class8_unsupervisedmachinelearning

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side note before we start, why is scaling important for PCAs

```
mtcars
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2

```
Lotus Europa         30.4   4  95.1 113 3.77 1.513 16.90  1 1    5    2
Ford Pantera L       15.8   8 351.0 264 4.22 3.170 14.50  0 1    5    4
Ferrari Dino         19.7   6 145.0 175 3.62 2.770 15.50  0 1    5    6
Maserati Bora        15.0   8 301.0 335 3.54 3.570 14.60  0 1    5    8
Volvo 142E           21.4   4 121.0 109 4.11 2.780 18.60  1 1    4    2
```

```
head(mtcars)
```

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

```
apply(mtcars, 2, mean)
```

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

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

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

```
pca<-prcomp(mtcars)
biplot(pca)
```
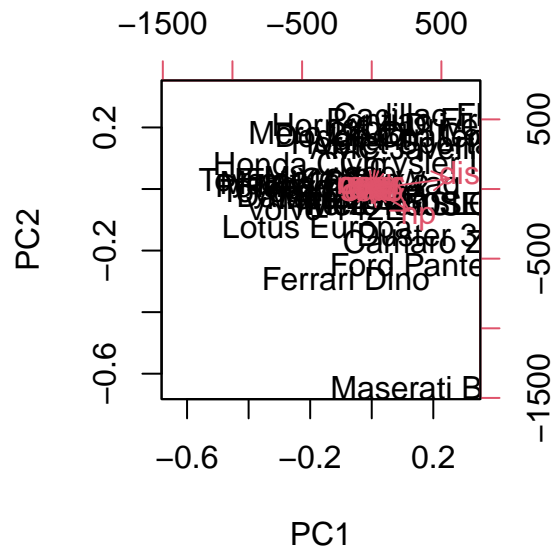
```
#now lets try scaling
mtscale<-scale(mtcars)
head(mtscale)
```

```
                          mpg        cyl        disp         hp        drat
Mazda RX4           0.1508848 -0.1049878 -0.57061982 -0.5350928   0.5675137
Mazda RX4 Wag       0.1508848 -0.1049878 -0.57061982 -0.5350928   0.5675137
Datsun 710          0.4495434 -1.2248578 -0.99018209 -0.7830405   0.4739996
Hornet 4 Drive      0.2172534 -0.1049878  0.22009369 -0.5350928  -0.9661175
Hornet Sportabout  -0.2307345  1.0148821  1.04308123  0.4129422  -0.8351978
Valiant            -0.3302874 -0.1049878 -0.04616698 -0.6080186  -1.5646078
                             wt       qsec         vs         am        gear
Mazda RX4           -0.610399567 -0.7771651 -0.8680278  1.1899014   0.4235542
Mazda RX4 Wag       -0.349785269 -0.4637808 -0.8680278  1.1899014   0.4235542
Datsun 710          -0.917004624  0.4260068  1.1160357  1.1899014   0.4235542
Hornet 4 Drive      -0.002299538  0.8904872  1.1160357 -0.8141431  -0.9318192
Hornet Sportabout    0.227654255 -0.4637808 -0.8680278 -0.8141431  -0.9318192
Valiant              0.248094592  1.3269868  1.1160357 -0.8141431  -0.9318192
                          carb
Mazda RX4            0.7352031
Mazda RX4 Wag        0.7352031
Datsun 710          -1.1221521
Hornet 4 Drive      -1.1221521
```

