

Class 8: Breast Cancer Mini Project

AUTHOR

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Before we get stuck into project work we will have a quick look at applying PCA to some example RNA Seq data (tail end of lab &)

Read the document

```
url2 <- "https://tinyurl.com/expression-CSV"
rna.data <- read.csv(url2, row.names=1)
head(rna.data)
```

	wt1	wt2	wt3	wt4	wt5	ko1	ko2	ko3	ko4	ko5
gene1	439	458	408	429	420	90	88	86	90	93
gene2	219	200	204	210	187	427	423	434	433	426
gene3	1006	989	1030	1017	973	252	237	238	226	210
gene4	783	792	829	856	760	849	856	835	885	894
gene5	181	249	204	244	225	277	305	272	270	279
gene6	460	502	491	491	493	612	594	577	618	638

Q1. How many genes are in this data set? `nrow(rna.data)`

```
nrow(rna.data)
```

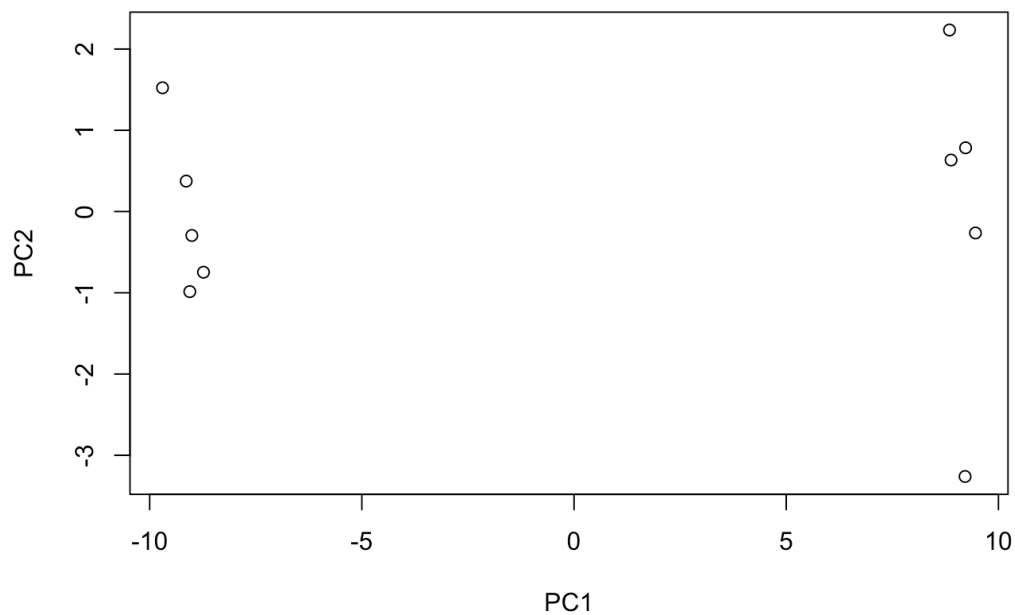
```
[1] 100
```

generating barplot etc. to make sense of this data is really not an exciting or worthwhile option to consider. So lets do PCA and plot the results:

##Run PCA

```
# Again we have to take the transpose of our data
pca <- prcomp(t(rna.data), scale = TRUE)

##Simple un polished plot of pc1 and pc2
plot(pca$x[,1], pca$x[,2], xlab="PC1", ylab="PC2")
```



take summary

```
summary(pca)
```

Importance of components:

	PC1	PC2	PC3	PC4	PC5
PC6					
PC7					
Standard deviation	9.6237	1.5198	1.05787	1.05203	0.88062
	0.82545	0.80111			
Proportion of Variance	0.9262	0.0231	0.01119	0.01107	0.00775
	0.00681	0.00642			
Cumulative Proportion	0.9262	0.9493	0.96045	0.97152	0.97928
	0.98609	0.99251			
		PC8	PC9	PC10	
Standard deviation		0.62065	0.60342	3.345e-15	
Proportion of Variance		0.00385	0.00364	0.000e+00	
Cumulative Proportion		0.99636	1.00000	1.000e+00	

A quick barplot summary of this Proportion of variance for each PC can be obtained by calling the `plot()` function directly on our `prcomp` result object.

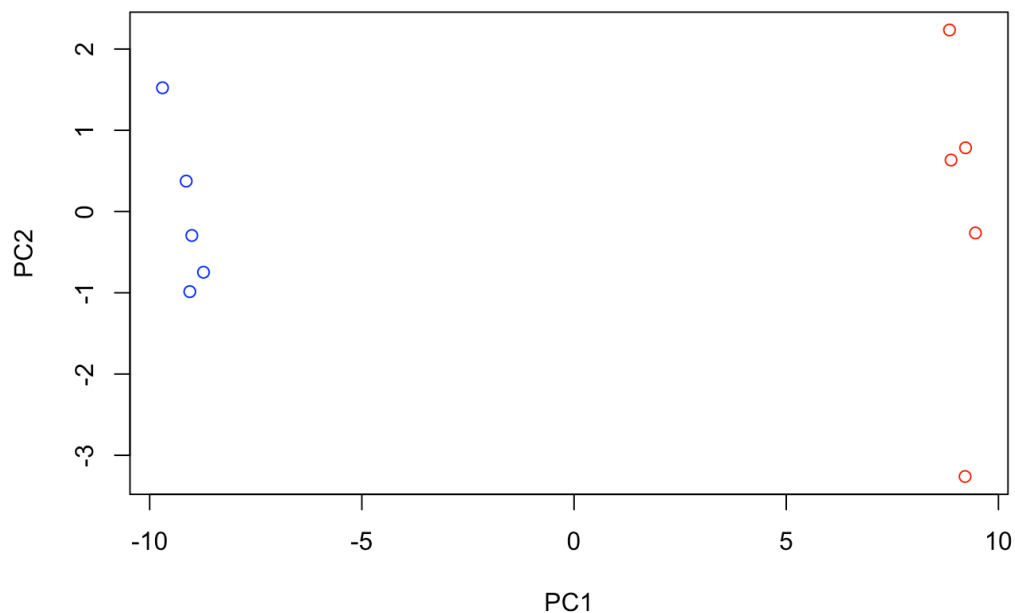
```
pca$x
```

	PC1	PC2	PC3	PC4	PC5
PC6					
wt1	-9.697374	1.5233313	-0.2753567	0.7322391	-0.6749398
	1.1823860				
wt2	-9.138950	0.3748504	1.0867958	-1.9461655	0.7571209
	-0.4369228				
wt3	-9.054263	-0.9855163	0.4152966	1.4166028	0.5835918
	0.6937236				
wt4	-8.731483	-0.7468371	0.5875748	0.2268129	-1.5404775
	-1.2723618				
wt5	-9.006312	-0.2945307	-1.8498101	-0.4303812	0.8666124
	-0.2496025				
ko1	8.846999	2.2345475	-0.1462750	-1.1544333	-0.6947862
	0.7128021				
ko2	9.213885	-3.2607503	0.2287292	-0.7658122	-0.4922849
	0.9170241				
ko3	9.458412	-0.2636283	-1.5778183	0.2433549	0.3654124
	-0.5837724				
ko4	8.883412	0.6339701	1.5205064	0.7760158	1.2158376
	-0.1446094				
ko5	9.225673	0.7845635	0.0103574	0.9017667	-0.3860869
	-0.8186668				
PC7		PC8	PC9	PC10	
wt1	-0.24446614	1.03519396	0.07010231	3.388516e-15	
wt2	-0.03275370	0.26622249	0.72780448	2.996563e-15	
wt3	-0.03578383	-1.05851494	0.52979799	3.329630e-15	
wt4	-0.52795595	-0.20995085	-0.50325679	3.317526e-15	
wt5	0.83227047	-0.05891489	-0.81258430	2.712504e-15	
ko1	-0.07864392	-0.94652648	-0.24613776	2.768138e-15	
ko2	0.30945771	0.33231138	-0.08786782	3.317091e-15	
ko3	-1.43723425	0.14495188	0.56617746	3.299214e-15	
ko4	-0.35073859	0.30381920	-0.87353886	3.000948e-15	
ko5	1.56584821	0.19140827	0.62950330	2.785473e-15	

```
# we have 5 wt and 5 ko samples
mycols <- c(rep("blue", 5), rep("red", 5))
mycols
```

```
[1] "blue" "blue" "blue" "blue" "blue" "red" "red" "red"
"red" "red"
```

```
plot(pca$x[,1], pca$x[,2], xlab="PC1", ylab="PC2", col=mycols)
```



