry_se fractal_dimension_se radius_worst texture_worst
842302      0.03003             0.006193        25.38         17.33
842517      0.01389             0.003532        24.99         23.41
84300903    0.02250             0.004571        23.57         25.53
84348301    0.05963             0.009208        14.91         26.50
84358402    0.01756             0.005115        22.54         16.67
843786      0.02165             0.005082        15.47         23.75
        perimeter_worst area_worst smoothness_worst compactness_worst
842302           184.60     2019.0           0.1622            0.6656
842517           158.80     1956.0           0.1238            0.1866
84300903         152.50     1709.0           0.1444            0.4245
84348301          98.87      567.7           0.2098            0.8663
84358402         152.20     1575.0           0.1374            0.2050
843786           103.40      741.6           0.1791            0.5249
        concavity_worst concave.points_worst symmetry_worst
842302           0.7119               0.2654         0.4601
842517           0.2416               0.1860         0.2750
84300903         0.4504               0.2430         0.3613
84348301         0.6869               0.2575         0.6638
84358402         0.4000               0.1625         0.2364
843786           0.5355               0.1741         0.3985
        fractal_dimension_worst
842302                  0.11890
842517                  0.08902
84300903                0.08758
84348301                0.17300
84358402                0.07678
843786                  0.12440
```

Create diagnosis vector for later

```r
diagnosis <- as.factor(wisc.df$diagnosis)
```

Explanatory data Analysis

Q1. How many observations are in this dataset?

```
# Count the number of observations in the dataset
num_observations <- nrow(wisc.df)
num_observations
```

[1] 569

Q2. How many of the observations have a malignant diagnosis?

```
# Count the number of malignant diagnosis
num_malignant <- sum(diagnosis =="M")
num_malignant
```

[1] 212

Q3. How many variables/features in the data are suffixed with _mean?

```
colnames(wisc.data)
```

```
 [1] "radius_mean"            "texture_mean"
 [3] "perimeter_mean"         "area_mean"
 [5] "smoothness_mean"        "compactness_mean"
 [7] "concavity_mean"         "concave.points_mean"
 [9] "symmetry_mean"          "fractal_dimension_mean"
[11] "radius_se"              "texture_se"
[13] "perimeter_se"           "area_se"
[15] "smoothness_se"          "compactness_se"
[17] "concavity_se"           "concave.points_se"
[19] "symmetry_se"            "fractal_dimension_se"
[21] "radius_worst"           "texture_worst"
[23] "perimeter_worst"        "area_worst"
[25] "smoothness_worst"       "compactness_worst"
[27] "concavity_worst"        "concave.points_worst"
[29] "symmetry_worst"         "fractal_dimension_worst"
```

```
length(grep("_mean", colnames(wisc.data)))
```

[1] 10

Principle Component Analysis

```
wisc.pr <- prcomp( wisc.data, scale= T )
summary(wisc.pr)
```

```
Importance of components:
                          PC1     PC2     PC3     PC4     PC5     PC6     PC7
Standard deviation     3.6444  2.3857 1.67867 1.40735 1.28403 1.09880 0.82172
Proportion of Variance 0.4427  0.1897 0.09393 0.06602 0.05496 0.04025 0.02251
Cumulative Proportion  0.4427  0.6324 0.72636 0.79239 0.84734 0.88759 0.91010
                          PC8     PC9    PC10    PC11    PC12    PC13    PC14
Standard deviation     0.69037 0.6457 0.59219 0.5421 0.51104 0.49128 0.39624
Proportion of Variance 0.01589 0.0139 0.01169 0.0098 0.00871 0.00805 0.00523
Cumulative Proportion  0.92598 0.9399 0.95157 0.9614 0.97007 0.97812 0.98335
                         PC15    PC16    PC17    PC18    PC19    PC20    PC21
Standard deviation     0.30681 0.28260 0.24372 0.22939 0.22244 0.17652 0.1731
Proportion of Variance 0.00314 0.00266 0.00198 0.00175 0.00165 0.00104 0.0010
Cumulative Proportion  0.98649 0.98915 0.99113 0.99288 0.99453 0.99557 0.9966
                         PC22    PC23   PC24    PC25    PC26    PC27    PC28
Standard deviation     0.16565 0.15602 0.1344 0.12442 0.09043 0.08307 0.03987
Proportion of Variance 0.00091 0.00081 0.0006 0.00052 0.00027 0.00023 0.00005
Cumulative Proportion  0.99749 0.99830 0.9989 0.99942 0.99969 0.99992 0.99997
                         PC29    PC30
Standard deviation     0.02736 0.01153
Proportion of Variance 0.00002 0.00000
Cumulative Proportion  1.00000 1.00000
```

Main "PC score plot", "PC1 vs PC2 plot"

See what is in our PCA result object:

```
attributes(wisc.pr)
```

```
$names
[1] "sdev"     "rotation" "center"   "scale"    "x"

$class
[1] "prcomp"
```

```
head(wisc.pr$x)
```

```
                 PC1        PC2        PC3       PC4       PC5        PC6
842302    -9.184755  -1.946870 -1.1221788 3.6305364 1.1940595   1.41018364
842517    -2.385703   3.764859 -0.5288274 1.1172808 -0.6212284  0.02863116
84300903  -5.728855   1.074229 -0.5512625 0.9112808 0.1769302   0.54097615
84348301  -7.116691 -10.266556 -3.2299475 0.1524129 2.9582754   3.05073750
84358402  -3.931842   1.946359  1.3885450 2.9380542 -0.5462667 -1.22541641
843786    -2.378155  -3.946456 -2.9322967 0.9402096 1.0551135  -0.45064213
                 PC7         PC8         PC9       PC10       PC11       PC12
842302    2.15747152  0.39805698 -0.15698023 -0.8766305 -0.2627243 -0.8582593
842517    0.01334635 -0.24077660 -0.71127897  1.1060218 -0.8124048  0.1577838
84300903 -0.66757908 -0.09728813  0.02404449  0.4538760  0.6050715  0.1242777
84348301  1.42865363 -1.05863376 -1.40420412 -1.1159933  1.1505012  1.0104267
84358402 -0.93538950 -0.63581661 -0.26357355  0.3773724 -0.6507870 -0.1104183
843786    0.49001396  0.16529843 -0.13335576 -0.5299649 -0.1096698  0.0813699
                 PC13        PC14         PC15        PC16        PC17
842302    0.10329677 -0.690196797  0.601264078  0.74446075 -0.26523740
842517   -0.94269981 -0.652900844 -0.008966977 -0.64823831 -0.01719707
84300903 -0.41026561  0.016665095 -0.482994760  0.32482472  0.19075064
84348301 -0.93245070 -0.486988399  0.168699395  0.05132509  0.48220960
84358402  0.38760691 -0.538706543 -0.310046684 -0.15247165  0.13302526
843786   -0.02625135  0.003133944 -0.178447576 -0.01270566  0.19671335
                 PC18       PC19        PC20         PC21        PC22
842302   -0.54907956  0.1336499  0.34526111  0.096430045 -0.06878939
842517    0.31801756 -0.2473470 -0.11403274 -0.077259494  0.09449530
84300903 -0.08789759 -0.3922812 -0.20435242  0.310793246  0.06025601
84348301 -0.03584323 -0.0267241 -0.46432511  0.433811661  0.20308706
84358402 -0.01869779  0.4610302  0.06543782 -0.116442469  0.01763433
843786   -0.29727706 -0.1297265 -0.07117453 -0.002400178  0.10108043
                 PC23        PC24         PC25         PC26        PC27
842302    0.08444429  0.175102213  0.150887294 -0.201326305 -0.25236294
842517   -0.21752666 -0.011280193  0.170360355 -0.041092627  0.18111081
84300903 -0.07422581 -0.102671419 -0.171007656  0.004731249  0.04952586
84348301 -0.12399554 -0.153294780 -0.077427574 -0.274982822  0.18330078
84358402  0.13933105  0.005327110 -0.003059371  0.039219780  0.03213957
843786    0.03344819 -0.002837749 -0.122282765 -0.030272333 -0.08438081
                  PC28         PC29         PC30
842302   -0.0338846387  0.045607590  0.0471277407
842517    0.0325955021 -0.005682424  0.0018662342
84300903  0.0469844833  0.003143131 -0.0007498749
84348301  0.0424469831 -0.069233868  0.0199198881
```

```
84358402  -0.0347556386   0.005033481 -0.0211951203
843786     0.0007296587  -0.019703996 -0.0034564331
```

