# Class 8 PCA Mini Project

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It is important to consider scalling your data before analysis such as PCA. For example:

#### head(mtcars)

```
mpg cyl disp hp drat
                                          wt qsec vs am gear carb
Mazda RX4
                           160 110 3.90 2.620 16.46
                 21.0
                                                    0
Mazda RX4 Wag
                 21.0
                          160 110 3.90 2.875 17.02
                                                    0
Datsun 710
                 22.8
                        4 108 93 3.85 2.320 18.61
                                                                1
                 21.4
                           258 110 3.08 3.215 19.44 1 0
Hornet 4 Drive
                        6
                                                                1
                                                                2
                          360 175 3.15 3.440 17.02 0 0
                                                           3
Hornet Sportabout 18.7
                        8
Valiant
                 18.1
                           225 105 2.76 3.460 20.22 1 0
                                                           3
```

#### colMeans(mtcars)

```
mpg
                  cyl
                            disp
                                          hp
                                                   drat
                                                                 wt
                                                                           qsec
20.090625
            6.187500 230.721875 146.687500
                                               3.596563
                                                           3.217250 17.848750
                                        carb
       ٧s
                            gear
                   am
 0.437500
            0.406250
                        3.687500
                                    2.812500
```

#### apply(mtcars, 2, sd)

```
mpg
                   cyl
                              disp
                                             hp
                                                       drat
                                                                      wt
            1.7859216 123.9386938
6.0269481
                                    68.5628685
                                                  0.5346787
                                                               0.9784574
                                                       carb
     qsec
                   ٧s
                                           gear
                                am
1.7869432
            0.5040161
                         0.4989909
                                     0.7378041
                                                  1.6152000
```

# x <- scale(mtcars) head(x)</pre>

```
cyl
                                            disp
                       mpg
                                                         hp
                                                                 drat
                  0.1508848 -0.1049878 -0.57061982 -0.5350928 0.5675137
Mazda RX4
                  0.1508848 - 0.1049878 - 0.57061982 - 0.5350928 0.5675137
Mazda RX4 Wag
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
                 -0.3302874 -0.1049878 -0.04616698 -0.6080186 -1.5646078
Valiant
                                   qsec
                          wt
                                               ٧S
                                                          am
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
                 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
```

#### round(colMeans(x), 2)

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

#### **Breast Cancer Biopsy Analysis**

```
# 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)</pre>
```

## head(wisc.df)

	diagnosis radiu	s mean	texture mean	perimeter mea	n area mean	
842302	М	17.99	10.38	• –	<del>-</del>	
842517	М	20.57	17.77			
84300903	М	19.69	21.25			
84348301	М	11.42	20.38			
84358402	М	20.29	14.34			
843786	M	12.45	15.70			
0.101.00	smoothness_mean					
842302	0.11840	_	0.27760	0.3001	1	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 f	ractal			exture_se p	erimeter_se
842302	0.2419	_	0.078		0.9053	8.589
842517	0.1812		0.056	67 0.5435	0.7339	3.398
84300903	0.2069		0.059	99 0.7456	0.7869	4.585
84348301	0.2597		0.097	44 0.4956	1.1560	3.445
84358402	0.1809		0.058	83 0.7572	0.7813	5.438
843786	0.2087		0.076	13 0.3345	0.8902	2.217
	area_se smoothn	ess_se	compactness_	se concavity_s	e concave.p	oints_se
842302		006399	0.049	•	_	0.01587
842517	74.08 0.	005225	0.013	0.0186	0	0.01340
84300903	94.03 0.	006150	0.040	0.0383	2	0.02058
84348301	27.23 0.	009110	0.074	58 0.0566	1	0.01867
84358402	94.44 0.	011490	0.024	61 0.0568	8	0.01885
843786	27.19 0.	007510	0.033	45 0.0367	2	0.01137
	symmetry_se fra	ctal_di	imension_se r	adius_worst te	xture_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_v	worst smoothn	ess_worst comp	actness_wor	st
842302	184.60	20	019.0	0.1622	0.66	56
842517	158.80	19	956.0	0.1238	0.18	66
84300903	152.50	17	709.0	0.1444	0.42	45

```
84348301
                    98.87
                               567.7
                                                0.2098
                                                                   0.8663
84358402
                   152.20
                              1575.0
                                                0.1374
                                                                   0.2050
843786
                               741.6
                                                0.1791
                                                                   0.5249
                   103.40
         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)</pre>
```

```
diagnosis
B M
357 212
```

Remove this first 'diagnosis' column from the dataset as I don't want to pass this to PCA ect. It is esentially the expert "answer" that we will compare our analysis results to.

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

	radius_mean text	ure_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	concavit	ty_mean concave	.points_mea	n symmetry_mean
842302	0.27760		0.3001	0.1471	0.2419

040517	0.07064	0.0060	0	07017	0 1010
842517	0.07864	0.0869		07017	0.1812
84300903	0.15990	0.1974		12790	0.2069
84348301	0.28390 0.13280	0.2414 0.1980		10520	0.2597
84358402				10430	0.1809
843786	0.17000	0.1578		08089	0.2087
842302	ctal_dimension_me 0.078		-		153.40
842517	0.076			3.398	
84300903	0.059			4.585	
84348301	0.039			3.445	
84358402	0.058			5.445	
843786	0.076		0.8902	2.217	
	othness_se compac		-	_	
842302	0.006399	0.04904	0.05373	0.015	
842517	0.005225	0.01308	0.01860	0.013	
84300903	0.006150	0.04006	0.03832	0.020	
84348301	0.009110	0.07458	0.05661	0.018	
84358402	0.011490	0.02461	0.05688	0.018	
843786	0.007510	0.03345	0.03672	0.011	
•	metry_se fractal_				
842302	0.03003	0.006193		17.	
842517	0.01389	0.003532		23.4	
84300903	0.02250	0.004571	23.57	25.	
84348301	0.05963	0.009208		26.	
84358402	0.01756	0.005115	22.54	16.	
843786	0.02165	0.005082	15.47	23.	
	imeter_worst area				
842302		2019.0	0.1622		6656
842517		1956.0	0.1238		1866
84300903		1709.0	0.1444		4245
84348301	98.87	567.7	0.2098		8663
84358402		1575.0	0.1374		2050
843786	200.20	741.6	0.1791		5249
	cavity_worst conc	_			
842302	0.7119			0.4601	
842517	0.2416			2750	
84300903	0.4504			0.3613	
84348301	0.6869			0.6638	
84358402	0.4000			.2364	
843786	0.5355		1741 C	.3985	
	ctal_dimension_wo				
842302	0.11				
842517	0.08	902			

```
843009030.08758843483010.17300843584020.076788437860.12440
```

```
# Create diagnosis vector for later
diagnosis <- as.factor(wisc.df$diagnosis)</pre>
```