I could examine which genes contribute most to this first pt

```
head(sort(abs(pca$rotation[,1]), decreasing = T))
```

```
gene100 gene66 gene45 gene68 gene98 gene60
0.1038708 0.1038455 0.1038402 0.1038395 0.1038372 0.1038055
```

#Analysis of Breast Cancer FNA data.

The data itself comes from Wisconsin Breast Cancer Diagnostic Data Set.

Values in this data set describe characteristics of the cell nuclei present in digitized images. of a fine needle aspiration (FNA) of a breast mass.

```
wisc.df <- read.csv("WisconsinCancer (3).csv", row.names=1)
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 <- as.factor(wisc.df$diagnosis)
```

Now I want to make sure I remove that column from my dataset for analysis

```
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		

Q1 How many observations are in this dataset

Q2 How many of the observations have a malignant diagnosis

```
table(wisc.df$diagnosis)
```

```

  B    M
357 212

```

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), value=TRUE) )
```

```
[1] 10
```

#Principal component analysis

here we will use 'prcomp()' on the 'wisc.data' object - the one without the diagnosis column.

First, we have decide whether to use the 'scale=TRUE' argument when we run 'prcomp()'

We can look at the means and sd of each coluumn. If they are similar then we are all good to go. If not we should use 'scale= TRUE'

```
colMeans(wisc.data)
```

radius_mean	texture_mean
perimeter_mean	
1.412729e+01	1.928965e+01
9.196903e+01	
area_mean	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
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
      smoothness_worst      compactness_worst
concavity_worst
      1.323686e-01      2.542650e-01
2.721885e-01
      concave.points_worst      symmetry_worst
fractal_dimension_worst
      1.146062e-01      2.900756e-01
8.394582e-02

```

```
apply(wisc.data, 2, sd)
```

```

      radius_mean      texture_mean
perimeter_mean
      3.524049e+00      4.301036e+00
2.429898e+01
      area_mean      smoothness_mean
compactness_mean
      3.519141e+02      1.406413e-02
5.281276e-02
      concavity_mean      concave.points_mean
symmetry_mean
      7.971981e-02      3.880284e-02
2.741428e-02
      fractal_dimension_mean      radius_se
texture_se
      7.060363e-03      2.773127e-01
5.516484e-01

```

perimeter_se	area_se
smoothness_se	
2.021855e+00	4.549101e+01
3.002518e-03	
compactness_se	concavity_se
concave.points_se	
1.790818e-02	3.018606e-02
6.170285e-03	
symmetry_se	fractal_dimension_se
radius_worst	
8.266372e-03	2.646071e-03
4.833242e+00	
texture_worst	perimeter_worst
area_worst	
6.146258e+00	3.360254e+01
5.693570e+02	
smoothness_worst	compactness_worst
concavity_worst	
2.283243e-02	1.573365e-01
2.086243e-01	
concave.points_worst	symmetry_worst
fractal_dimension_worst	
6.573234e-02	6.186747e-02
1.806127e-02	

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

	PC15	PC16	PC17	PC18	PC19
0.97812 0.98335					
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			

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

44.27%

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

3 PCs capture 72.6% of the original variance

Plotting the PCA results

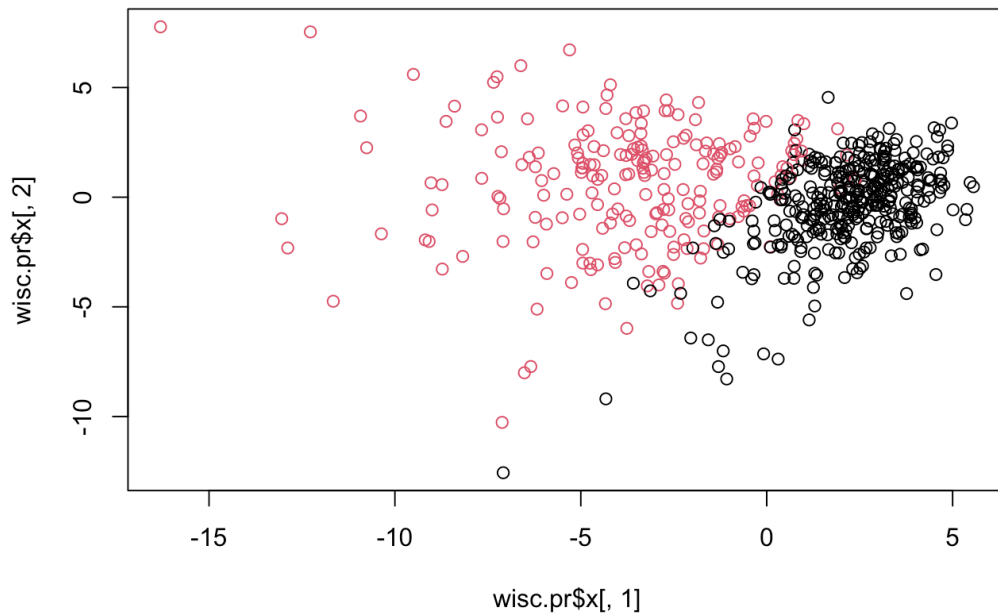
```
#biplot(wisc.pr)
```

we need to make our own plot

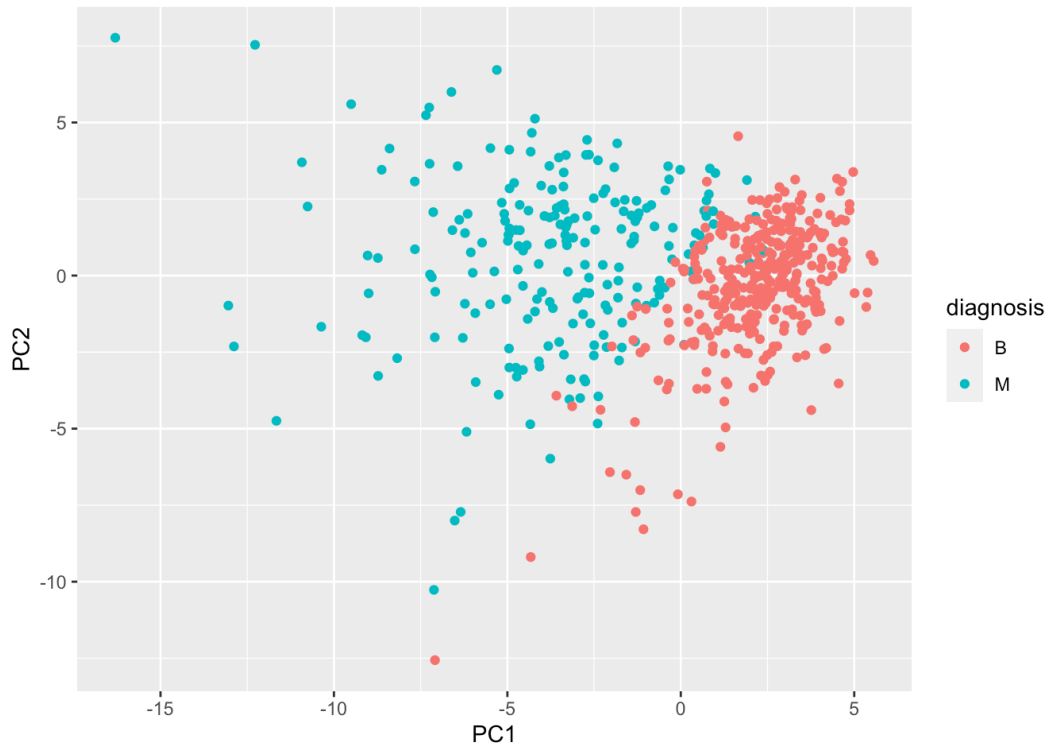
```
attributes (wisc.pr)
```

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

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