```
plot(wisc.pr$x[,1], wisc.pr$x[,2],
     col=as.factor(diagnosis))
```
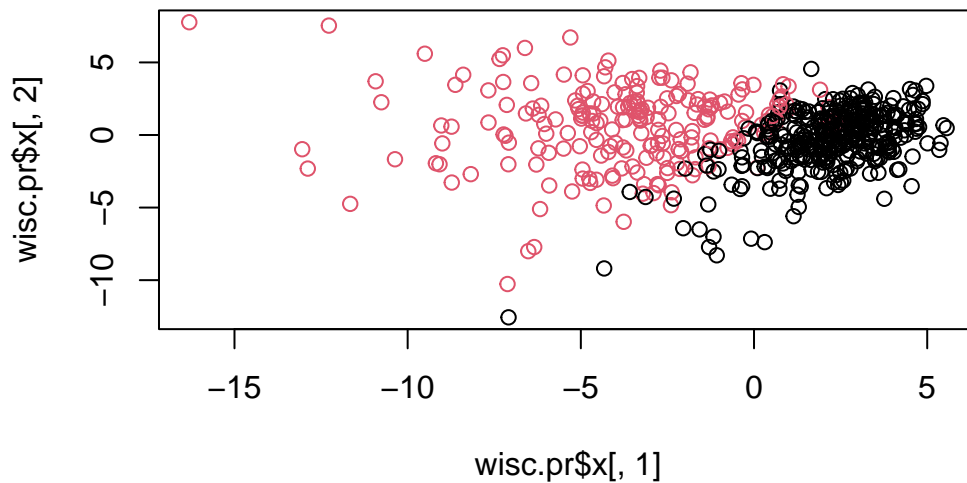

Q4. From your results, what proportion of the original variance is captured by the first principal components (PC1)?

```
# Perform PCA on the data (assuming wisc.data is already prepared)
pca_result <- prcomp(wisc.data, scale. = TRUE)

# Calculate the proportion of variance captured by PC1
proportion_pc1 <- (pca_result$sdev[1]^2/sum(pca_result$sdev^2))

# Print the proportion
proportion_pc1
```

```
[1] 0.4427203
```

Q5. How many principal components (PCs) are required to describe at least 70% of the original variance in the data?

```
# Perform PCA and calculate the number of PCs needed to explain at least 70% of the variance
num_pcs_70 <- which(cumsum((pca_result <- prcomp(wisc.data, scale. = TRUE))$sdev^2 / sum(pca_

# Print the number of PCs required
num_pcs_70
```

[1] 3

Q6. How many principal components (PCs) are required to describe at least 90%
of the original variance in the data?

```
# Perform PCA and calculate the number of PCs needed to explain at least 90% of the variance
num_pcs_90 <- which(cumsum((pca_result <- prcomp(wisc.data, scale. = TRUE))$sdev^2 / sum(pca_

# Print the number of PCs required
num_pcs_90
```

[1] 7

```
x <- summary(wisc.pr)
plot(x$importance[2,], type="b")
```
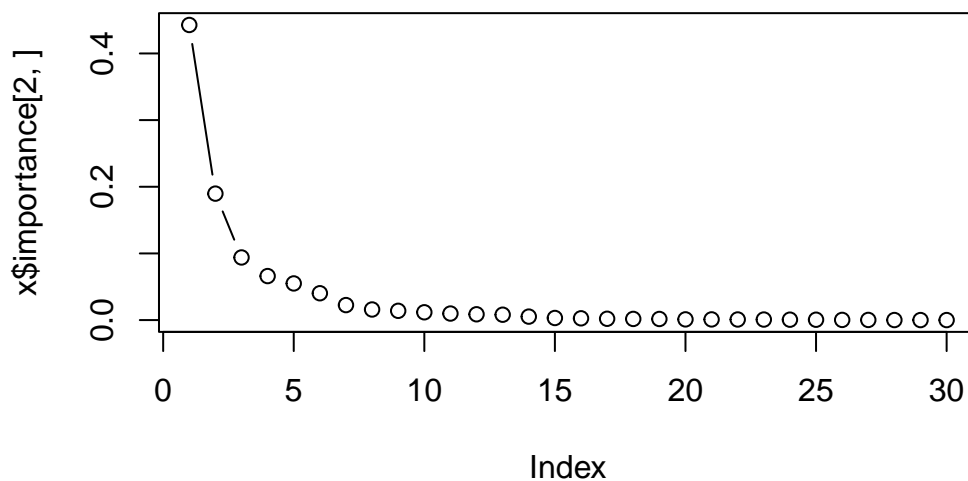
Q7. What stands out to you about this plot? Is it easy or difficult to understand? Why?

```
pca_result <- prcomp(wisc.data,scale. = TRUE)
biplot(pca_result)
```
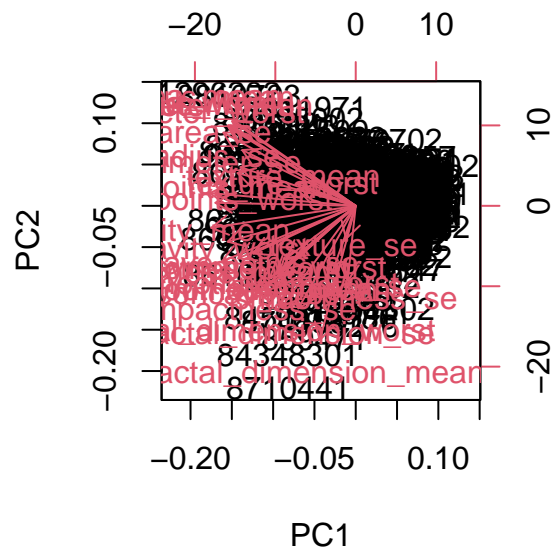

The overlapping in the plot stands out. # It can be difficult to interpret due to no visible relationionship.

Scatter plot observations by components 1 and 2

```
plot( pca_result$x[, 1], pca_result$x[, 2], col = diagnosis ,
      xlab = "PC1", ylab = "PC2")
```
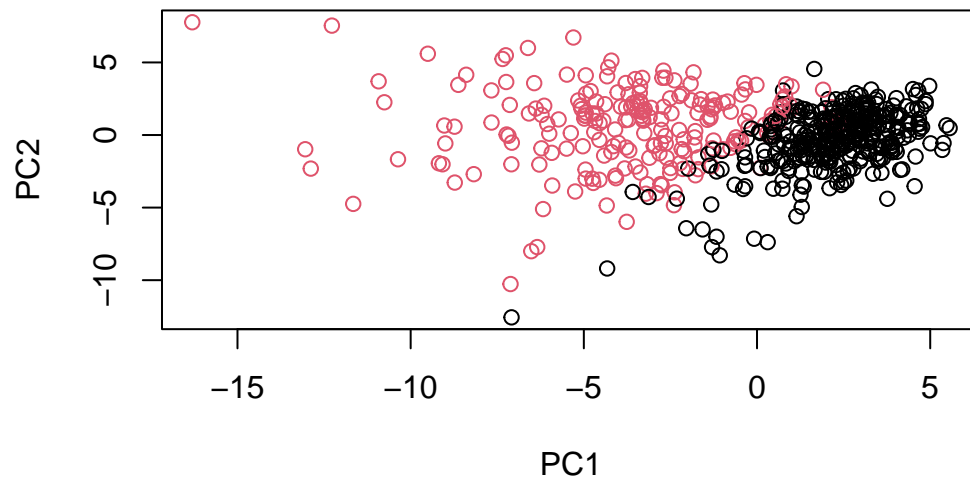
Q8. Generate a similar plot for principal components 1 and 3. What do you notice about these plots?