#### **Exploratory 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</pre>
```

[1] 569

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

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

[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

## **Principal Component Analysis**

# Check column means and standard deviations
colMeans(wisc.data)

radius_mean	texture_mean	perimeter_mean
1.412729e+01	1.928965e+01	9.196903e+01
area_mean	${\tt smoothness\_mean}$	compactness_mean
6.548891e+02	9.636028e-02	1.043410e-01
concavity_mean	concave.points_mean	symmetry_mean
8.879932e-02	4.891915e-02	1.811619e-01
fractal_dimension_mean	radius_se	texture_se
6.279761e-02	4.051721e-01	1.216853e+00
perimeter_se	area_se	${\tt smoothness\_se}$
2.866059e+00	4.033708e+01	7.040979e-03
compactness_se	concavity_se	concave.points_se
2.547814e-02	3.189372e-02	1.179614e-02
symmetry_se	fractal_dimension_se	radius_worst
2.054230e-02	3.794904e-03	1.626919e+01
texture_worst	perimeter_worst	area_worst
2.567722e+01	1.072612e+02	8.805831e+02
${\tt smoothness\_worst}$	${\tt compactness\_worst}$	concavity_worst
1.323686e-01	2.542650e-01	2.721885e-01
concave.points_worst	symmetry_worst	${\tt fractal\_dimension\_worst}$
1.146062e-01	2.900756e-01	8.394582e-02

apply(wisc.data, 2, sd)

perimeter_mean	texture_mean	radius_mean
2.429898e+01	4.301036e+00	3.524049e+00
${\tt compactness\_mean}$	${\tt smoothness\_mean}$	area_mean
5.281276e-02	1.406413e-02	3.519141e+02
${\tt symmetry\_mean}$	concave.points_mean	concavity_mean
2.741428e-02	3.880284e-02	7.971981e-02
texture_se	radius_se	fractal_dimension_mean
5.516484e-01	2.773127e-01	7.060363e-03
smoothness_se	area_se	perimeter_se
3.002518e-03	4.549101e+01	2.021855e+00
concave.points_se	concavity_se	compactness_se
6.170285e-03	3.018606e-02	1.790818e-02
radius_worst	fractal_dimension_se	symmetry_se
4.833242e+00	2.646071e-03	8.266372e-03
area_worst	perimeter_worst	texture_worst
5.693570e+02	3.360254e+01	6.146258e+00
${\tt concavity\_worst}$	${\tt compactness\_worst}$	smoothness_worst
2.086243e-01	1.573365e-01	2.283243e-02
${\tt fractal\_dimension\_worst}$	symmetry_worst	concave.points_worst
1.806127e-02	6.186747e-02	6.573234e-02

wisc.pr <- prcomp(wisc.data, scale = T)
summary(wisc.pr)</pre>

#### 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
                       0.30681 0.28260 0.24372 0.22939 0.22244 0.17652 0.1731
Standard deviation
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

See what is in our PCA result object:

#### attributes(wisc.pr)

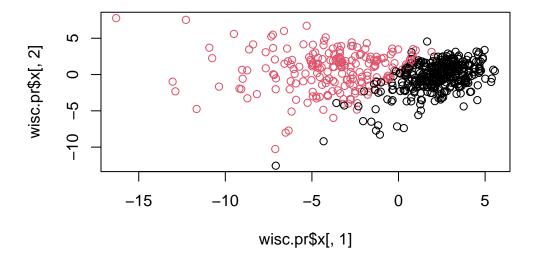
```
$names
[1] "sdev" "rotation" "center" "scale" "x"
$class
[1] "prcomp"
```

#### 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
        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
        -0.94269981 -0.652900844 -0.008966977 -0.64823831 -0.01719707
842517
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
        0.19671335
               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
        -0.29727706 -0.1297265 -0.07117453 -0.002400178
843786
                                                       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
        842517
         0.0325955021 -0.005682424
                                  0.0018662342
84300903 0.0469844833 0.003143131 -0.0007498749
         0.0424469831 -0.069233868 0.0199198881
84348301
84358402 -0.0347556386 0.005033481 -0.0211951203
843786
         0.0007296587 -0.019703996 -0.0034564331
```

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



```
#plot(wisc.pr$x)
```