```
library(ggplot2)  
  
pc <- as.data.frame(wisc.pr$x)  
  
ggplot(pc) +  
  aes(PC1, PC2, col=diagnosis) +  
  geom_point()
```



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

7 PCs are required to describe 90% of the original variance.

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

I like how the diagnoses are not interlapped, which shows distinguishable differences. It is however hard to understand.

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`?

```
wisc.pr$rotation ["concave.points_mean",1]
```

```
[1] -0.2608538
```

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

```
tbl <- summary(wisc.pr)
which(tbl$importance [3,] > 0.8) [1]
```

PC5

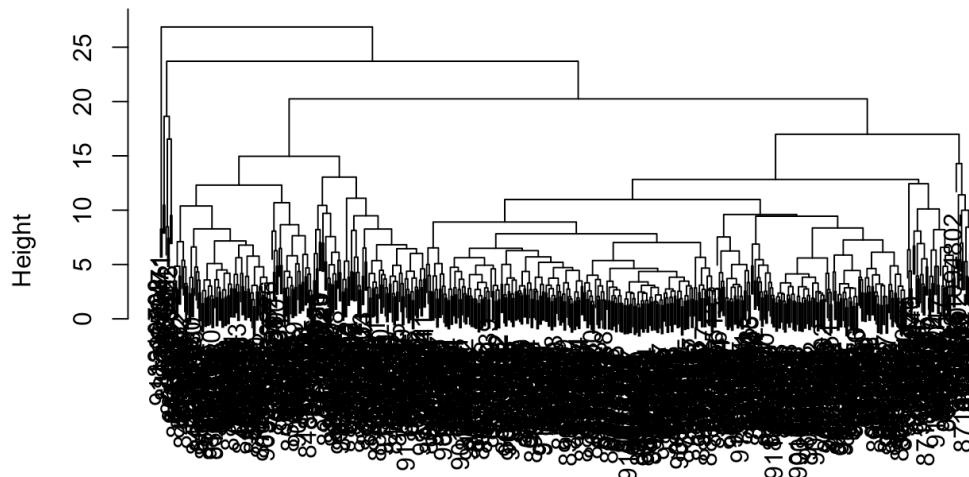
5

#Hierarchical clustering

The main function for Hierarchical clustering is called 'hclust()' it takes a distance matrix as input.

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

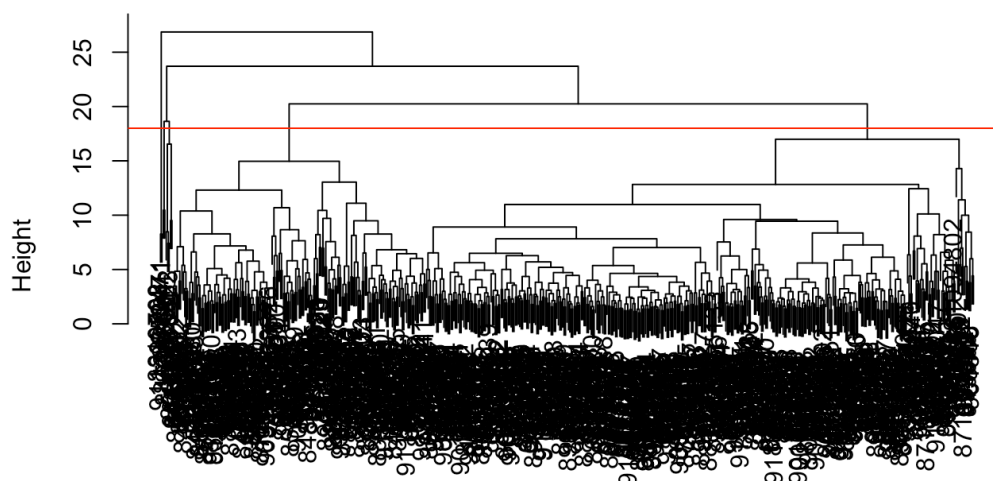
Cluster Dendrogram



d
hclust (*, "complete")

```
plot(wisc.hclust)
abline(h=18, col="red")
```


Cluster Dendrogram



d
hclust (*, "complete")

```
grps <- cutree(wisc.hclust, h=18)
table(grps)
```

```
grps
  1  2  3  4  5
177  5 383  2  2
```

come back here. later to see how our cluster grps correspond to M or B groups

5. Combining methods

Her we will perform clustering on our PCA results rather than the original data.

In other words we will cluster using ' wisc.pr\$x' - our new better variables or PCs. We can chose as many or as few PCs to use as we like. It is your call!