```
plot(wisc.pr$x[, 1 ], wisc.pr$x[,3], col = diagnosis,
     xlab = "PC1", ylab = "PC3")
```
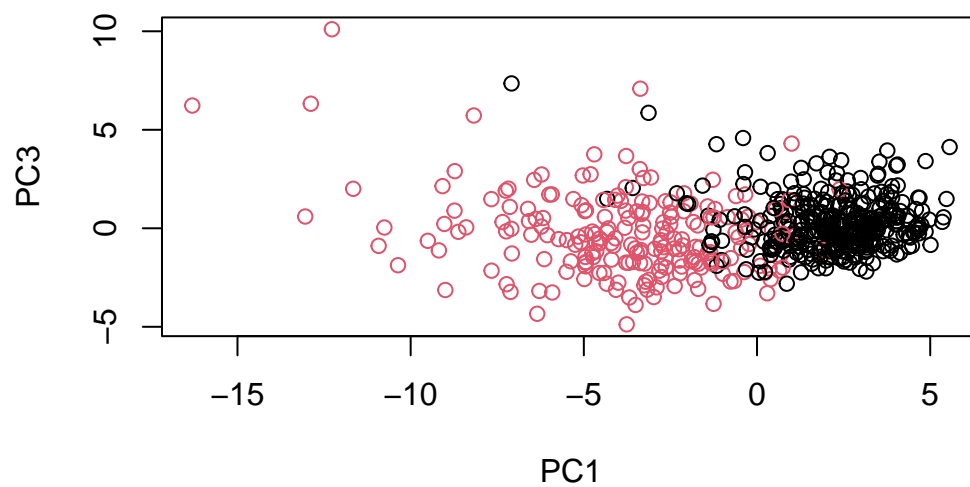
```r
# Create a data.frame for ggplot
df <- as.data.frame(wisc.pr$x)
df$diagnosis <- diagnosis
# Load the ggplot2 package
library(ggplot2)
# Make a scatter plot colored by diagnosis
ggplot(df) +
  aes(PC1, PC2, col=diagnosis) +
  geom_point() +
  labs(title = "PCA Scatter Plot of PC1 vs PC2",
       x = "PC1",
       y = "PC2")
```

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PCA Scatter Plot of PC1 vs PC2
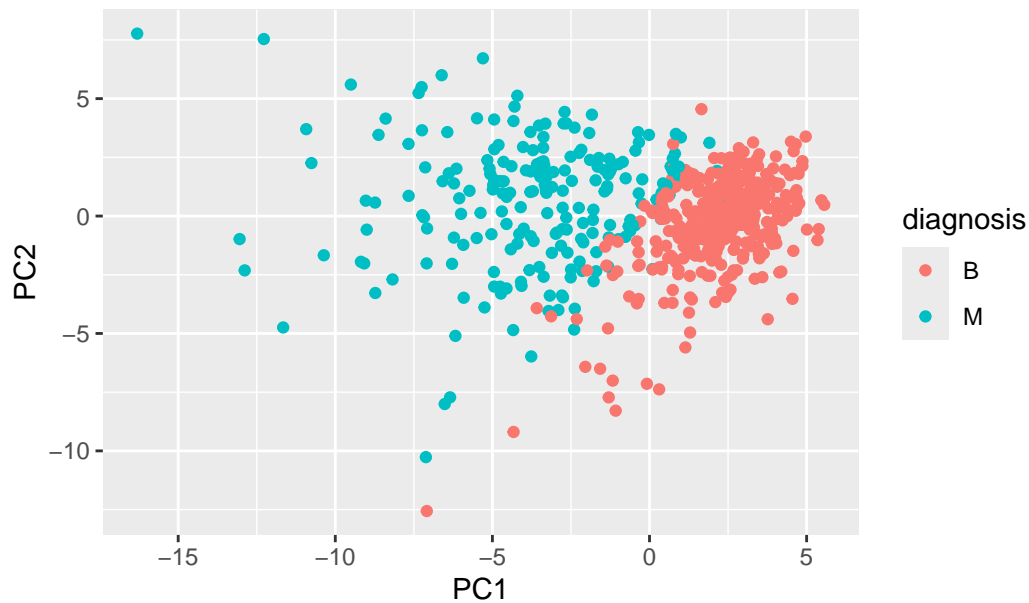
```
 # Calculate variance of each component
pr.var <- wisc.pr$sdev^2
head(pr.var)
```

```
[1] 13.281608  5.691355  2.817949  1.980640  1.648731  1.207357
```

```
# Variance explained by each principal component: pve
pve <- pca_result$sdev^2 / sum(pca_result$sdev^2)
# Plot variance explained for each principal component
plot(pve, xlab = "Principal Component",
     ylab = "Proportion of Variance Explained",
     ylim = c(0, 1), type = "o")
```

Principal Component
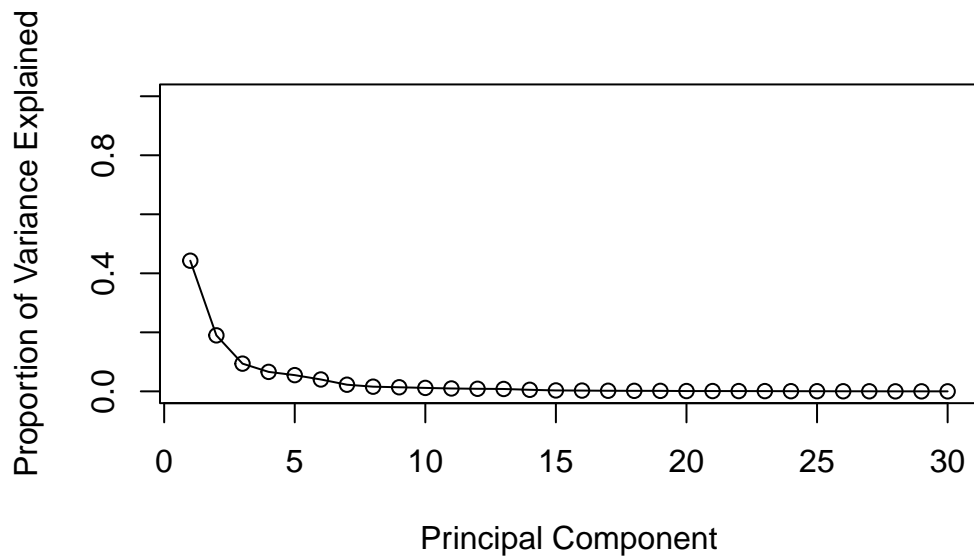
Q9. For the first principal component, what is the component of the loading vector (i.e. wisc.pr$rotation[,1]) for the feature concave.points_mean?

```
 # Assuming pca_result is the result of the PCA
loading_concave_points_mean <- pca_result$rotation["concave.points_mean", 1]
loading_concave_points_mean
```

```
[1] -0.2608538
```

Q10. What is the minimum number of principal components required to explain 80% of the variance of the data?

```
# Calculate the proportion of variance
pve <- pca_result$sdev^2 / sum(pca_result$sdev^2)
# Calculate cumulative variance
cumulative_variance <- cumsum(pve)
# at least 80% of the variance
num_pcs_80 <- which(cumulative_variance >= 0.80)[1]
num_pcs_80
```

```
[1] 5
```

Hierarchical Clustering

```
# Scale the wisc.data data using the "scale()" function
data.scaled <- scale(wisc.data)
data.dist <- dist(data.scaled)
wisc.hclust <- hclust(data.dist, method = "complete")
```

Q11. Using the plot() and abline() functions, what is the height at which the clustering model has 4 clusters?

```
d <- dist(scale(wisc.data))
hc.raw <- hclust(d)
plot(hc.raw)
```

Cluster Dendrogram

d
hclust (*, "complete")
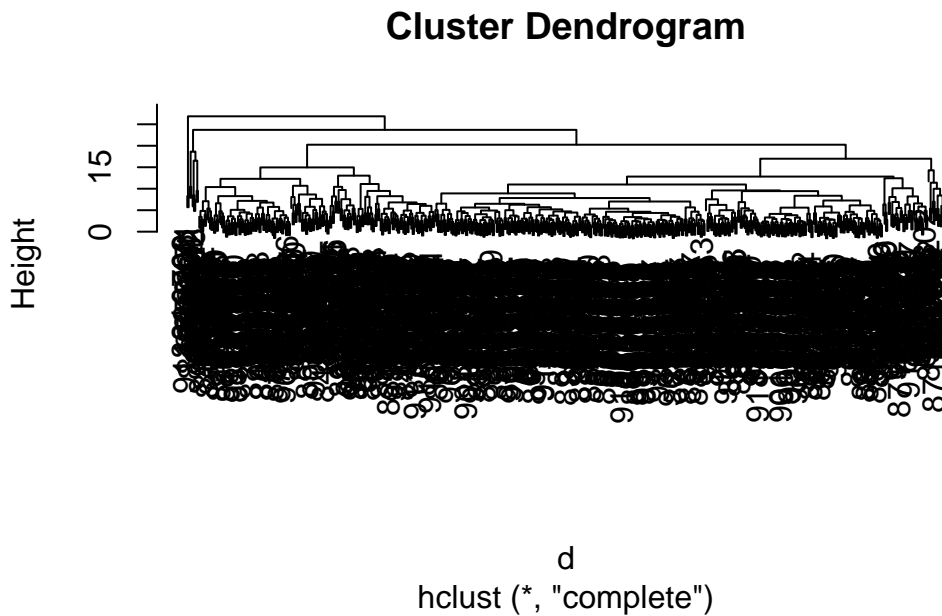
Combine PCA and Clistering

Our PCA results were in 'wisc.pr'