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</pre>
```

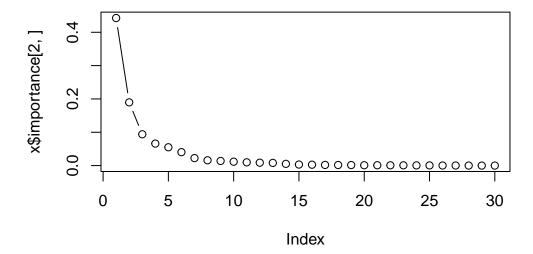
#### [1] 0.4427203

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

#### [1] 3

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

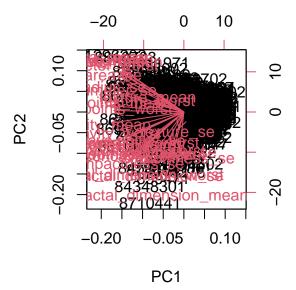
```
x <- summary(wisc.pr)
plot(x$importance[2,], typ="b")</pre>
```



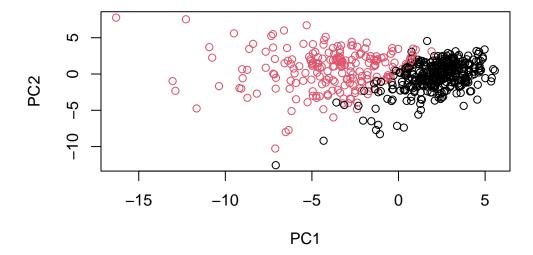
Q7. What stands out to you about this plot? Is it easy or difficult to understand? Why?

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

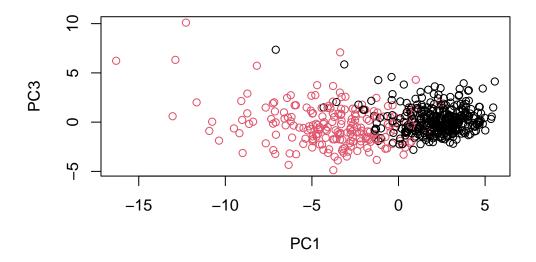
# Create a biplot
biplot(pca_result)</pre>
```



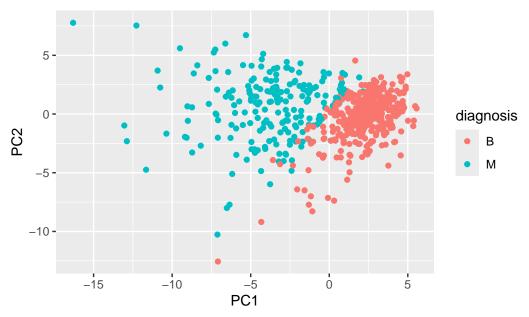
# Something that stands out are the overlapping in plot. It is hard to # understand because there is no visible relationship in the plot.



Q8. Generate a similar plot for principal components 1 and 3. What do you notice about these plots?



## PCA Scatter Plot of PC1 vs PC2

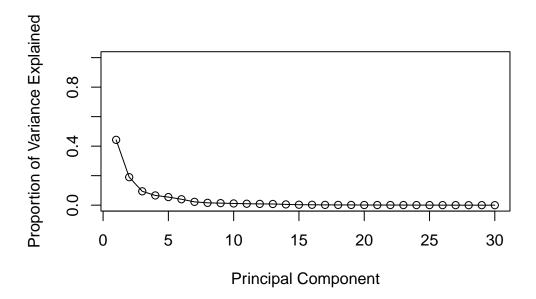


```
# Calculate variance of each component
pr.var <- wisc.pr$sdev^2
head(pr.var)</pre>
```

#### [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")</pre>
```



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</pre>
```

#### [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**

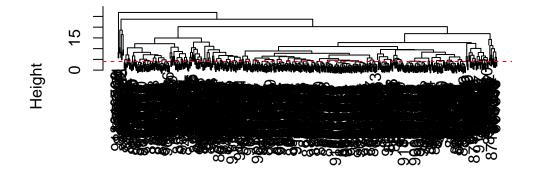
```
# Scale the wisc.data data using the "scale()" function
data.scaled <- scale(wisc.data)

data.dist <- dist(data.scaled)

wisc.hclust <- hclust(data.dist, method = "complete")</pre>
```

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

## **Dendrogram of Hierarchical Clustering**



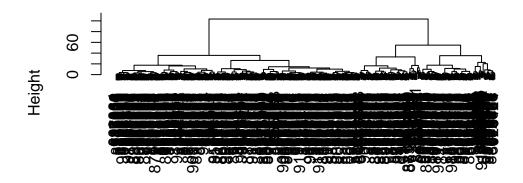
Observations hclust (\*, "complete")

#### **Combine PCA and clustering**

Our PCA results were in 'wisc.pr'

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

## **Cluster Dendrogram**

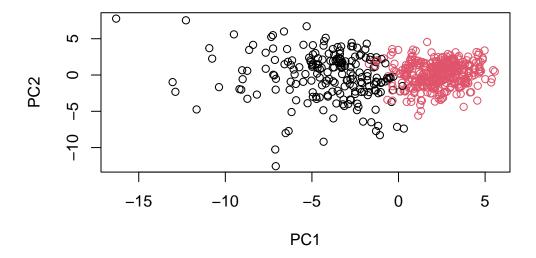


d hclust (\*, "ward.D2")

Cut tree into two groups/branches/clusters...

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

```
plot(wisc.pr$x, col=grps)
```



 $\label{lem:wisc.hclust.clusters} $$ \leftarrow $ \operatorname{cutree}(wisc.hclust, k=4) $$ table(wisc.hclust.clusters, diagnosis) $$$ 

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

Compare my clustering result (my 'grps') to to expert 'diagnosis':