```
wisc.pr$x [,1:3]
```

	PC1	PC2	PC3
842302	-9.18475521	-1.946870030	-1.122178766

842517	-2.38570263	3.764859063	-0.528827374
84300903	-5.72885549	1.074228589	-0.551262540
84348301	-7.11669126	-10.266555635	-3.229947535
84358402	-3.93184247	1.946358977	1.388544953
843786	-2.37815462	-3.946456430	-2.932296681
844359	-2.23691506	2.687666414	-1.638471247
84458202	-2.14141428	-2.338186649	-0.871180715
844981	-3.17213315	-3.388831138	-3.117243065
84501001	-6.34616284	-7.720380945	-4.338098744
845636	0.80970132	2.656937673	-0.488400053
84610002	-2.64876984	-0.066509405	-1.525113359
846226	-8.17783882	-2.698602007	5.725193241
846381	-0.34182514	0.967428026	1.715661982
84667401	-4.33856172	-4.856809832	-2.813639832
84799002	-4.07207318	-2.974443983	-3.122526655
848406	-0.22985277	1.563382114	-0.801813642
84862001	-4.41412695	-1.417423150	-2.268323145
849014	-4.94435304	4.110716528	-0.314472408
8510426	1.23597583	0.188049490	-0.592761930
8510653	1.57677384	-0.572304625	-1.799863016
8510824	3.55420904	-1.661487969	0.450790799
8511133	-4.72904972	-3.302058265	-1.465247427
851509	-4.20482441	5.123858059	-0.751740573
852552	-4.94528075	1.542395143	-1.711687827
852631	-7.09232236	-2.016835734	-0.028984132
852763	-3.50717666	-2.169715994	-3.891122637
852781	-3.06136021	1.874902631	2.579478032
852973	-4.00374127	-0.536769860	-2.759197831
853201	-1.71380176	1.522365502	0.146058578
853401	-6.05411853	0.756511800	-0.348932376
853612	-2.89968469	-4.001774373	-2.998823809
85382601	-4.55077848	-0.337239419	-0.753637681
854002	-4.98621538	1.131593223	-2.575118337
854039	-2.98271631	-0.757756497	-3.490690279
854253	-2.76393718	0.354044421	-1.895295337
854268	-1.29505925	-0.912393466	-1.574383382
854941	3.74601730	1.412230504	1.730784885
855133	0.99719148	3.348346731	4.301788720
855138	-0.76459136	-0.885464837	-2.702540362
855167	2.14906252	1.922300194	-1.179446370
855563	0.09324934	-2.258764532	-1.903051997
855625	-9.08001023	-2.016898441	2.139343894
856106	-0.98958304	-0.984064148	-2.308702241
85638502	0.29328849	0.136978564	-3.299029123
857010	-5.37620991	0.134758404	-1.677366657

85713702	4.57790860	-1.482915508	0.042037623
85715	-1.69851237	-2.350203862	-3.075383081
857155	2.13456708	-0.095745364	-1.491099878
857156	1.56610099	1.207370855	-0.368834570
857343	3.53979091	1.281368110	1.017315805
857373	3.15503795	1.687473796	-0.495857416
857374	3.44745515	0.497780720	-0.152383875
857392	-3.29964761	1.129943574	0.825666100
857438	0.67402621	2.114549137	-1.394992302
85759902	2.85564577	-0.152588874	0.428557855
857637	-4.64465207	2.308301508	-0.728168145
857793	-2.17494916	-0.971261438	-1.942179421
857810	3.71818738	1.786070097	1.278807604
858477	4.13232693	-2.401679261	-1.241865694
858970	2.38373822	-2.755233814	1.213018303
858981	2.57661610	-3.135912650	1.399049169
858986	-4.75492832	-3.009032875	-0.166094576
859196	2.31209785	-3.265116721	2.793766025
85922302	-1.69012080	-1.539322116	-1.798262954
859283	-1.81071217	-0.722104815	-1.464960560
859464	2.78347559	-2.308617372	0.472309720
859465	3.51555502	0.657730736	0.590855071
859471	-4.32619605	-9.194435552	1.491650337
859487	3.25841241	0.937013647	0.204949679
859575	-2.70221851	4.433240985	0.307075192
859711	0.30758513	-7.381317396	3.815728542
859717	-5.49886689	-0.937500513	-2.208188675
859983	0.36139121	-0.119633821	-2.039161544
8610175	2.62766457	0.696696349	-0.583428281
8610404	-1.42691206	1.965372092	1.110961327
8610629	0.83378424	-1.963876860	0.789737653
8610637	-6.22541880	-0.919260690	0.089748341
8610862	-11.65845644	-4.744442593	2.004115633
8610908	2.01980045	0.254675746	-0.647302452
861103	1.63694460	-1.714440587	0.433824539
8611161	-1.16643527	-2.512305286	-1.904043397
8611555	-10.75977535	2.255997858	0.038801648
8611792	-5.03038488	-0.773728357	2.679979922
8612080	2.17255269	-0.496441169	-0.948257444
8612399	-3.28534463	1.666770480	0.146802675
86135501	-0.60707378	-0.162071919	1.635935419
86135502	-3.58041324	2.204721916	-1.703037100
861597	0.93333687	-0.926885919	-0.040128345
861598	-1.25849730	-1.014684255	-0.080521995
861648	1.58686770	1.618232954	0.309726682

861799	-0.25227559	0.530884425	0.588809736
861853	2.84492835	2.891103732	0.527524677
862009	1.96322268	0.964308498	-0.081136715
862028	-2.77342525	-0.557509977	-0.605238702
86208	-4.39236314	2.121640892	0.579000549
86211	2.58980407	-0.213446120	1.034701089
862261	3.90090576	-1.189020421	1.550616806
862485	2.81575365	-0.367560567	-1.350247556
862548	-0.61573908	-0.638349988	-0.199743121
862717	0.43247968	1.390820523	-0.082646762
862722	4.55102442	-3.525683788	-0.215074716
862965	3.44515217	1.423370040	-0.088646005
862980	2.11410008	-1.847747782	-0.556184595
862989	2.68898618	-1.418813334	0.968298772
863030	-3.21109134	-4.043198634	-2.712997305
863031	0.74861266	-1.796058175	-0.567866143
863270	3.15622889	1.034838878	-1.489373670
86355	-13.04464395	-0.980650357	0.598286247
864018	2.22672053	-0.666823902	-1.090600727
864033	2.49063954	-2.596401708	1.668257671
86408	0.10325957	-2.278139015	2.107708229
86409	-3.58813694	-3.922881433	2.045207163
864292	1.34776279	-3.553098748	1.730668471
864496	2.50791098	-3.248461200	-1.686140767
864685	2.04423086	-0.304616836	-0.533369397
864726	2.09522559	-3.663872062	3.629007335
864729	-3.10779316	-1.568009873	-2.611638159
864877	-4.95236801	-2.382749650	-1.933405900
865128	-0.85026612	2.304707468	0.566963050
865137	2.96339173	-0.371179883	-2.064716427
86517	-3.33120209	1.324392029	0.727373652
865423	-12.88327621	-2.314585873	6.323133317
865432	0.77006610	0.064052860	-1.133411514
865468	2.20057925	0.734958544	0.266845303
86561	3.14064881	1.875758557	-0.669779705
866083	0.63831885	0.910564828	-2.140840449
866203	-1.91744627	3.534971966	1.253821297
866458	-1.40762980	-1.303782215	0.640864876
866674	-4.63960895	1.480714297	-1.169651383
866714	1.87581684	-1.421979452	-1.069870821
8670	-1.43081046	1.048681220	-1.260901861
86730502	-1.35143790	1.153126842	-1.208729712
867387	0.70849143	1.566853657	-0.669405084
867739	-2.16950708	2.823776101	-0.561613332
868202	1.97510247	0.419018755	-0.380240597

868223	2.59850310	0.481911436	1.870726668
868682	3.25514318	0.417953651	-0.691197447
868826	-3.77870160	-0.859625218	3.667773435
868871	1.99028348	-1.328186508	1.134246527
868999	5.01059989	-0.574194748	-0.841697543