```
#distance matrix from PCA result
d <- dist(wisc.pr$x[,1:3])
hc <- hclust(d, method= "ward.D2")
plot(hc)
```

Cluster Dendrogram
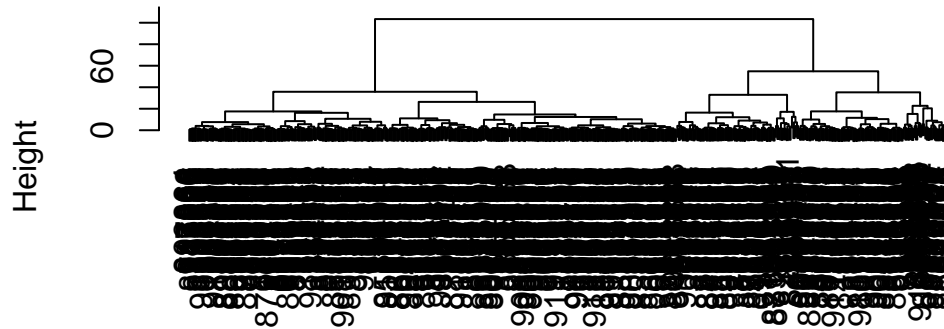
d
hclust (*, "ward.D2")

```
grps <- cutree(hc, k=2)
```

Cute tree into two groups

```
plot(wisc.pr$x, col=grps)
```
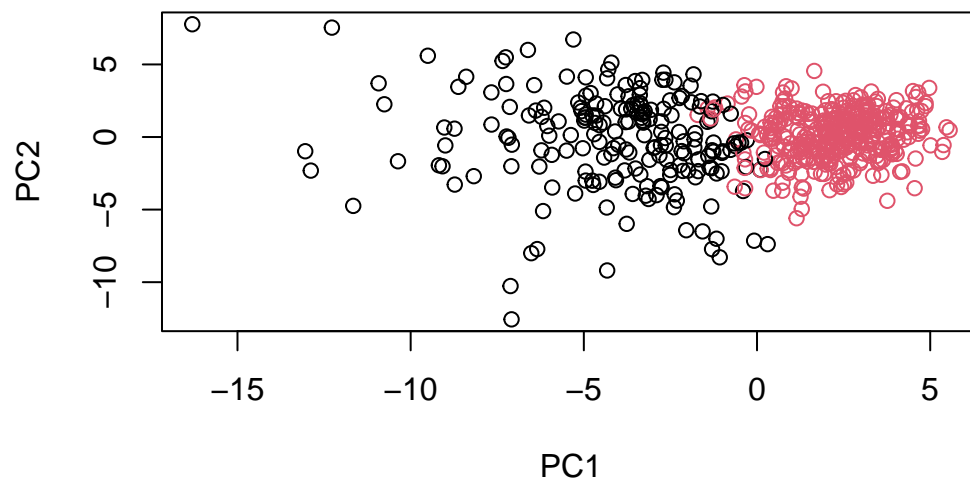
```
wisc.hclust.clusters <- cutree(wisc.hclust, k=4)
table(wisc.hclust.clusters, diagnosis)
```

```
                      diagnosis
wisc.hclust.clusters   B    M
                   1  12  165
                   2   2    5
                   3 343   40
                   4   0    2
```

```
table(diagnosis, grps)
```

```
         grps
diagnosis   1    2
        B  24  333
        M 179   33
```

```
table(grps)
```

```
grps
  1   2
203 366
```

Q12. Can you find a better cluster vs diagnoses match by cutting into a different number of clusters between 2 and 10?

```
# Initialize results list
results <- lapply(2:10, function(k) {
  clusters <- cutree(wisc.hclust, k)
  table_clusters <- table(clusters, diagnosis)
  accuracy <- sum(apply(table_clusters, 1, max)) / nrow(wisc.data)
  list(clusters = clusters, table = table_clusters, accuracy = accuracy)
})
# Name the results list by cluster count
names(results) <- 2:10
results
```

```
$`2`
$`2`$clusters
   842302     842517   84300903   84348301   84358402      843786     844359   84458202
        1          1          1          1          1          1          1          1
   844981   84501001     845636   84610002     846226      846381   84667401   84799002
        1          1          1          1          1          1          1          1
   848406   84862001     849014    8510426    8510653     8510824    8511133     851509
        1          1          1          1          1          1          1          1
   852552     852631     852763     852781     852973      853201     853401     853612
        1          1          1          1          1          1          1          1
 85382601     854002     854039     854253     854268      854941     855133     855138
        1          1          1          1          1          1          1          1
   855167     855563     855625     856106   85638502      857010   85713702      85715
        1          1          1          1          1          1          1          1
   857155     857156     857343     857373     857374      857392     857438   85759902
        1          1          1          1          1          1          1          1
   857637     857793     857810     858477     858970      858981     858986     859196
        1          1          1          1          1          1          1          1
 85922302     859283     859464     859465     859471      859487     859575     859711
        1          1          1          1          1          1          1          1
   859717     859983    8610175    8610404    8610629     8610637    8610862    8610908
        1          1          1          1          1          1          1          1
   861103    8611161    8611555    8611792    8612080     8612399   86135501   86135502
        1          1          1          1          1          1          1          1
   861597     861598     861648     861799     861853      862009     862028      86208
        1          1          1          1          1          1          1          1
    86211     862261     862485     862548     862717      862722     862965     862980
        1          1          1          1          1          1          1          1
```

862989	863030	863031	863270	86355	864018	864033	86408
1	1	1	1	1	1	1	1
86409	864292	864496	864685	864726	864729	864877	865128
1	1	1	1	1	1	1	1
865137	86517	865423	865432	865468	86561	866083	866203
1	1	1	1	1	1	1	1
866458	866674	866714	8670	86730502	867387	867739	868202
1	1	1	1	1	1	1	1
868223	868682	868826	868871	868999	869104	869218	869224
1	1	1	1	1	1	1	1
869254	869476	869691	86973701	86973702	869931	871001501	871001502
1	1	1	1	1	1	1	1
8710441	87106	8711002	8711003	8711202	8711216	871122	871149
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8711561	8711803	871201	8712064	8712289	8712291	87127	8712729
1	1	1	1	1	1	1	1
8712766	8712853	87139402	87163	87164	871641	871642	872113
1	1	1	1	1	1	1	1
872608	87281702	873357	873586	873592	873593	873701	873843
1	1	1	1	1	1	1	1
873885	874158	874217	874373	874662	874839	874858	875093
1	1	1	1	1	1	1	1
875099	875263	87556202	875878	875938	877159	877486	877500
1	1	1	1	1	1	1	1
877501	877989	878796	87880	87930	879523	879804	879830
1	1	1	1	1	1	1	1
8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
1	1	1	1	2	1	1	1
8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
1	1	1	1	1	1	1	1
8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
1	1	1	1	1	1	1	1
88203002	88206102	882488	88249602	88299702	883263	883270	88330202
1	1	1	1	1	1	1	1
88350402	883539	883852	88411702	884180	884437	884448	884626
1	1	1	1	1	1	1	1
88466802	884689	884948	88518501	885429	8860702	886226	886452
1	1	1	1	1	1	1	1
88649001	886776	887181	88725602	887549	888264	888570	889403
1	1	1	1	1	1	1	1
889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
1	1	1	1	1	1	1	1
8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834

1	1	1	1	1	1	1	1
8912049	8912055	89122	8912280	8912284	8912521	8912909	8913
1	1	1	1	1	1	1	1
8913049	89143601	89143602	8915	891670	891703	891716	891923
1	1	1	1	1	1	1	1
891936	892189	892214	892399	892438	892604	89263202	892657
1	1	1	1	1	1	1	1
89296	893061	89344	89346	893526	893548	893783	89382601
1	1	1	1	1	1	1	1
89382602	893988	894047	894089	894090	894326	894329	894335
1	1	1	1	1	1	1	1
894604	894618	894855	895100	89511501	89511502	89524	895299
1	1	1	1	1	1	1	1
8953902	895633	896839	896864	897132	897137	897374	89742801
1	1	1	1	1	1	1	1
897604	897630	897880	89812	89813	898143	89827	898431
1	1	1	1	1	1	1	1
89864002	898677	898678	89869	898690	899147	899187	899667
1	1	1	1	1	1	1	1
899987	9010018	901011	9010258	9010259	901028	9010333	901034301
1	1	1	1	1	1	1	1
901034302	901041	9010598	9010872	9010877	901088	9011494	9011495
1	1	1	1	1	1	1	1
9011971	9012000	9012315	9012568	9012795	901288	9013005	901303
1	1	1	1	1	1	1	1
901315	9013579	9013594	9013838	901549	901836	90250	90251
1	1	1	1	1	1	1	1
902727	90291	902975	902976	903011	90312	90317302	903483
1	1	1	1	1	1	1	1
903507	903516	903554	903811	90401601	90401602	904302	904357
1	1	1	1	1	1	1	1
90439701	904647	904689	9047	904969	904971	905189	905190
1	1	1	1	1	1	1	1
90524101	905501	905502	905520	905539	905557	905680	905686
1	1	1	1	1	1	1	1
905978	90602302	906024	906290	906539	906564	906616	906878
1	1	1	1	1	1	1	1
907145	907367	907409	90745	90769601	90769602	907914	907915
1	1	1	1	1	1	1	1
908194	908445	908469	908489	908916	909220	909231	909410
1	1	1	1	1	1	1	1
909411	909445	90944601	909777	9110127	9110720	9110732	9110944
1	1	1	1	1	1	1	1

911150	911157302	9111596	9111805	9111843	911201	911202	9112085
1	1	1	1	1	1	1	1
9112366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
1	1	1	1	1	2	1	1
911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
1	1	1	1	1	1	1	1
911384	9113846	911391	911408	911654	911673	911685	911916
1	1	1	1	1	1	1	1
912193	91227	912519	912558	912600	913063	913102	913505
1	1	1	1	1	1	1	1
913512	913535	91376701	91376702	914062	914101	914102	914333
1	1	1	1	1	1	1	1
914366	914580	914769	91485	914862	91504	91505	915143
1	1	1	1	1	1	1	1
915186	915276	91544001	91544002	915452	915460	91550	915664
1	1	1	1	1	1	1	1
915691	915940	91594602	916221	916799	916838	917062	917080
1	1	1	1	1	1	1	1
917092	91762702	91789	917896	917897	91805	91813701	91813702
1	1	1	1	1	1	1	1
918192	918465	91858	91903901	91903902	91930402	919537	919555
1	1	1	1	1	1	1	1
91979701	919812	921092	921362	921385	921386	921644	922296
1	1	1	1	1	1	1	1
922297	922576	922577	922840	923169	923465	923748	923780
1	1	1	1	1	1	1	1
924084	924342	924632	924934	924964	925236	925277	925291
1	1	1	1	1	1	1	1
925292	925311	925622	926125	926424	926682	926954	927241
1	1	1	1	1	1	1	1
92751							
1							