## table(diagnosis)

diagnosis

B M

357 212

## table(grps)

```
grps
1 2
203 366
```

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

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

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</pre>
```

## \$`2`

\$`2`\$clusters 

055005	055500	055040	050455	050050	050004	050000	050400
857637		857810					
1	1			1			1
85922302	859283				859487		
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
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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		8712291	87127	8712729
1	1			1			
8712766	8712853			87164		<del>-</del>	872113
1	1		1	1			
872608	_	873357	_		873593	_	_
1	1		1	1			
873885	874158	874217		874662		874858	875093
1	1			1			1
		87556202					
1	1						1
_		878796					
1		1					
		881046502					
1		1					1
_		8811842					
0012100	1		1			1	
8813129	88143502	88147101	8814/102	88147202	881861	881972	88199202

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88649001	886776	887181	88725602	887549	888264	888570	889403
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8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
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89382602		894047	894089	894090		894329	894335
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8953902	895633				897137		89742801
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897604	897630	897880	89812	89813			898431
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89864002	898677		89869				899667
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899987		901011					901034301
1	-	_	-	_	1	-	-
							9011495
1							1
							901303
							1
							90251
1							1
							903483
1	1				1		
							904357
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911150	911157302	9111596	9111805	9111843	911201	911202	9112085
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912193	91227	912519	912558	912600	913063	913102	913505
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924084	924342	924632	924934	924964	925236	925277	925291
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925292	925311	925622	926125	926424	926682	926954	927241
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92751							

1

\$`2`\$table

diagnosis

clusters B M

1 357 210

2 0 2

\$`2`\$accuracy

[1] 0.6309315

\$`3`

\$`3`\$clusters

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857155	857156	857343	857373	857374	857392	857438	85759902
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857637	857793	857810	858477	858970	858981	858986	859196
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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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8712766		87139402					872113
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872608		873357					
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873885		874217					
1	1	_	_	1	_	_	_
875099		87556202					
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		911201				911157302	911150
		1					1
		911296202				9112367	9112366

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912193	91227	912519	912558	912600	913063	913102	913505
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913512	913535	91376701	91376702	914062	914101	914102	914333
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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
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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

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1	3	1	1	3	3	3	3
8913049	89143601	89143602	8915	891670	891703	891716	891923
3	3	3	3	3	3	3	3
891936	892189	892214	892399	892438	892604	89263202	892657
3	3	3	3	1	3	1	3
89296	893061	89344	89346	893526	893548	893783	89382601
3	3	3	3	3	3	3	3
89382602	893988	894047	894089	894090	894326	894329	894335
3		3					
894604	894618	894855	895100	89511501	89511502	89524	895299
3	3	3	1	3	3	3	3
8953902	895633	896839	896864	897132	897137	897374	89742801
1	1				3		1
897604	897630	897880	89812	89813	898143	89827	898431
3	1	3	1	3	3	3	1

89864002	898677	898678	89869	898690	899147	899187	899667
3	3	3	3	3	3	3	1
899987	9010018	901011	9010258	9010259	901028	9010333	901034301
1	1	3	3	3	3	3	3
901034302	901041	9010598	9010872	9010877	901088	9011494	9011495
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9011971	9012000	9012315	9012568	9012795	901288	9013005	901303
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901315	9013579	9013594	9013838	901549	901836	90250	90251
3	3	3	1	3	3	3	3
902727	90291	902975	902976	903011	90312	90317302	903483
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
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90524101	905501	905502	905520	905539	905557	905680	905686
1	3	3	3	3	3	3	3
905978	90602302	906024	906290	906539	906564	906616	906878
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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			911202	9112085
3	1	3	1	3	3	3	3
9112366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
3	3	3	3	1	4	3	3
911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
3	3	3	3	_		3	
911384	9113846	911391	911408	911654	911673	911685	911916
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912193	91227	912519			913063	913102	913505
3		3	3	3	3	3	1
913512	913535	91376701	91376702	914062	914101	914102	914333
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914366	914580						
1				3			
	915276						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
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92751							
3							

## **\$`4`\$**table

diagnosis

clusters B M
1 12 165
2 2 5
3 343 40
4 0 2

## \$`4`\$accuracy

[1] 0.9050967

#### \$`5`

### \$`5`\$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
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			8610862	8610908
1	1	_		3			_
861103	8611161	8611555					
3	1					_	
		861648					
3	1		3	3		1	
86211		862485					
3	3	_	3	_			_
862989	863030		863270				
3	1			1			_
86409		864496					
3	3			3			_
		865423 2					
3	1						_
866458		866714					
1	1	_			_		_
868223	868682 3		868871				
3	_	1 869691					-
869254 3	3						3
ى 8710441			8711003				
6710441	3						
8711561		871201				87127	
3	0711003						
_	_	87139402	-	_	_		
1	3			1			
_	_	873357		_	_		_
3	1		3		1	1	3
		874217					
1	3						
		87556202					
3		1					1
		878796					
3	3	1	1	3	3	3	3
	8810436	881046502					8810987
1			3				1
8811523		8811842				8812844	8812877
3	3			3			

0012100	001/2500	88147101	001/7100	001/7000	001061	001070	00100000
3	3	3	3				
88203002		882488					88330202
							00330202
3	1	883852					884626
	3						
3				1			
88466802		884948					
3	3	_		1			3
		887181					
1	1		1			1	
889719		8910251					
1		3					
8910988		8911163					
1	3			3			3
8912049		89122					
1	3	1			3	3	_
8913049		89143602					
3		3	3		3	_	3
891936		892214					
3	3			1			
89296	893061	89344	89346	893526	893548	893783	89382601
3	3	3	3	3	3	3	3
89382602	893988	894047	894089	894090	894326	894329	894335
3	3	3	3	3	1	3	3
894604	894618	894855	895100	89511501	89511502	89524	895299
3	3	3	1	3	3	3	3
8953902	895633	896839	896864	897132	897137	897374	89742801
1	1	1	1	3	3	3	1
897604	897630	897880	89812	89813	898143	89827	898431
3	1	3	1	3	3	3	1
89864002	898677	898678	89869	898690	899147	899187	899667
3	3	3	3	3	3	3	1
899987	9010018	901011	9010258	9010259	901028	9010333	901034301
1	1	3	3	3	3	3	
901034302	901041		9010872	9010877		9011494	9011495
3	3	3					
							901303
1	1			1			
901315		9013594					
3	3	3					
							903483
302727		302313					300403
							904357
203301	203310	200004	203011	20-01001	20-01002	JU <del>1</del> JUZ	JU <del>1</del> 331

1	1	3	2	3	3	3	3
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_	905501						
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_	90602302						
300370		300024					
_	907367						
307143		307403					
	908445						
1					303220		
_	909445						
303411		30344001			3110720		
_	911157302						
311130					311201		
9112366	_				911296202		
		3112594			5		
3 911320502					911366		3 9113816
					911300		
3							
911384				911654			911916
3	_	3					1
	91227						
3		3					
	913535						
3	_	3			3		_
	914580						
1	_						
915186					915460		
3	_						3
	915940						
1		3			1		
917092	91762702						
3					3		3