869104	-1.34383800	1.273650278	0.555354894
869218	2.45380972	-0.897665441	0.352823033
869224	1.83566648	0.090946742	-1.444010288
869254	4.34266862	0.892786708	0.638694049
869476	0.73216868	-3.698927716	0.657926113
869691	-2.39788795	-4.833735642	-1.027253164
86973701	-0.39275308	-1.082115915	2.245629588
86973702	0.41196533	0.389288784	-1.044851048
869931	3.04724369	2.235817239	-0.469040276
871001501	1.44129554	-0.305601552	0.551062974
871001502	-0.08311297	-7.144073768	-0.059957215
8710441	-7.08707084	-12.562140869	7.352238887
87106	3.74011364	-0.250281306	-0.097297641
8711002	0.96832079	-0.944113582	-0.890028129
8711003	2.41659356	-0.005547532	-0.797678511
8711202	-4.09718264	0.378470806	1.445046044
8711216	0.75094226	3.067949187	1.447907672
871122	3.65143365	0.674055644	-0.906188637
871149	4.67609710	1.102886823	-0.257081973
8711561	0.59725624	-1.784081072	1.480433343
8711803	-3.38435289	2.908477953	3.004594027
871201	-6.14447970	2.015878994	-1.564766888
8712064	1.32386648	-1.468002337	0.847675513
8712289	-5.48932277	4.162167037	-0.600732185
8712291	2.99476813	2.736453261	-0.161042080
87127	4.38287625	-0.006866240	-0.947274735
8712729	-1.21256768	2.037246395	0.979834026
8712766	-5.06520424	1.783582969	1.172615291
8712853	1.97596280	1.841159394	-0.277115927
87139402	2.51266554	-0.114151857	-0.496186180
87163	0.94665494	1.683272444	-0.350877607
87164	-2.81688978	-1.263990953	-2.151251366
871641	3.48092345	-1.618268077	2.673117328
871642	4.65463399	0.222718846	1.557987797
872113	5.34691339	-1.025855214	0.324700222
872608	-1.16986842	-7.008319996	4.268106508
87281702	-2.95370292	-0.705800822	-1.041419103
873357	4.97132782	3.383227983	0.439451738
873586	4.06045289	1.245070643	0.573972801
873592	-9.50430706	5.598558052	-0.636679193

873593	-8.99924714	-0.580520281	-3.131959404
873701	-0.75821134	1.607118481	-1.513763762
873843	2.65702172	-0.539461132	1.705514033
873885	0.38967611	0.988372689	-2.582896564
874158	3.88564657	-0.815354285	1.014824328
874217	-0.36455538	3.571318842	-2.222023387
874373	2.83339783	0.398379162	-0.347139642
874662	3.30737348	-0.155604280	0.541002917
874839	3.35435293	1.102762109	0.151956099
874858	-6.51738201	-8.004126824	-0.326136731
875093	1.71622508	0.542688019	3.295475582
875099	5.56084294	0.477427493	4.123834207
875263	-1.77809695	-2.774146213	-0.941934046
87556202	-2.60918908	-1.560049030	-0.217995141
875878	2.81656023	0.969257722	-0.382255094
875938	-2.49624245	-2.276479790	1.318318594
877159	-1.27590451	2.441111044	2.464148795
877486	-3.47014398	2.275846405	-1.237595112
877500	-1.25557034	-0.382057094	-3.834946034
877501	1.47213604	-0.116787496	-0.214479145
877989	-1.64801062	2.100442902	-0.974414210
878796	-9.02864522	0.654596849	0.221085545
87880	-4.55058603	-3.083925626	-2.268408346
87930	0.78050321	-0.652275325	-0.643091145
879523	0.22289648	0.701204504	-2.268765765
879804	3.45185811	-1.305789765	-0.029238791
879830	-0.44615183	2.785257008	0.443991604
8810158	-0.31416180	-2.075734301	-2.081480386
8810436	2.05738166	2.470613908	-1.460433790
881046502	-4.80474158	3.026440019	2.741606351
8810528	2.99607430	0.396429212	-0.595941573
8810703	-12.27421974	7.536778599	10.103533703
881094802	-3.36923202	-2.585550416	7.085840019
8810955	-2.50656080	-2.612349885	0.206198902
8810987	-1.31690973	-2.152585453	-1.785061911
8811523	0.38841453	-2.274796314	0.626780574
8811779	2.75450931	-1.085879226	1.705737291
8811842	-4.93923501	2.845820436	0.913075404
88119002	-4.29429880	4.662172958	-0.006834994
8812816	2.37141521	0.732757814	-1.524685925
8812818	0.96634003	-0.438052741	-1.446423567
8812844	2.97318270	-1.809381711	-0.223238842
8812877	-1.80166175	-0.166314618	-2.626288708
8813129	2.47618073	1.417329346	-0.316254972
88143502	0.82531310	1.249148354	0.267725157

88147101	3.89127342	-0.538097276	-0.880783727
88147102	0.38923560	0.613875324	-1.351679911
88147202	1.45604019	0.201549415	-1.097912687
881861	-2.75314552	-3.462726769	-2.471875866
881972	-3.25439115	0.125090426	-2.893551435
88199202	4.01560693	1.353056834	-0.360155815
88203002	3.67318128	1.290493562	0.424237023
88206102	-3.31340866	3.935689268	-0.205273062
882488	4.03305870	-1.161524089	0.189581014
88249602	2.33218128	1.347793816	0.232482459
88299702	-8.39645911	4.150252991	0.046927784
883263	-2.64524110	3.947699392	1.370675284
883270	0.68116951	1.134992457	1.232581929
88330202	-3.34735048	2.152675899	-1.107968825
88350402	2.22576208	1.213931555	-0.192244621
883539	4.47364832	1.739598699	-0.887426246
883852	-1.32145867	-4.785266054	-0.661952674
88411702	1.84846341	1.582735509	1.262806090
884180	-3.79222888	1.025330459	0.897845626
884437	2.27931254	-2.075859442	2.428512195
884448	3.22593164	1.171043084	0.264431658
884626	-1.02499890	-2.359186109	-1.615464155
88466802	2.58028546	-0.728572047	-0.547660903
884689	2.48369783	-0.460191483	-0.598393817
884948	-7.13756174	2.073018195	1.087430513
88518501	3.02981522	0.648897838	0.310409540
885429	-7.07878207	-0.527758800	-1.278861780
8860702	-1.31294375	1.773865017	-1.671161321
886226	-3.70838653	2.805008998	-1.754649703
886452	-0.46007427	-0.393819769	-1.003815294
88649001	-6.38703001	1.821491443	0.479427881
886776	-5.25092469	-3.891107226	-0.833120389
887181	-8.72618338	-3.276993966	2.901146761
88725602	-3.68807276	-1.064709236	-3.512498419
887549	-3.37528098	3.368264175	-1.765224543
888264	0.83947101	3.497008034	0.182323228
888570	-3.28148526	0.989802279	2.552140777
889403	1.90709089	3.119201237	-1.062121558
889719	-1.61336234	2.472397898	-1.989384336
88995002	-6.61390681	5.997998811	0.988507976
8910251	1.46338831	-1.685149061	1.168877382
8910499	2.01038350	1.102516460	1.336847795
8910506	2.28233204	-0.009485293	-0.450043551
8910720	0.73909276	-3.149749158	1.468565664
8910721	4.50260070	3.166486414	-0.187896260

8910748	3.15597737	-0.409941090	-1.107842420
8910988	-7.66940121	3.072602737	1.480656591
8910996	3.63593673	-1.588189625	0.715650110
8911163	-0.33704893	3.141609173	-0.115619749
8911164	1.27546111	-0.848306563	3.067369195
8911230	4.34219338	0.321694999	0.388133185
8911670	-0.01741547	3.456302110	0.306650981
8911800	3.48935577	2.631766723	-0.072124181
8911834	1.86490793	0.901271186	-0.870402828
8912049	-4.95590744	1.339944038	-1.455772409
8912055	2.46855062	0.137904923	1.793307382
89122	-3.78173258	1.900235409	-1.742708503