```
$`2`$table
      diagnosis
clusters   B   M
      1 357 210
      2   0   2

$`2`$accuracy
[1] 0.6309315
```

```
$`3`
$`3`$clusters
   842302     842517   84300903   84348301   84358402     843786     844359   84458202 
        1          1          1          2          1          1          1          1 
   844981   84501001     845636   84610002     846226     846381   84667401   84799002 
        1          2          1          1          1          1          1          1 
   848406   84862001     849014    8510426    8510653    8510824    8511133     851509 
        1          1          1          1          1          1          1          1 
   852552     852631     852763     852781     852973     853201     853401     853612 
        1          1          1          1          1          1          1          1 
 85382601     854002     854039     854253     854268     854941     855133     855138 
        1          1          1          1          1          1          1          1 
   855167     855563     855625     856106   85638502     857010   85713702      85715 
        1          1          1          1          1          1          1          1 
   857155     857156     857343     857373     857374     857392     857438   85759902 
        1          1          1          1          1          1          1          1 
   857637     857793     857810     858477     858970     858981     858986     859196 
        1          1          1          1          1          1          1          1 
 85922302     859283     859464     859465     859471     859487     859575     859711 
        1          1          1          1          2          1          1          1 
   859717     859983    8610175    8610404    8610629    8610637    8610862    8610908 
        1          1          1          1          1          1          2          1 
   861103    8611161    8611555    8611792    8612080    8612399   86135501   86135502 
        1          1          1          1          1          1          1          1 
   861597     861598     861648     861799     861853     862009     862028      86208 
        1          1          1          1          1          1          1          1 
    86211     862261     862485     862548     862717     862722     862965     862980 
        1          1          1          1          1          1          1          1 
   862989     863030     863031     863270      86355     864018     864033      86408 
        1          1          1          1          1          1          1          1 
    86409     864292     864496     864685     864726     864729     864877     865128 
        1          1          1          1          1          1          1          1 
   865137      86517     865423     865432     865468      86561     866083     866203 
        1          1          2          1          1          1          1          1 
   866458     866674     866714       8670   86730502     867387     867739     868202 
        1          1          1          1          1          1          1          1 
   868223     868682     868826     868871     868999     869104     869218     869224 
        1          1          1          1          1          1          1          1 
   869254     869476     869691   86973701   86973702     869931  871001501  871001502 
        1          1          1          1          1          1          1          1 
  8710441      87106    8711002    8711003    8711202    8711216     871122     871149 
        2          1          1          1          1          1          1          1 
  8711561    8711803     871201    8712064    8712289    8712291      87127    8712729 
```

1	1	1	1	1	1	1	1
8712766	8712853	87139402	87163	87164	871641	871642	872113
1	1	1	1	1	1	1	1
872608	87281702	873357	873586	873592	873593	873701	873843
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873885	874158	874217	874373	874662	874839	874858	875093
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875099	875263	87556202	875878	875938	877159	877486	877500
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8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
1	1	1	1	3	1	1	1
8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
1	1	1	1	1	1	1	1
8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
1	1	1	1	1	1	1	1
88203002	88206102	882488	88249602	88299702	883263	883270	88330202
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88350402	883539	883852	88411702	884180	884437	884448	884626
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88466802	884689	884948	88518501	885429	8860702	886226	886452
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88649001	886776	887181	88725602	887549	888264	888570	889403
1	1	1	1	1	1	1	1
889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
1	1	1	1	1	1	1	1
8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
1	1	1	1	1	1	1	1
8912049	8912055	89122	8912280	8912284	8912521	8912909	8913
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8913049	89143601	89143602	8915	891670	891703	891716	891923
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891936	892189	892214	892399	892438	892604	89263202	892657
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89296	893061	89344	89346	893526	893548	893783	89382601
1	1	1	1	1	1	1	1
89382602	893988	894047	894089	894090	894326	894329	894335
1	1	1	1	1	1	1	1
894604	894618	894855	895100	89511501	89511502	89524	895299
1	1	1	1	1	1	1	1
8953902	895633	896839	896864	897132	897137	897374	89742801
1	1	1	1	1	1	1	1

897604	897630	897880	89812	89813	898143	89827	898431
1	1	1	1	1	1	1	1
89864002	898677	898678	89869	898690	899147	899187	899667
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899987	9010018	901011	9010258	9010259	901028	9010333	901034301
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901034302	901041	9010598	9010872	9010877	901088	9011494	9011495
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9011971	9012000	9012315	9012568	9012795	901288	9013005	901303
1	1	1	1	1	1	1	1
901315	9013579	9013594	9013838	901549	901836	90250	90251
1	1	1	1	1	1	1	1
902727	90291	902975	902976	903011	90312	90317302	903483
1	1	1	1	1	1	1	1
903507	903516	903554	903811	90401601	90401602	904302	904357
1	1	1	1	1	1	1	1
90439701	904647	904689	9047	904969	904971	905189	905190
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90524101	905501	905502	905520	905539	905557	905680	905686
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905978	90602302	906024	906290	906539	906564	906616	906878
1	1	1	1	1	1	1	1
907145	907367	907409	90745	90769601	90769602	907914	907915
1	1	1	1	1	1	1	1
908194	908445	908469	908489	908916	909220	909231	909410
1	1	1	1	1	1	1	1
909411	909445	90944601	909777	9110127	9110720	9110732	9110944
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911150	911157302	9111596	9111805	9111843	911201	911202	9112085
1	1	1	1	1	1	1	1
9112366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
1	1	1	1	1	3	1	1
911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
1	1	1	1	1	1	1	1
911384	9113846	911391	911408	911654	911673	911685	911916
1	1	1	1	1	1	1	1
912193	91227	912519	912558	912600	913063	913102	913505
1	1	1	1	1	1	1	1
913512	913535	91376701	91376702	914062	914101	914102	914333
1	1	1	1	1	1	1	1
914366	914580	914769	91485	914862	91504	91505	915143
1	1	1	1	1	1	1	1
915186	915276	91544001	91544002	915452	915460	91550	915664

```
        1          1          1          1          1          1          1          1
   915691     915940   91594602     916221     916799     916838     917062     917080
        1          1          1          1          1          1          1          1
   917092   91762702      91789     917896     917897      91805   91813701   91813702
        1          1          1          1          1          1          1          1
   918192     918465      91858   91903901   91903902   91930402     919537     919555
        1          1          1          1          1          1          1          1
 91979701     919812     921092     921362     921385     921386     921644     922296
        1          1          1          1          1          1          1          1
   922297     922576     922577     922840     923169     923465     923748     923780
        1          1          1          1          1          1          1          1
   924084     924342     924632     924934     924964     925236     925277     925291
        1          1          1          1          1          1          1          1
   925292     925311     925622     926125     926424     926682     926954     927241
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    92751
        1


$`3`$table
       diagnosis
clusters   B   M
       1 355 205
       2   2   5
       3   0   2