	918465						
3		3					
	919812						
3				3		3	
	922576						
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	924342						
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	925311						
3	3	1	1	1	1	3	1

92751 3

## **\$`5`\$table**

diagnosis
clusters B M
1 12 165
2 0 5
3 343 40
4 2 0
5 0 2

\$`5`\$accuracy
[1] 0.9086116

\$`6`

\$`6`\$clusters

842302	842517	84300903	84348301	84358402	843786	844359	84458202
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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
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

3	3	3	3	3	3	3	3
862989	863030	863031		86355			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
3	1	2	3	3	3	1	3
866458	866674	866714	8670	86730502	867387	867739	868202
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868223	868682	868826	868871			869218	
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869254	869476	869691	86973701	86973702	869931	871001501	871001502
3	3	1	3	3	3	3	5
8710441	87106	8711002	8711003	8711202	8711216	871122	871149
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8711561	8711803	871201	8712064	8712289	8712291	87127	8712729
3	1		3				3
8712766	8712853	87139402					872113
1	3	3	3	1	3	3	3
872608	87281702	873357	873586	873592	873593	873701	873843
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873885	874158	874217				874858	875093
1	3						
875099	875263	87556202	875878	875938	877159	877486	877500
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877501		878796					
3	3		_				
8810158	8810436	881046502					
1	3						
8811523		8811842					
3	3			3			
8813129		88147101					
3	· ·	3	•	•	_	_	•
		882488					
	1		3				1
		883852					
	3						3
		884948					
	3						3
		887181					
1	1		1				3
		8910251					
1	1	3	3	3	3	3	3

8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
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8912049	8912055	89122			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
3	3	3	3	3	3	3	3
89382602	893988	894047	894089	894090	894326	894329	894335
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894604	894618	894855	895100	89511501	89511502	89524	895299
3	3	3	1	3	3	3	3
8953902	895633	896839	896864	897132	897137	897374	89742801
1	1	1	1	3	3	3	1
897604	897630	897880	89812	89813	898143	89827	898431
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89864002	898677	898678	89869	898690	899147	899187	899667
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899987	9010018	901011	9010258	9010259	901028	9010333	901034301
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901315	9013579	9013594		901549			
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902727		902975				90317302	903483
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		903554					
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90439701	904647		9047		904971	905189	
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		906024					906878
3	1		3		1		
_		907409					
3	3	3	3		3	1	
		908469					
1			1				
							9110944
303411	503445	30344001	303111	2110121	2110120	3110132	2110344

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911150	911157302	9111596			911201	911202	9112085
3	1		1				3
9112366	9112367		9112712	911296201	911296202	9113156	911320501
3	3	3	3	1	6	3	3
911320502	9113239	9113455	9113514	9113538	911366	9113778	9113816
3	3	3	3	1	1	3	3
911384	9113846	911391	911408	911654	911673	911685	911916
3	3	3	3	3	3	3	1
912193	91227	912519	912558	912600	913063	913102	913505
3	3	3	3	3	5	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	•	1	1	•	_		_
915186	915276		91544002		915460	91550	915664
5	_	3	3				
915691	915940	91594602			916838	917062	917080
1	3	3	3				_
917092	91762702		917896	917897	91805		
3	1	3	3	3	3	1	3
918192					91930402	919537	919555
3		3	3			_	_
91979701	919812	921092			921386	921644	922296
3	_	3	5			_	_
922297					923465		
3	3	3	3	_		3	_
924084		924632					
3	_	3	3			3	_
925292					926682		
3	3	1	1	1	1	3	1
92751							
3							

# **\$`6`\$**table

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

ф		-	
æ	-	7	-

							Ψί
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84458202	844359	843786	84358402	84348301	84300903	842517	842302
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851509	8511133	8510824	8510653	8510426	849014	84862001	848406
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853612			852973	852781	852763	852631	852552
_		-	_	_	_	_	1
855138			854268	854253	854039	854002	85382601
_					_	_	1
85715	85713702	857010	85638502	856106	855625	855563	855167
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85759902	857438		857374		857343	857156	857155
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859196	858986		858970		857810	857793	857637
•	_					_	1
859711			859471			859283	85922302
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8610908	8610862			8610404	8610175	859983	859717
_	-			_	_	_	1
86135502	86135501				8611555	8611161	861103
_						1	3
86208			861853			861598	861597
_					•	1	3
862980			862717		862485		86211
-	_					3	3
86408			86355		863031		862989
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			864726		864496		86409
•		_	_	-		3	5
			865468		865423		
_				_		1	3
			86730502				866458
-		3	_	_	3	1	1
			868999				
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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
3	1	1	3	1	3	3	3
8712766	8712853	87139402	87163	87164	871641	871642	872113
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872608	87281702	873357	873586	873592	873593	873701	873843
5	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
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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			884448	884626
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88466802	884689		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		8911834
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8912049	8912055	89122	8912280				
	3		1		3		
8913049		89143602					
3		5					
		892214	892399				
3	3				3		
		89344					
3					3		
89382602	893988	894047	894089	894090	894326	894329	894335

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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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89864002	898677	898678	89869	898690	899147	899187	899667
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9011971	9012000	9012315	9012568		901288	9013005	901303
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5	3	3		3			
902727					90312		
3		3	3				
903507	903516	903554	903811	90401601	90401602		
1	_	3					_
90439701					904971		
1	_	3	3			3	
90524101	905501	905502		905539			
1	_	3		3		3	_
905978	90602302	906024			906564		
3	_	3	3				_
907145	907367	907409			90769602		
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908194	000110				909220		
1	1	3	1	_		3	
909411					9110720		
3	•	•	•	•	3	_	•
	911157302						
3					3		
	9112367						
	3						
	9113239						
3					1		
	9113846						
	3						
	91227						
3	3	3	3	3	5	3	1

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914366	914580	914769	91485	914862	91504	91505	915143
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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
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918192	918465	91858	91903901	91903902	91930402	919537	919555
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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
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92751							
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#### **\$**`7`\$table

diagnosis

## \$`7`\$accuracy

[1] 0.9086116

#### \$`8`

\$`8`\$clusters

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 84358402
 843786
 844359
 84458202

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 2
 3
 2
 1
 1
 1
 1

 844981
 84501001
 845636
 84610002
 846226
 846381
 84667401
 84799002

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85382601	854002			854268			855138
1	1	1					_
855167	855563						85715
4	1			1			1
857155			857373				
4	4	4					
			858477				
2	1			4			4
85922302			859465				
1	1	4					
859717	859983					8610862	
1	1		4				4
861103		8611555					86135502
4	1						
861597	861598						86208
4	1				4		
86211	862261		862548				
4	4	4					
862989		863031		86355			86408