8912280	-2.63493731	-0.576647607	-1.992946242
8912284	1.37147827	-0.005800358	1.547927203
8912521	4.13524399	1.375298123	0.877276691
8912909	0.68633639	-1.693519506	1.025310679
8913	4.30833870	1.976746804	-0.251085558
8913049	-0.40295486	-3.720160654	4.582436940
89143601	3.00096526	-0.353848878	1.232930128
89143602	-3.13125303	-4.269702670	5.861122345
8915	0.41746954	0.807865734	-1.092330348
891670	1.41897459	-1.392752638	-0.836251021
891703	2.86806475	0.268408338	-0.468574962
891716	3.36288672	0.806890637	-0.806369895
891923	3.31208587	1.440908382	-0.583119519
891936	4.76551701	0.542484530	0.893082182
892189	2.38378528	0.823391074	1.982219343
892214	2.78464581	2.530807159	-0.883257225
892399	3.39085817	-0.753301131	1.770235939
892438	-6.58444233	1.483557076	0.361022239
892604	1.45405111	-0.591422478	1.145332613
89263202	-7.17661843	-0.055097580	2.011148288
892657	3.57568917	-0.890799182	0.261257526
89296	3.05434514	0.179055836	0.621226832
893061	3.07173303	0.305789373	1.258146621
89344	3.85015201	1.523386003	-1.143503482
89346	5.38551771	-0.555766489	0.559577694
893526	4.65358767	3.062692587	-0.075942289
893548	4.02400169	2.540671520	0.352906609
893783	3.34487880	0.068502773	-0.269955756
89382601	3.29694105	3.135950089	0.148761476
89382602	2.13452598	0.004388987	-0.055090483
893988	4.03446724	0.240486452	-1.326959165
894047	3.76210430	-4.394333943	3.946735131
894089	4.86695697	2.337158334	-0.168146877

894090	4.74307511	1.796820963	0.169570993
894326	-1.89365006	2.390134936	-1.675017462
894329	-1.57154834	-6.503377021	2.165253786
894335	4.02308037	1.400973753	3.183698584
894604	1.29372783	-3.467757378	1.108552569
894618	-1.83322742	4.317723823	0.316406925
894855	1.80878902	-0.395858988	-1.229252510
895100	-7.23012357	0.035670411	-2.838568987
89511501	3.14288478	0.741873771	-0.861593396
89511502	2.88472980	0.464323069	-0.475325102
89524	3.14688506	1.769691255	-0.035802185
895299	4.62431058	1.834004631	0.064174505
8953902	-2.24853190	0.348229535	-1.063814825
895633	-2.10594822	-1.120987593	1.773597643
896839	-1.78437991	0.268984957	-1.721001037
896864	0.52723271	-1.264758769	-0.919631937
897132	3.21067592	-1.102473082	1.610564041
897137	4.38256677	0.760434627	-0.400245248
897374	3.80666840	0.909118626	0.442778081
89742801	-3.31675558	1.575666422	1.359532256
897604	2.39117199	-0.989160421	-0.756844005
897630	-4.67605183	0.967741443	-0.291016193
897880	3.06499827	-1.134839030	0.374293207
89812	-7.34675421	5.238014242	0.316677175
89813	-0.29505357	-0.226735533	-1.088458865
898143	1.93726491	-2.542750760	-1.000543159
89827	2.07535283	-1.804931340	-1.166053416
898431	-4.97078859	1.331400687	0.870211875
89864002	2.17500311	-0.958068260	-0.234058923
898677	2.42941383	-3.444173357	3.453905770
898678	3.36500493	0.562434015	-0.192404359
89869	1.20553704	1.315886497	-0.929922572
898690	3.32315522	-0.474753848	-0.897496041
899147	1.92709976	-1.460184989	-0.100554033
899187	4.03828183	1.355724562	0.537868401
899667	-6.17684877	-5.103514894	0.520682438
899987	-10.92468559	3.699998472	-0.890910165
9010018	-2.11663452	-0.296368297	0.866722769
901011	3.00954689	-0.243545681	1.981989096
9010258	0.98178471	-0.796551513	2.367338148
9010259	-0.35757923	-2.125968004	0.707586438
901028	3.19111003	1.847526445	0.099310968
9010333	2.99060189	-1.629958015	2.554470244
901034301	3.19110631	-0.578830133	0.489333658
901034302	4.58792496	2.758699732	0.979680613

901041	2.48373073	1.187894183	0.348470172
9010598	2.39655663	0.250524355	-0.326850211
9010872	0.77892982	2.122475872	0.320506876
9010877	3.13722800	1.486714010	-1.197824530
901088	-2.73260737	3.941699950	-0.017154393
9011494	-6.22155168	1.388887616	2.731833465
9011495	2.22182078	0.356846723	-1.100713817
9011971	-5.30247440	6.717504288	1.484358772
9012000	-7.24162919	3.652255530	-0.155565119
9012315	-4.20352196	-1.175208822	-1.588620367
9012568	2.49743889	2.016761090	-0.730631718
9012795	-3.63181933	1.954720962	-0.828046542
901288	-3.51615443	3.855214937	-1.021630135
9013005	2.61264945	1.101505251	-1.239645246
901303	0.09602363	0.129733431	-1.669994689
901315	-2.04305926	-6.421169887	1.273001142
9013579	3.06405348	2.180177374	-0.278817341
9013594	1.60217670	-0.292338995	-1.584830948
9013838	-3.76262144	-5.980033549	-4.876070721
901549	0.92475292	-2.300457270	-1.594708683
901836	3.28545874	-0.201134359	-0.627204410
90250	1.55348525	-0.978996316	1.195507876
90251	0.39842934	-2.159312724	-0.944773717
902727	2.29854534	0.931258175	-1.128959899
90291	0.54242409	1.315910048	0.994879134
902975	2.05700950	-0.320153445	-0.122350756
902976	3.42150749	2.443368505	0.045009146
903011	0.47199125	-3.699574203	1.952067274
90312	-4.69936579	0.195783486	3.753730061
90317302	3.64017727	-0.786168171	-1.161124120
903483	3.59152918	-2.602797030	1.850401478
903507	-4.14544978	-0.766814129	-0.887194062
903516	-7.66539681	0.859727681	-2.151756805
903554	2.00861205	-0.429311811	-0.103997306
903811	2.91826573	1.698977554	0.295467269
90401601	0.50029759	-0.106637635	-1.027843564
90401602	1.90981814	0.650821226	1.449013512
904302	3.78177167	0.325859645	-1.057150017
904357	2.70601296	0.219472629	-0.314228262
90439701	-6.28414409	-2.034757025	-3.179284831
904647	3.42775463	0.991737410	-0.731051348
904689	1.99962900	0.293068594	0.618659534
9047	2.47111877	0.334752480	-1.481058853
904969	3.64405137	1.240273815	1.385405524
904971	2.34412427	-0.682141105	1.131738080

905189	1.14199209	1.960446508	-1.239628958
905190	1.34966974	-0.369249002	2.484489568
90524101	-2.76094145	1.077685260	-1.178586912
905501	1.96759233	0.175693916	0.420361503
905502	2.92861019	0.494421191	-1.016176763
905520	2.92380175	-0.377000536	-0.886014238
905539	3.99267514	-0.959012260	0.204224433
905557	-0.15500167	0.437623166	-0.461040030
905680	0.93326963	2.104094210	1.431657320
905686	1.92792536	-0.891682104	0.042307522
905978	2.62003325	-2.499901968	2.432858840
90602302	-5.99833869	0.090949196	1.709697317
906024	2.91930912	0.009204582	-0.900511128
906290	3.33900683	0.022205192	0.502858739
906539	2.01314368	-0.777767778	0.125468395
906564	-1.98671401	-2.314011967	1.235217081
906616	1.66813615	-0.861560770	-1.009417991
906878	0.37085180	-0.113512779	-0.997485893
907145	1.84733447	-2.538995601	2.003584668
907367	4.69890766	0.431922385	0.005300424
907409	1.28205907	-2.548666752	-0.083786622