$`3`$accuracy
[1] 0.6362039



$`4`
$`4`$clusters
   842302     842517   84300903   84348301   84358402     843786     844359   84458202
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   844981   84501001     845636   84610002     846226     846381   84667401   84799002
        1          2          3          1          1          3          1          1
   848406   84862001     849014    8510426    8510653    8510824    8511133     851509
        3          1          1          3          3          3          1          1
   852552     852631     852763     852781     852973     853201     853401     853612
        1          1          1          1          1          3          1          1
 85382601     854002     854039     854253     854268     854941     855133     855138
        1          1          1          1          1          3          3          1
   855167     855563     855625     856106   85638502     857010   85713702      85715
        3          1          1          1          1          1          3          1
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857155	857156	857343	857373	857374	857392	857438	85759902
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85922302	859283	859464	859465	859471	859487	859575	859711
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859717	859983	8610175	8610404	8610629	8610637	8610862	8610908
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8712766	8712853	87139402	87163	87164	871641	871642	872113
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872608	87281702	873357	873586	873592	873593	873701	873843
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88466802	884689	884948	88518501	885429	8860702	886226	886452
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8953902	895633	896839	896864	897132	897137	897374	89742801
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905978	90602302	906024	906290	906539	906564	906616	906878
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909411	909445	90944601	909777	9110127	9110720	9110732	9110944
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911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
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914366	914580	914769	91485	914862	91504	91505	915143
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915691	915940	91594602	916221	916799	916838	917062	917080
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918192	918465	91858	91903901	91903902	91930402	919537	919555
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922297	922576	922577	922840	923169	923465	923748	923780
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924084	924342	924632	924934	924964	925236	925277	925291
3	3	3	3	3	3	3	3
925292	925311	925622	926125	926424	926682	926954	927241

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        3


$`4`$table
      diagnosis
clusters  B   M
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      2   2   5
      3 343  40
      4   0   2


$`4`$accuracy
[1] 0.9050967



$`5`
$`5`$clusters
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   844981  84501001    845636  84610002    846226    846381  84667401  84799002
        1         2         3         1         1         3         1         1
   848406  84862001    849014   8510426   8510653   8510824   8511133    851509
        3         1         1         3         3         3         1         1
   852552    852631    852763    852781    852973    853201    853401    853612
        1         1         1         1         1         3         1         1
 85382601    854002    854039    854253    854268    854941    855133    855138
        1         1         1         1         1         3         3         1
   855167    855563    855625    856106  85638502    857010  85713702     85715
        3         1         1         1         1         1         3         1
   857155    857156    857343    857373    857374    857392    857438  85759902
        3         3         3         3         3         1         3         3
   857637    857793    857810    858477    858970    858981    858986    859196
        1         1         3         3         3         3         1         3
 85922302    859283    859464    859465    859471    859487    859575    859711
        1         1         3         3         4         3         1         3
   859717    859983   8610175   8610404   8610629   8610637   8610862   8610908
        1         1         3         3         3         1         2         3
   861103   8611161   8611555   8611792   8612080   8612399  86135501  86135502
        3         1         1         1         3         1         3         1
   861597    861598    861648    861799    861853    862009    862028     86208
        3         1         3         3         3         3         1         1
    86211    862261    862485    862548    862717    862722    862965    862980
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      3          3          3          3          3          3          3          3
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  86409     864292     864496     864685     864726     864729     864877     865128
      3          3          3          3          3          1          1          3
 865137      86517     865423     865432     865468      86561     866083     866203
      3          1          2          3          3          3          1          3
 866458     866674     866714       8670   86730502     867387     867739     868202
      1          1          3          1          1          3          1          3
 868223     868682     868826     868871     868999     869104     869218     869224
      3          3          1          3          3          3          3          3
 869254     869476     869691   86973701   86973702     869931  871001501  871001502
      3          3          1          3          3          3          3          3
8710441      87106    8711002    8711003    8711202    8711216     871122     871149
      4          3          3          3          1          3          3          3
8711561    8711803     871201    8712064    8712289    8712291      87127    8712729
      3          1          1          3          1          3          3          3
8712766    8712853   87139402      87163      87164     871641     871642     872113
      1          3          3          3          1          3          3          3
 872608   87281702     873357     873586     873592     873593     873701     873843
      3          1          3          3          1          1          1          3
 873885     874158     874217     874373     874662     874839     874858     875093
      1          3          3          3          3          3          2          3
 875099     875263   87556202     875878     875938     877159     877486     877500
      3          1          1          3          1          3          1          1
 877501     877989     878796      87880      87930     879523     879804     879830
      3          3          1          1          3          3          3          3
8810158    8810436  881046502    8810528    8810703  881094802    8810955    8810987
      1          3          1          3          5          3          1          1
8811523    8811779    8811842   88119002    8812816    8812818    8812844    8812877
      3          3          1          1          3          3          3          1
8813129   88143502   88147101   88147102   88147202     881861     881972   88199202
      3          3          3          3          3          1          1          3
88203002   88206102     882488   88249602   88299702     883263     883270   88330202
      3          1          3          3          1          1          3          1
88350402    883539     883852   88411702     884180     884437     884448     884626
      3          3          3          3          1          3          3          3
88466802    884689     884948   88518501     885429    8860702     886226     886452
      3          3          1          3          1          3          1          3
88649001    886776     887181   88725602     887549     888264     888570     889403
      1          1          1          1          1          3          1          3
 889719   88995002    8910251    8910499    8910506    8910720    8910721    8910748
      1          1          3          3          3          3          3          3
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8913049	89143601	89143602	8915	891670	891703	891716	891923
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891936	892189	892214	892399	892438	892604	89263202	892657
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89296	893061	89344	89346	893526	893548	893783	89382601
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89382602	893988	894047	894089	894090	894326	894329	894335
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894604	894618	894855	895100	89511501	89511502	89524	895299
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897604	897630	897880	89812	89813	898143	89827	898431
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901315	9013579	9013594	9013838	901549	901836	90250	90251
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90524101	905501	905502	905520	905539	905557	905680	905686
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905978	90602302	906024	906290	906539	906564	906616	906878
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 9112366    9112367    9112594    9112712  911296201  911296202    9113156  911320501
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911320502    9113239    9113455    9113514    9113538     911366    9113778    9113816
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  911384    9113846     911391     911408     911654     911673     911685     911916
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  912193      91227     912519     912558     912600     913063     913102     913505
       3          3          3          3          3          3          3          1
  913512     913535   91376701   91376702     914062     914101     914102     914333
       3          3          3          3          1          3          3          3
  914366     914580     914769      91485     914862      91504      91505     915143
       1          3          1          1          3          1          3          1
  915186     915276   91544001   91544002     915452     915460      91550     915664
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  915691     915940   91594602     916221     916799     916838     917062     917080
       1          3          3          3          1          1          3          3
  917092   91762702      91789     917896     917897      91805   91813701   91813702
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  918192     918465      91858   91903901   91903902   91930402     919537     919555
       3          3          3          3          3          1          3          1
91979701     919812     921092     921362     921385     921386     921644     922296
       3          1          3          3          3          1          3          3
  922297     922576     922577     922840     923169     923465     923748     923780
       3          3          3          3          3          3          3          3
  924084     924342     924632     924934     924964     925236     925277     925291
       3          3          3          3          3          3          3          3
  925292     925311     925622     926125     926424     926682     926954     927241
       3          3          1          1          1          1          3          1
   92751
       3
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$`5`$table
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        diagnosis
clusters   B   M
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       2   0   5
       3 343  40
       4   2   0
       5   0   2
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$`5`$accuracy
[1] 0.9086116