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865137			865432				866203
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866458			8670				
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			868871				869224
							4
							871001502
4	4						
							871149
5							4
							8712729
4	2			2			4
							872113
	4		4				4
							873843
6	1	4	4	2	2	1	4

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		874217					
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875099		87556202					
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1	4	_			6		_
8811523	8811779	8811842	88119002	8812816	8812818	8812844	8812877
4	4		2				
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88350402	883539	883852	88411702	884180	884437	884448	884626
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88649001	886776	887181	88725602	887549	888264	888570	889403
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889719	88995002	8910251	8910499	8910506	8910720	8910721	8910748
1	2	4	4	4	4		
8910988	8910996	8911163	8911164	8911230	8911670	8911800	8911834
2	4		4	4			4
8912049	8912055	89122		8912284			8913
1	4		1				
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891936	892189				892604		=
4	4		4	2		2	
89296	=	89344			893548		
4	4			4	4		4
89382602	893988	_	894089	894090	894326		
4	4		4		1		4
		894855					
9053003		896839	206964				
1	1	897880			4		
4	2				4		
		898678					
4					4		
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9011971	9012000	9012315	9012568	9012795	901288	9013005	901303
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901315	9013579	9013594	9013838	901549	901836	90250	90251
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902727	90291	902975	902976	903011	90312	90317302	903483
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903507	903516	903554	903811	90401601	90401602	904302	904357
1	1	4	4	4	4	4	4
90439701			9047	904969	904971	905189	905190
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90524101	905501	905502			905557	905680	905686
1	4	4	4	4	4	4	4
905978	90602302				906564		
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907145	907367				90769602		
4	4	4	4	4	4	1	4
908194					909220		
2					4		
					9110720	9110732	
4		4					
911150					911201		
4					4		
9112366					911296202		
4	_				8		4
911320502					911366		
4					1		
911384					911673		
4	_	4	4		_		_
					913063		
					6		
					914101		
4							4
					91504		
1					1		
					915460		
6		4					4
					916838		
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					91805		
4	2	4	4	4	4	1	4

918192	918465	91858	91903901	91903902	91930402	919537	919555
4	4	4	4	4	2	4	2
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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	2	2	2	4	2
92751							
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**\$`8`\$table** 

\$`8`\$accuracy
[1] 0.9086116

8

\$`9`

\$`9`\$clusters

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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         857368         857343         857373         857374         857392         857438         85759902         4         5         4         2         6         859711         1         1         4         4         5         5         4         2         6         859717         859983         8610175         8610404         8610629         8610637         8610862         8610908         1         1         1         4         4         4         2         7         4         4         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4	055455	055450	055040	05555	055054	057000	055400	05550000
857637         857793         857810         858477         858970         858981         858986         859196           2         1         4         4         4         4         1         4           8592302         859283         859464         859465         859471         859487         859575         859711           1         1         4         4         4         5         5         4         2         6           859717         859983         8610175         8610404         8610629         8610637         8610862         8610908           1         1         4         4         4         2         7         4           861131         8611568         8611799         8612080         8612399         862028         86208           4         1         4         4         4         4         1         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         2         2         4         4         4         4         4         4         4								
2         1         4         4         4         4         1         4           8592302         859283         859464         859465         859471         859487         859575         859711           1         1         959983         8610175         8610404         8610629         8610637         8610862         8610908           1         1         1         4         4         4         2         7         4           861103         8611611         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	_	_			_			
85922302         859283         859464         859465         859471         859487         859575         859711           1         1         4         4         5         4         2         6           859717         859983         8610175         8610404         8610629         86163637         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 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
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           86211         86261         862485         862548         862717         862722         862965         862980           4         1         1         4         4         4         4         4         4         4           862989         863030         863031         863270         86355         864018         864033         86603           86403         864685         864626	_							-
859717         859983         8610175         8610404         8610629         8610637         8610862         8610908           1         1         4         4         4         2         7         4           8611033         8611161         86115555         8611792         8612080         8612399         86135501         8613502           4         1         2         2         4         2         4         2           861597         861598         861648         861799         861853         862009         862028         86208           4         1         4         4         4         4         1         2           86211         862261         862485         862717         862722         862965         862980           4	85922302	859283	859464					
1         1         4         4         4         2         7         4           861103         8611161         8611555         8611792         8612080         8612399         86135501         8613502           4         1         2         2         4         2         4         2           861577         861598         861648         861799         861853         862009         862028         86208           4         1         4 <t< td=""><td>1</td><td>1</td><td>4</td><td>4</td><td></td><td></td><td></td><td>_</td></t<>	1	1	4	4				_
861103         8611161         8611555         8611792         8612080         8612399         86135501         8613502           4         1         2         2         4         2         4         2           861597         861598         861648         861799         861853         862009         862028         862028           4         1         4         4         4         4         4         4         4         4           86211         862261         862485         862548         862717         862722         862965         862980           4	859717	859983	8610175	8610404	8610629	8610637	8610862	8610908