90745	2.31221232	-0.401678043	0.274381769
90769601	4.65498928	0.781611021	0.191953023
90769602	3.94000659	2.028231657	0.691127602
907914	-4.94550694	-3.003421435	-1.752529645
907915	0.91499842	-2.476833776	0.362287911
908194	-4.54511193	0.815283142	-0.518299038
908445	-4.43843746	0.991566424	1.441051113
908469	2.19305464	1.803766114	-0.434726892
908489	-0.66385679	-0.436476802	-2.678425146
908916	2.23890605	0.454189872	-0.465118333
909220	2.12331215	1.193746541	0.489940891
909231	2.61301823	1.830449830	0.763657618
909410	3.20814515	2.233177743	-0.166078298
909411	0.30648073	-2.183077955	0.039251705
909445	-2.47018342	1.498506224	0.590933256
90944601	3.45168126	2.134583340	0.196989342
909777	3.89709781	-0.730133530	2.134193239
9110127	-0.98086448	2.208486712	-1.698424795
9110720	1.25614629	-1.066752885	0.259247160
9110732	-3.24256054	1.776795240	-1.791577273
9110944	1.55585043	1.037014643	-1.300101127
911150	1.24815985	1.587442008	-0.326126484
911157302	-4.32784530	4.045772565	-0.192336290
9111596	1.07650412	-1.802032564	1.779475879

9111805	-2.50954497	2.526584455	0.797500590
9111843	2.21514321	-0.029865010	0.635900610
911201	1.17279871	0.474422064	-0.481147553
911202	2.83380799	1.017230750	-1.485323075
9112085	1.85545330	1.570011674	0.825756166
9112366	1.32744636	-0.776412499	1.255653387
9112367	2.80030738	1.664836753	-0.193847761
9112594	3.17177797	2.073908798	0.074834422
9112712	4.08348433	0.484283961	0.630808963
911296201	-3.47243837	1.671413723	0.856073545
911296202	-16.30488665	7.769016888	6.229933870
9113156	2.55786437	2.491852880	0.170162861
911320501	2.96627878	0.068786611	-0.777727248
911320502	2.75500634	1.792341696	-0.757147909
9113239	-1.36913518	-2.108156394	-0.852969723
9113455	0.41729731	-0.116417262	-0.535671262
9113514	3.83502421	-0.898388162	0.699948069
9113538	-5.92575082	-1.227216861	1.720074272
911366	-0.64491119	-3.422999542	0.607750202
9113778	2.68148698	-1.442286469	0.339105123
9113816	2.03986918	0.902461858	2.840741857
911384	1.39806620	1.770668244	-1.478260847
9113846	3.53330636	1.245758018	3.382434941
911391	1.98877953	-1.897792693	-2.029212586
911408	1.99642872	0.206189711	-1.639882150
911654	0.52020039	0.972512103	-0.323850426
911673	3.16958159	2.087215768	-0.977945244
911685	2.20077374	-1.284908734	-0.886619084
911916	-3.82107090	-2.303209735	0.027521977
912193	2.98286009	0.672747298	-0.589970772
91227	2.47887396	2.361880555	-0.432234246
912519	1.27099312	-0.509385643	-2.237023334
912558	2.23319191	1.297562775	-0.900644424
912600	0.05613371	0.227183495	-2.253532782
913063	-2.31535334	-4.385275755	1.776847691
913102	2.28232306	2.464672105	-0.820466562
913505	-4.75043499	1.488114177	-1.252648906
913512	1.72479328	-0.997300316	-0.080167877
913535	0.74112965	2.449879331	-1.995953713
91376701	2.89176621	0.977084588	-0.804935982
91376702	1.65306732	4.551659142	0.751661685
914062	-3.10079133	1.235066483	1.286223339
914101	4.06069761	0.560461075	2.174771231
914102	2.79087498	1.076940539	0.843799658
914333	1.47362330	1.589695437	0.319710133

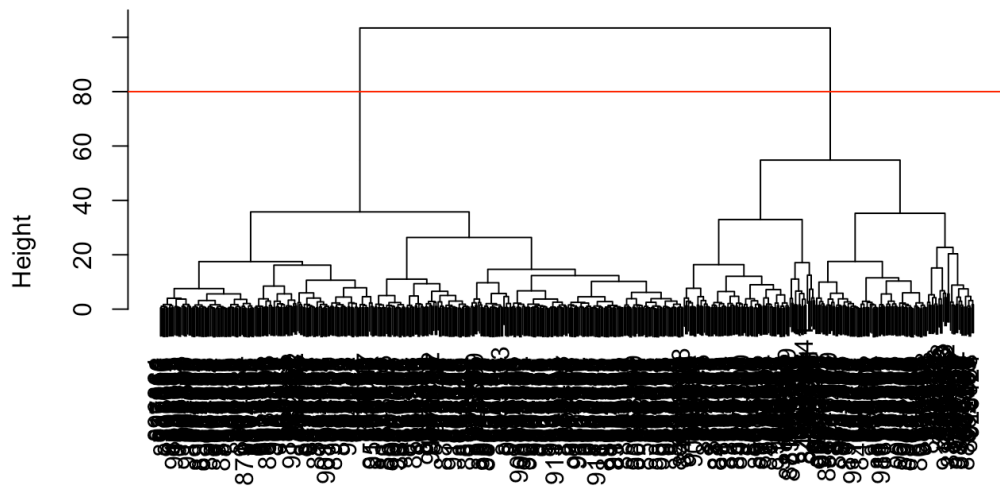
914366	0.22919297	-1.514570755	-2.214334625
914580	2.55101378	0.763228924	-1.607988258
914769	-3.71243855	1.057755506	0.521494703
91485	-5.09036286	2.017432706	-0.708746074
914862	0.60008810	0.837717560	-0.686437977
91504	-2.78794673	-3.382584454	-0.752414277
91505	1.40753273	-1.504446838	-0.353584900
915143	-7.25279714	5.490904302	1.909245947
915186	-1.29772469	-7.723057325	-0.688309017
915276	-1.07574673	-8.287483337	0.433810751
91544001	1.24866183	-1.594281055	-1.355282076
91544002	1.25582341	-4.113567176	-0.412366931
915452	1.16550969	1.664229389	-0.737229323
915460	-4.09054331	-2.800463137	-0.506987325
91550	1.88597978	-1.670721680	0.119692299
915664	2.76500279	2.159148972	-0.021077623
915691	-2.22503669	-1.939927827	-2.283594176
915940	1.13058210	1.409761524	-0.564556376
91594602	0.73312738	1.941988438	-0.274994234
916221	2.33161916	-0.789451973	-0.349735677
916799	-2.69485257	1.942001189	-0.959719996
916838	-3.37604410	2.331377578	-1.200875536
917062	0.19969487	-1.075413752	-0.672557052
917080	1.17499204	-1.010481061	-0.711142576
917092	1.29150016	-4.959860548	0.345622908
91762702	-8.62316838	3.456410638	-0.178899380
91789	4.42556234	0.785345015	-0.473002900
917896	0.61929383	-0.635789842	-0.488421490
917897	3.24945659	-1.284794677	-0.218284421
91805	3.34997942	-2.670950443	-1.777523046
91813701	0.85904712	-0.096763381	-2.811570840
91813702	3.15384692	0.870776432	-2.193784489
918192	-0.34622347	-1.539870352	2.843951628
918465	2.45924278	-0.600319751	-1.170435277
91858	1.52875558	-0.404861554	0.603933344
91903901	1.77202587	-0.803503014	-2.026135257
91903902	2.67808519	1.483403662	-1.740162222
91930402	-4.02489378	2.938844225	1.658026507
919537	2.13447312	-1.517245623	0.178807901
919555	-5.16086993	2.380108987	-0.421906048
91979701	-0.53546080	-0.380380451	-0.442745212
919812	-0.34282174	-3.531373815	0.069607554
921092	4.19339024	-2.365311059	1.325978010
921362	1.14182718	-5.594535868	1.299893249
921385	1.66401100	-2.387517361	1.500928782

921386	-1.01082308	-1.091429307	-0.632142163
921644	1.29978604	1.819814057	0.372979316
922296	2.37134219	1.680097929	0.384190094
922297	1.66440651	0.213774641	-0.147942249
922576	1.92598353	1.136739705	0.477781900
922577	4.23349159	-0.184110499	-0.326131445
922840	2.67551655	-2.313756961	-0.053800867
923169	3.83312511	-0.495813665	0.922428047
923465	2.54919727	-0.228129228	1.412934778
923748	4.69079604	0.766803238	1.542607509
923780	2.02325691	-1.260133116	0.504482203
924084	2.89340232	1.450359601	0.779859803
924342	3.49912218	-1.799249342	2.764024589
924632	2.15201013	0.829339088	0.564300199
924934	2.05327740	-1.615038205	1.837342797
924964	3.87388097	-1.083301553	1.858308794
925236	4.06028949	-0.122061034	3.235925374
925277	0.09858059	0.213372093	0.388587548
925291	1.08841850	-1.291711328	1.428122289
925292	0.48134743	0.177863190	1.031200235
925311	4.86602793	2.129232607	3.411187296
925622	-5.91241029	-3.479575000	-3.259923297
926125	-8.73365338	0.573350185	0.896301447
926424	-6.43365455	3.573672989	2.457324373
926682	-3.79004753	3.580897052	2.086640366
926954	-1.25507494	1.900624364	0.562235817
927241	-10.36567336	-1.670540206	-1.875379194
92751	5.47042990	0.670047220	1.489132801