$`6`
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        1         2         3         1         1         3         1         1
   848406  84862001    849014   8510426   8510653   8510824   8511133    851509
        3         1         1         3         3         3         1         1
   852552    852631    852763    852781    852973    853201    853401    853612
        1         1         1         1         1         3         1         1
 85382601    854002    854039    854253    854268    854941    855133    855138
        1         1         1         1         1         3         3         1
   855167    855563    855625    856106  85638502    857010  85713702     85715
        3         1         1         1         1         1         3         1
   857155    857156    857343    857373    857374    857392    857438  85759902
        3         3         3         3         3         1         3         3
   857637    857793    857810    858477    858970    858981    858986    859196
        1         1         3         3         3         3         1         3
 85922302    859283    859464    859465    859471    859487    859575    859711
        1         1         3         3         4         3         1         5
   859717    859983   8610175   8610404   8610629   8610637   8610862   8610908
        1         1         3         3         3         1         2         3
   861103   8611161   8611555   8611792   8612080   8612399  86135501  86135502
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   861597    861598    861648    861799    861853    862009    862028     86208
        3         1         3         3         3         3         1         1
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        3         3         3         3         3         3         3         3
   862989    863030    863031    863270     86355    864018    864033     86408
        3         1         1         3         1         3         3         3
    86409    864292    864496    864685    864726    864729    864877    865128
        5         3         3         3         3         1         1         3
   865137     86517    865423    865432    865468     86561    866083    866203
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   866458    866674    866714      8670  86730502    867387    867739    868202
        1         1         3         1         1         3         1         3
   868223    868682    868826    868871    868999    869104    869218    869224
        3         3         1         3         3         3         3         3
   869254    869476    869691  86973701  86973702    869931 871001501 871001502
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8712766	8712853	87139402	87163	87164	871641	871642	872113
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872608	87281702	873357	873586	873592	873593	873701	873843
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873885	874158	874217	874373	874662	874839	874858	875093
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875099	875263	87556202	875878	875938	877159	877486	877500
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877501	877989	878796	87880	87930	879523	879804	879830
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8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
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8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
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8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
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88203002	88206102	882488	88249602	88299702	883263	883270	88330202
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88350402	883539	883852	88411702	884180	884437	884448	884626
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88466802	884689	884948	88518501	885429	8860702	886226	886452
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88649001	886776	887181	88725602	887549	888264	888570	889403
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889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
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8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
1	3	3	3	3	3	3	3
8912049	8912055	89122	8912280	8912284	8912521	8912909	8913
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8913049	89143601	89143602	8915	891670	891703	891716	891923
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891936	892189	892214	892399	892438	892604	89263202	892657
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89382602	893988	894047	894089	894090	894326	894329	894335
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894604	894618	894855	895100	89511501	89511502	89524	895299
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901315	9013579	9013594	9013838	901549	901836	90250	90251
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905978	90602302	906024	906290	906539	906564	906616	906878
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907145	907367	907409	90745	90769601	90769602	907914	907915
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908194	908445	908469	908489	908916	909220	909231	909410
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909411	909445	90944601	909777	9110127	9110720	9110732	9110944
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911150	911157302	9111596	9111805	9111843	911201	911202	9112085
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9112366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
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911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
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912193	91227	912519	912558	912600	913063	913102	913505
3	3	3	3	3	5	3	1
913512	913535	91376701	91376702	914062	914101	914102	914333

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         3          3          3          3          1          3          3          3
    914366     914580     914769      91485     914862      91504      91505     915143
         1          3          1          1          3          1          3          1
    915186     915276   91544001   91544002     915452     915460      91550     915664
         5          5          3          3          3          1          3          3
    915691     915940   91594602     916221     916799     916838     917062     917080
         1          3          3          3          1          1          3          3
    917092   91762702      91789     917896     917897      91805   91813701   91813702
         3          1          3          3          3          3          1          3
    918192     918465      91858   91903901   91903902   91930402     919537     919555
         3          3          3          3          3          1          3          1
  91979701     919812     921092     921362     921385     921386     921644     922296
         3          1          3          5          3          1          3          3
    922297     922576     922577     922840     923169     923465     923748     923780
         3          3          3          3          3          3          3          3
    924084     924342     924632     924934     924964     925236     925277     925291
         3          3          3          3          3          3          3          3
    925292     925311     925622     926125     926424     926682     926954     927241
         3          3          1          1          1          1          3          1
     92751
         3
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$`6`$table
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        diagnosis
clusters   B   M
       1  12 165
       2   0   5
       3 331  39
       4   2   0
       5  12   1
       6   0   2
```

$`6`$accuracy
```
[1] 0.9086116
```

$`7`
$`7`$clusters
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         1          2          3          1          1          3          1          1
    848406   84862001     849014    8510426    8510653    8510824    8511133     851509
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855167	855563	855625	856106	85638502	857010	85713702	85715
3	1	1	1	1	1	3	1
857155	857156	857343	857373	857374	857392	857438	85759902
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857637	857793	857810	858477	858970	858981	858986	859196
1	1	3	3	3	3	1	3
85922302	859283	859464	859465	859471	859487	859575	859711
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859717	859983	8610175	8610404	8610629	8610637	8610862	8610908
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861103	8611161	8611555	8611792	8612080	8612399	86135501	86135502
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861597	861598	861648	861799	861853	862009	862028	86208
3	1	3	3	3	3	1	1
86211	862261	862485	862548	862717	862722	862965	862980
3	3	3	3	3	3	3	3
862989	863030	863031	863270	86355	864018	864033	86408
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86409	864292	864496	864685	864726	864729	864877	865128
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865137	86517	865423	865432	865468	86561	866083	866203
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866458	866674	866714	8670	86730502	867387	867739	868202
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868223	868682	868826	868871	868999	869104	869218	869224
3	3	1	3	3	3	3	3
869254	869476	869691	86973701	86973702	869931	871001501	871001502
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8710441	87106	8711002	8711003	8711202	8711216	871122	871149
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8711561	8711803	871201	8712064	8712289	8712291	87127	8712729
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8712766	8712853	87139402	87163	87164	871641	871642	872113
1	3	3	3	1	3	3	3
872608	87281702	873357	873586	873592	873593	873701	873843
5	1	3	3	1	1	1	3
873885	874158	874217	874373	874662	874839	874858	875093
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875099	875263	87556202	875878	875938	877159	877486	877500
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877501	877989	878796	87880	87930	879523	879804	879830
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8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
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8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
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8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
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88203002	88206102	882488	88249602	88299702	883263	883270	88330202
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88350402	883539	883852	88411702	884180	884437	884448	884626
3	3	5	3	1	3	3	3
88466802	884689	884948	88518501	885429	8860702	886226	886452
3	3	1	3	1	3	1	3
88649001	886776	887181	88725602	887549	888264	888570	889403
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889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
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8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
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8912049	8912055	89122	8912280	8912284	8912521	8912909	8913
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8913049	89143601	89143602	8915	891670	891703	891716	891923
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891936	892189	892214	892399	892438	892604	89263202	892657
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89296	893061	89344	89346	893526	893548	893783	89382601
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89382602	893988	894047	894089	894090	894326	894329	894335
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894604	894618	894855	895100	89511501	89511502	89524	895299
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8953902	895633	896839	896864	897132	897137	897374	89742801
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897604	897630	897880	89812	89813	898143	89827	898431
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901034302	901041	9010598	9010872	9010877	901088	9011494	9011495

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  901315     9013579     9013594     9013838      901549      901836       90250       90251
       5           3           3           1           3           3           3           3
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       3           3           3           3           3           1           3           3
  903507      903516      903554      903811    90401601    90401602      904302      904357
       1           1           3           3           3           3           3           3
90439701      904647      904689        9047      904969      904971      905189      905190
       1           3           3           3           3           3           3           3
90524101      905501      905502      905520      905539      905557      905680      905686
       1           3           3           3           3           3           3           3
  905978    90602302      906024      906290      906539      906564      906616      906878
       3           1           3           3           3           1           3           3
  907145      907367      907409       90745    90769601    90769602      907914      907915
       3           3           3           3           3           3           1           3
  908194      908445      908469      908489      908916      909220      909231      909410
       1           1           3           1           3           3           3           3
  909411      909445    90944601      909777     9110127     9110720     9110732     9110944
       3           3           3           3           3           3           1           3
  911150   911157302     9111596     9111805     9111843      911201      911202     9112085
       3           1           3           1           3           3           3           3
 9112366     9112367     9112594     9112712   911296201   911296202     9113156   911320501
       3           3           3           3           1           7           3           3
911320502    9113239     9113455     9113514     9113538      911366     9113778     9113816
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  911384     9113846      911391      911408      911654      911673      911685      911916
       3           3           3           3           3           3           3           1
  912193       91227      912519      912558      912600      913063      913102      913505
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  914366      914580      914769       91485      914862       91504       91505      915143
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  915186      915276    91544001    91544002      915452      915460       91550      915664
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  915691      915940    91594602      916221      916799      916838      917062      917080
       1           3           3           3           1           1           3           3
  917092    91762702       91789      917896      917897       91805    91813701    91813702
       3           1           3           3           3           3           1           3
  918192      918465       91858    91903901    91903902    91930402      919537      919555
       3           3           3           3           3           1           3           1
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        3         3         3         3         3         3         3         3
   924084    924342    924632    924934    924964    925236    925277    925291
        3         3         3         3         3         3         3         3
   925292    925311    925622    926125    926424    926682    926954    927241
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    92751
        3
```