4         1         2         2         4         2         4         2           861597         861598         861648         861799         861853         862009         862028         86208           4         1         4         4         4         4         1         2           86211         862261         862485         862717         862722         862965         862980           4         4         4         4         4         4         4         4         4           862989         863030         863031         863270         86355         864018         864033         86408           4         1         1         4         2         4         4         4           86409         864292         864496         864685         864726         864729         864877         865128           6         4         4         4         4         1         1         4           865137         86517         865423         865468         86561         86603         866202           4         2         7         4         4         4         1         4	1	1	4	4	4	2	7	4
861597         861598         861648         861799         861853         862009         862028         86208           4         1         4         4         4         4         1         2           86211         862261         862485         862548         862717         862722         862965         862980           4         4         4         4         4         4         4         4         4           862989         863030         863031         863270         86355         864018         864033         86403           4         1         1         4         2         4         4         4           86409         864292         864496         864685         864726         864729         864877         865128           6         4         4         4         4         1         1         4         4           865137         865173         865423         865468         86561         86603         866202           4         2         7         4         4         4         1         4           866223         868622         868871         8673052         867387 <td>861103</td> <td>8611161</td> <td>8611555</td> <td>8611792</td> <td>8612080</td> <td>8612399</td> <td>86135501</td> <td>86135502</td>	861103	8611161	8611555	8611792	8612080	8612399	86135501	86135502
4         1         4	4	1	2	2	4	2	4	2
86211         862261         862485         862548         862717         862722         862965         862980           4	861597	861598	861648	861799	861853	862009	862028	86208
4         4	4	1	4	4	4	4	1	2
862989         863030         863031         863270         86355         864018         864033         86408           4         1         1         4         2         4         4         4           86409         864292         864496         864855         864726         864729         864877         865128           6         4         4         4         4         1         1         4           865137         86517         865423         865468         86561         866083         866203           4         2         7         4         4         4         1         4           866458         866674         866714         8670         86730502         867387         86739         868202           1         1         4         1         1         4	86211	862261	862485	862548	862717	862722	862965	862980
4         1         1         4         2         4         4         4         4         4         86409         864292         864496         864685         864726         864729         864877         865128         865128         6         4         4         4         4         1         1         4         4         865137         86517         865423         865432         865468         86561         866083         866203         4         2         7         4         4         4         1         4         4         866203         86730502         867337         867739         868202         868202         1         1         4         4         1         4         4         1         4         4         1         4         4         868202         868202         86871         868999         869104         869218         869224         869224         4	4	4	4	4	4	4	4	4
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         1         4           868223         868682         868826         868871         868999         869104         869218         869224         4 <td>862989</td> <td>863030</td> <td>863031</td> <td>863270</td> <td>86355</td> <td>864018</td> <td>864033</td> <td>86408</td>	862989	863030	863031	863270	86355	864018	864033	86408
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         4         1         4         1         4           868223         868682         868826         868871         868999         869104         869218         869224           4         4         1         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         4         6         869224         6         871101501         8711002         87110	4	1	1	4	2	4	4	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         4         4         4         4         4         4         4         4         4         4         4         4         4         6         89101050         871001501         871001502         86931         871001501         871001502         86931         871001501         871001502         86931         871001501         871001502         8711001502         8711002         8711003         8711202         8711202         8711202         8711203         8711202         8711202         8711202         8711202         8711202         8711202	86409	864292	864496	864685	864726	864729	864877	865128
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         4         4         4         4         4         4           869254         869476         869691         86973701         86973702         869931         871001501         871001502           4         4         4         4         4         4         4         6           8710441         87106         8711002         8711003         8711202         8711216         871122         871149         6           8711561         8711803         871201         8712064         8712289         8712291         871277         8712729           4         2         1         4         2         4         4         4           8712766         8712853         87139402 <t< td=""><td>6</td><td>4</td><td>4</td><td>4</td><td>4</td><td>1</td><td>1</td><td>4</td></t<>	6	4	4	4	4	1	1	4
866458         866674         866714         8670         86730502         867387         86739         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         4         6           8710441         87106         8711002         8711003         8711202         8711216         871122         871149           5         4         4         4         2         4         4         4           8711561         8711803         871201         871204         8712289         8712291         871272         8712729           4         2         1         4         2         4         4         4           8712766         8712833         87139402	865137	86517	865423	865432	865468	86561	866083	866203
1         1         4         1         1         4         1         4         4         869224         868826         868871         868999         869104         869218         869224         6         871001501         871001502         8710102         869931         871001501         871001502         4         4         4         4         4         4         6         6         8710441         871060         8711002         8711202         8711216         8711222         871149         5         4         4         4         2         4 <td>4</td> <td>2</td> <td>7</td> <td>4</td> <td>4</td> <td>4</td> <td>1</td> <td>4</td>	4	2	7	4	4	4	1	4
868223         8688682         868826         868871         868999         869104         869218         869224           4         4         4         4         4         4         4           869254         869476         869691         86973701         869931         871001501         871001502           4         4         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 <td>866458</td> <td>866674</td> <td>866714</td> <td>8670</td> <td>86730502</td> <td>867387</td> <td>867739</td> <td>868202</td>	866458	866674	866714	8670	86730502	867387	867739	868202