```
d.pc <- dist(wisc.pr$x[, 1:3])

wisc.pr.hclust <- hclust( d.pc, method="ward.D2")
plot(wisc.pr.hclust)
abline(h=80, col="red")
```

Cluster Dendrogram



```
d.pc
hclust (*, "ward.D2")
```

```
grps <- cutree (wisc.pr.hclust, h=80)
table(grps)
```

```
grps
  1  2
203 366
```

We can use 'table()' function to make a cross-table as well as just a count table

```
table(diagnosis)
```

```
diagnosis
  B  M
357 212
```

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

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

Write a note here about how to read this cross-table result. The results indicate that our cluster 1 mostly captures cancer (M) and our cluster 2 mostly captures healthy (B) individuals.

##7. Prediction

```
#url <- "new_samples.csv"
url <- "https://tinyurl.com/new-samples-CSV"
new <- read.csv(url)
npc <- predict(wisc.pr, newdata=new)
npc
```

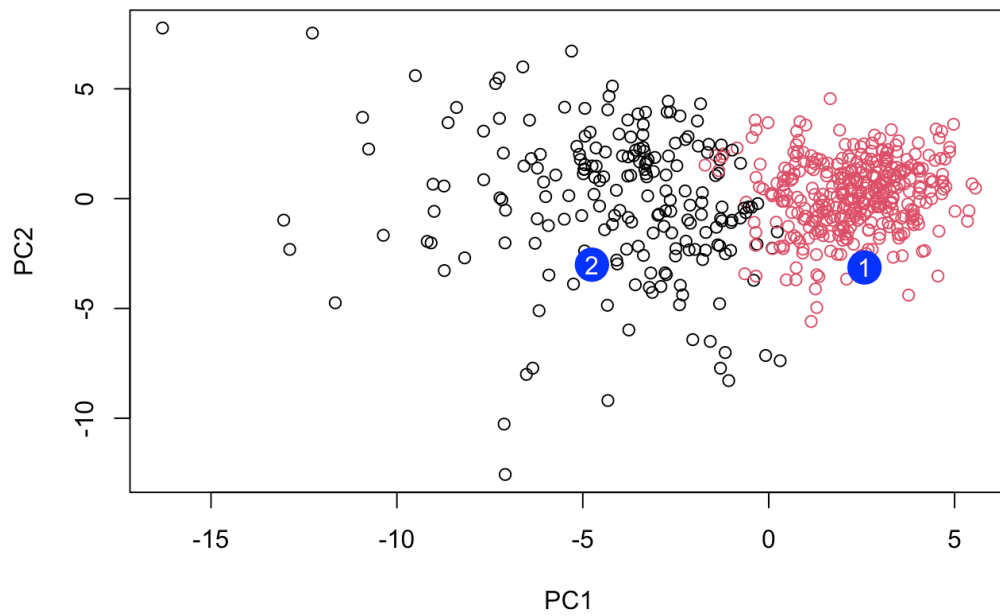
```
      PC1      PC2      PC3      PC4      PC5
PC6      PC7
[1,]  2.576616 -3.135913  1.3990492 -0.7631950  2.781648
-0.8150185 -0.3959098
[2,] -4.754928 -3.009033 -0.1660946 -0.6052952 -1.140698
-1.2189945  0.8193031
      PC8      PC9      PC10      PC11      PC12
PC13      PC14
[1,] -0.2307350  0.1029569 -0.9272861  0.3411457  0.375921
0.1610764  1.187882
[2,] -0.3307423  0.5281896 -0.4855301  0.7173233 -1.185917
0.5893856  0.303029
      PC15      PC16      PC17      PC18      PC19
PC20
[1,]  0.3216974 -0.1743616 -0.07875393 -0.11207028 -0.08802955
-0.2495216
[2,]  0.1299153  0.1448061 -0.40509706  0.06565549  0.25591230
-0.4289500
      PC21      PC22      PC23      PC24      PC25
PC26
[1,]  0.1228233  0.09358453  0.08347651  0.1223396  0.02124121
0.078884581
[2,] -0.1224776  0.01732146  0.06316631 -0.2338618 -0.20755948
-0.009833238
      PC27      PC28      PC29      PC30
[1,]  0.220199544 -0.02946023 -0.015620933  0.005269029
[2,] -0.001134152  0.09638361  0.002795349 -0.019015820
```

and plot this up

```
plot(wisc.pr$x[,1:2], col=grps)
points(npc[,1], npc[,2], col="blue", pch=16, cex=3)
```



```
text(npc[,1], npc[,2], c(1,2), col="white")
```



Q18. prioritize patient 2 because it shows the most malignant characteristics.