$`7`$table
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        diagnosis
clusters   B   M
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       3 331  39
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       5  12   1
       6   0   2
       7   0   2
```

$`7`$accuracy
[1] 0.9086116

$`8`
$`8`$clusters
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         1         3         4         1         2         4         1         1
    848406  84862001    849014   8510426   8510653   8510824   8511133    851509
         4         1         2         4         4         4         1         2
    852552    852631    852763    852781    852973    853201    853401    853612
         2         1         1         2         1         4         1         1
  85382601    854002    854039    854253    854268    854941    855133    855138
         1         1         1         1         1         4         4         1
    855167    855563    855625    856106  85638502    857010  85713702     85715
         4         1         2         1         1         2         4         1
    857155    857156    857343    857373    857374    857392    857438  85759902
         4         4         4         4         4         2         4         4
    857637    857793    857810    858477    858970    858981    858986    859196
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2	1	4	4	4	4	1	4
85922302	859283	859464	859465	859471	859487	859575	859711
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861597	861598	861648	861799	861853	862009	862028	86208
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86211	862261	862485	862548	862717	862722	862965	862980
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862989	863030	863031	863270	86355	864018	864033	86408
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86409	864292	864496	864685	864726	864729	864877	865128
6	4	4	4	4	1	1	4
865137	86517	865423	865432	865468	86561	866083	866203
4	2	7	4	4	4	1	4
866458	866674	866714	8670	86730502	867387	867739	868202
1	1	4	1	1	4	1	4
868223	868682	868826	868871	868999	869104	869218	869224
4	4	1	4	4	4	4	4
869254	869476	869691	86973701	86973702	869931	871001501	871001502
4	4	1	4	4	4	4	6
8710441	87106	8711002	8711003	8711202	8711216	871122	871149
5	4	4	4	2	4	4	4
8711561	8711803	871201	8712064	8712289	8712291	87127	8712729
4	2	1	4	2	4	4	4
8712766	8712853	87139402	87163	87164	871641	871642	872113
2	4	4	4	1	4	4	4
872608	87281702	873357	873586	873592	873593	873701	873843
6	1	4	4	2	2	1	4
873885	874158	874217	874373	874662	874839	874858	875093
1	4	4	4	4	4	3	4
875099	875263	87556202	875878	875938	877159	877486	877500
4	1	1	4	1	4	2	1
877501	877989	878796	87880	87930	879523	879804	879830
4	4	2	1	4	4	4	4
8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
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8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
4	4	2	2	4	4	4	1
8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
4	4	4	4	4	1	1	4

88203002	88206102	882488	88249602	88299702	883263	883270	88330202
4	2	4	4	2	2	4	2
88350402	883539	883852	88411702	884180	884437	884448	884626
4	4	6	4	2	4	4	4
88466802	884689	884948	88518501	885429	8860702	886226	886452
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88649001	886776	887181	88725602	887549	888264	888570	889403
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889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
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897604	897630	897880	89812	89813	898143	89827	898431
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$`8`$table
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       3   0    3
       4 331   39
       5   2    0
       6  12    1
       7   0    2
       8   0    2


$`8`$accuracy
[1] 0.9086116



$`9`
$`9`$clusters
  842302    842517  84300903  84348301  84358402    843786    844359  84458202
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       1         3         4         1         2         4         1         1
  848406  84862001    849014   8510426   8510653   8510824   8511133    851509
       4         1         2         4         4         4         1         2
  852552    852631    852763    852781    852973    853201    853401    853612
       2         1         1         2         1         4         1         1
85382601    854002    854039    854253    854268    854941    855133    855138
       1         1         1         1         1         4         4         1
  855167    855563    855625    856106  85638502    857010  85713702     85715
       4         1         2         1         1         2         4         1
  857155    857156    857343    857373    857374    857392    857438  85759902
       4         4         4         4         4         2         4         4
  857637    857793    857810    858477    858970    858981    858986    859196
       2         1         4         4         4         4         1         4
85922302    859283    859464    859465    859471    859487    859575    859711
       1         1         4         4         5         4         2         6
  859717    859983   8610175   8610404   8610629   8610637   8610862   8610908
       1         1         4         4         4         2         7         4
  861103   8611161   8611555   8611792   8612080   8612399  86135501  86135502
       4         1         2         2         4         2         4         2
  861597    861598    861648    861799    861853    862009    862028     86208
       4         1         4         4         4         4         1         2
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8712766	8712853	87139402	87163	87164	871641	871642	872113
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8810158	8810436	881046502	8810528	8810703	881094802	8810955	8810987
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8813129	88143502	88147101	88147102	88147202	881861	881972	88199202
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88203002	88206102	882488	88249602	88299702	883263	883270	88330202
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889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748

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8912049	8912055	89122	8912280	8912284	8912521	8912909	8913
1	4	2	1	4	4	4	4
8913049	89143601	89143602	8915	891670	891703	891716	891923
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89382602	893988	894047	894089	894090	894326	894329	894335
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894604	894618	894855	895100	89511501	89511502	89524	895299
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897604	897630	897880	89812	89813	898143	89827	898431
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901315	9013579	9013594	9013838	901549	901836	90250	90251
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         4          2          4          2          4          4          4          4
   9112366    9112367    9112594    9112712  911296201  911296202    9113156  911320501
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 911320502    9113239    9113455    9113514    9113538     911366    9113778    9113816
         4          4          4          4          2          1          4          4
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         4          4          4          4          4          4          4          1
    912193      91227     912519     912558     912600     913063     913102     913505
         4          4          4          4          4          6          4          1
    913512     913535   91376701   91376702     914062     914101     914102     914333
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    915186     915276   91544001   91544002     915452     915460      91550     915664
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    915691     915940   91594602     916221     916799     916838     917062     917080
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    917092   91762702      91789     917896     917897      91805   91813701   91813702
         4          2          4          4          4          4          1          4
    918192     918465      91858   91903901   91903902   91930402     919537     919555
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  91979701     919812     921092     921362     921385     921386     921644     922296
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    924084     924342     924632     924934     924964     925236     925277     925291
         4          4          4          4          4          4          4          4
    925292     925311     925622     926125     926424     926682     926954     927241
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$`9`$table

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       3   0   3
       4 331  39
       5   2   0
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          7    0    2
          8    0    2
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$`9`$accuracy
[1] 0.9103691


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         4         1         2         4         4         4         1         2
    852552    852631    852763    852781    852973    853201    853401    853612
         2         1         1         2         1         4         1         1
  85382601    854002    854039    854253    854268    854941    855133    855138
         1         1         1         1         1         4         4         1
    855167    855563    855625    856106  85638502    857010  85713702     85715
         4         1         5         1         1         2         4         1
    857155    857156    857343    857373    857374    857392    857438  85759902
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    865137     86517    865423    865432    865468     86561    866083    866203
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903507	903516	903554	903811	90401601	90401602	904302	904357
1	1	4	4	4	4	4	4
90439701	904647	904689	9047	904969	904971	905189	905190
1	4	4	4	4	4	4	4
90524101	905501	905502	905520	905539	905557	905680	905686
1	4	4	4	4	4	4	4
905978	90602302	906024	906290	906539	906564	906616	906878
4	5	4	4	4	1	4	4
907145	907367	907409	90745	90769601	90769602	907914	907915
4	4	4	4	4	4	1	4
908194	908445	908469	908489	908916	909220	909231	909410
2	2	4	1	4	4	4	4
909411	909445	90944601	909777	9110127	9110720	9110732	9110944
4	4	4	4	4	4	2	4
911150	911157302	9111596	9111805	9111843	911201	911202	9112085
4	2	4	2	4	4	4	4
9112366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
4	4	4	4	2	9	4	4
911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
4	4	4	4	5	1	4	4

```
   911384   9113846    911391    911408    911654    911673    911685    911916
        4         4         4         4         4         4         4         1
   912193     91227    912519    912558    912600    913063    913102    913505
        4         4         4         4         4         7         4         1
   913512    913535  91376701  91376702    914062    914101    914102    914333
        4         4         4         4         2         4         4         4
   914366    914580    914769     91485    914862     91504     91505    915143
        1         4         2         1         4         1         4         2
   915186    915276  91544001  91544002    915452    915460     91550    915664
        7         7         4         4         4         1         4         4
   915691    915940  91594602    916221    916799    916838    917062    917080
        1         4         4         4         1         2         4         4
   917092  91762702     91789    917896    917897     91805  91813701  91813702
        4         2         4         4         4         4         1         4
   918192    918465     91858  91903901  91903902  91930402    919537    919555
        4         4         4         4         4         2         4         2
 91979701    919812    921092    921362    921385    921386    921644    922296
        4         1         4         7         4         1         4         4
   922297    922576    922577    922840    923169    923465    923748    923780
        4         4         4         4         4         4         4         4
   924084    924342    924632    924934    924964    925236    925277    925291
        4         4         4         4         4         4         4         4
   925292    925311    925622    926125    926424    926682    926954    927241
        4         4         1         5         2         2         4         5
    92751
        4
```

```
$`10`$table
        diagnosis
clusters   B    M
      1   12   86
      2    0   59
      3    0    3
      4  331   39
      5    0   20
      6    2    0
      7   12    0
      8    0    2
      9    0    2
     10    0    1
```

```
$`10`$accuracy
[1] 0.9103691
```

Q13. Which method gives your favorite results for the same data.dist dataset? Explain your reasoning.

ward.d2 method reduces cluster variance and allows for more clarity within clusters