4         6         6         6         6         6         710441         87106         8711002         8711003         8711202         8711216         871122         871149         6         6         6         6         6         710441         87106         8711002         8711202         8711216         871122         871149         6         6         71149         6         6         71149         6         6         71149         6         6         71149         6         6         71149         6         6         71149         6         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         6         71149         71149         71149         71149         71149         71149         71149         71149         71149         71149	1	1	4	1	1	4	1	4
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5         4         4         2         4         4         4           8711561         8711803         871201         8712064         8712289         8712291         87127         8712729           4         2         4         4         4         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         3         4           875099         875263         87556202         875878         875938         877159         877486         877500           4         1         1         4         1         4         2         1	4	4	1	4	4	4	4	6
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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       4       4       4       4       4       4         8810158       8810436       881046502       8810528       8810703       881094802       8810955       8810955         1       4       2       4 </td <td>8711561</td> <td>8711803</td> <td>871201</td> <td>8712064</td> <td>8712289</td> <td>8712291</td> <td>87127</td> <td>8712729</td>	8711561	8711803	871201	8712064	8712289	8712291	87127	8712729
2       4       4       4       1       4       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       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         1       4       2       4       8       9       1       1       1	4	2	1	4	2	4	4	4
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6         1         4         4         2         2         1         4           873885         874158         874217         874373         874662         874839         874858         875093           1         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           1         4         2         4         8         9         1         1         1	2	4	4	4	1	4	4	4
873885       874158       874217       874373       874662       874839       874858       875093         1       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         1       4       2       4       8       9       1       1       1	872608	87281702	873357	873586	873592	873593	873701	873843
1       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       4         8810158       8810436       881046502       8810528       8810703       881094802       8810955       8810987         1       4       2       4       8       9       1       1	6	1	4	4	2	2	1	4
1       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       4         8810158       8810436       881046502       8810528       8810703       881094802       8810955       8810987         1       4       2       4       8       9       1       1	873885	874158	874217	874373	874662	874839	874858	875093
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877501     877989     878796     87880     87930     879523     879804     879830       4     4     2     1     4     4     4     4     4       8810158     8810436     881046502     8810528     8810703     881094802     8810955     8810987       1     4     2     4     8     9     1     1	875099	875263	87556202	875878	875938	877159	877486	877500
4       4       2       1       4       4       4       4       4         8810158       8810436       881046502       8810528       8810703       881094802       8810955       8810987         1       4       2       4       8       9       1       1	4	1	1	4	1	4	2	1
4       4       2       1       4       4       4       4       4         8810158       8810436       881046502       8810528       8810703       881094802       8810955       8810987         1       4       2       4       8       9       1       1	877501	877989	878796	87880	87930	879523	879804	879830
8810158     8810436     881046502     8810528     8810703     881094802     8810955     8810987       1     4     2     4     8     9     1     1								
1 4 2 4 8 9 1 1	8810158	8810436	881046502					
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8811523 8811779 8811842 88119002 8812816 8812818 8812844 8812877	8811523	8811779						

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88350402	883539	883852	88411702	884180	884437	884448	884626
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4			4				
894604			895100				
4	4	4					
8953902			896864				
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	897630						
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							899667
-	-	-	-	-	-	-	1
							901034301
2							4
901034302							
4							4
	9012000						901303
2			4				4
							90251
6		4			4		
							903483
4	4	4	4	4	2	4	4

90	3507						904302	904357
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	4	2	4	4	4	1	4	4
90	7145					90769602		
	4	_	4		4			4
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90	9411	909445	90944601	909777	9110127	9110720	9110732	9110944
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91	1150	911157302	9111596	9111805	9111843	911201	911202	9112085
	4	_			4			
911	2366	9112367	9112594	9112712	911296201	911296202	9113156	911320501
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91132	0502	9113239	9113455	9113514	9113538	911366	9113778	9113816
	4	4	4	4	2	1	4	4
91	1384	9113846	911391	911408	911654	911673	911685	911916
	4	4	4	4	4	4	4	1
91	2193	91227	912519	912558	912600	913063	913102	913505
	4	4	4	4	4	6	4	1
91	3512	913535	91376701	91376702	914062	914101	914102	914333
	4	4	4	4	2	4	4	4
91	4366	914580	914769	91485	914862	91504	91505	915143
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91	5186	915276	91544001	91544002	915452	915460	91550	915664
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91	5691	915940	91594602	916221	916799	916838	917062	917080
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91	7092	91762702	91789	917896	917897	91805	91813701	91813702
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91	8192	918465	91858	91903901	91903902	91930402	919537	919555
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9197	9701	919812	921092	921362	921385	921386	921644	922296
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92	2297	922576	922577	922840	923169	923465	923748	923780
	4						4	4
92	4084	924342	924632	924934	924964	925236	925277	925291
	4	4	4	4	4	4	4	4
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4 4 1 2 2 2 4 2 92751 4

### **\$`9`\$table**

\$`9`\$accuracy
[1] 0.9103691

### \$`10`

\$`10`\$clusters

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85382601	854002	854039	854253	854268	854941	855133	855138
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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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85922302	859283	859464	859465	859471	859487	859575	859711
1	1	4	4	6	4	2	7
859717	859983	8610175	8610404	8610629	8610637	8610862	8610908
1	1	4	4	4	5	8	4

861103	8611161	8611555	8611792	8612080	8612399	86135501	86135502
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861597	861598	861648	861799	861853	862009	862028	86208
4	1	4	4	4	4	1	2
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
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8710441	87106	8711002	8711003			871122	871149
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872608	87281702	873357	873586	873592	873593	873701	873843
7	1	4	4	2	5	1	4
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925292					926682		
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92751							
4							

\$`10`\$table

diagnosis clusters B M

1 12 86

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

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

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