```
Hornet Sportabout -0.5030337
Valiant            -1.1221521
```
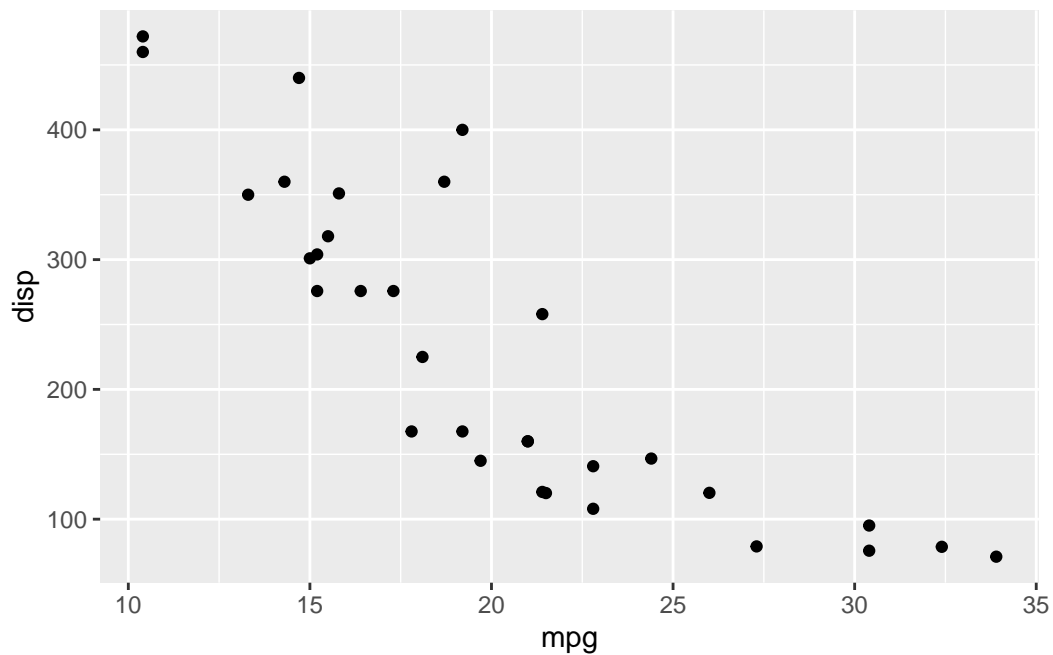
```
round(apply(mtscale, 2, mean), 3)
```

```
 mpg  cyl disp   hp drat   wt qsec   vs   am gear carb
   0    0    0    0    0    0    0    0    0    0    0
```
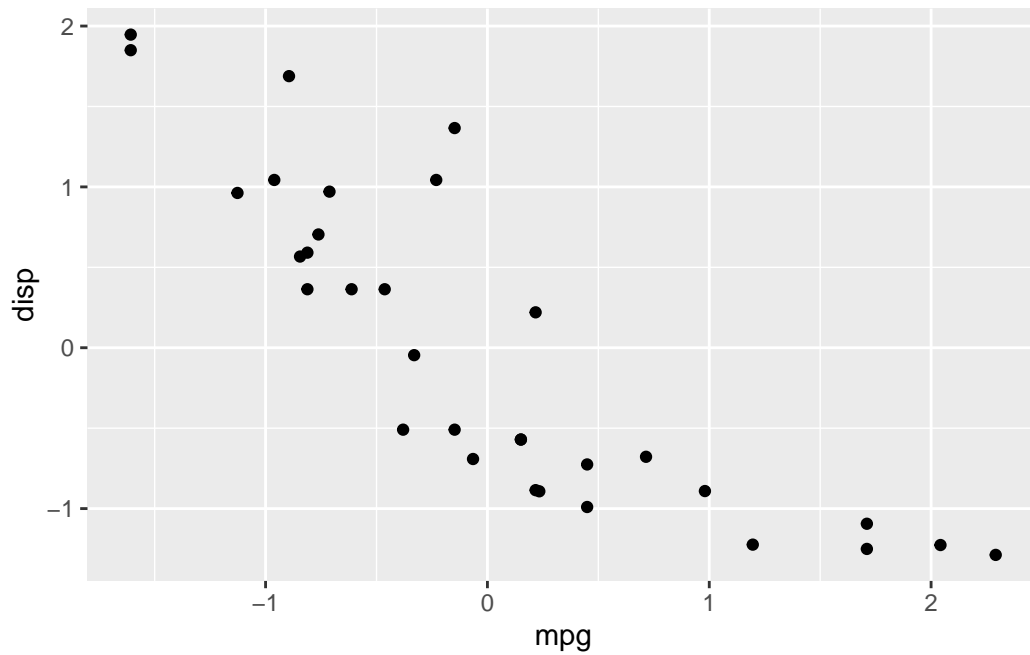
```
round(apply(mtscale, 2, sd), 3)
```

```
 mpg  cyl disp   hp drat   wt qsec   vs   am gear carb
   1    1    1    1    1    1    1    1    1    1    1
```
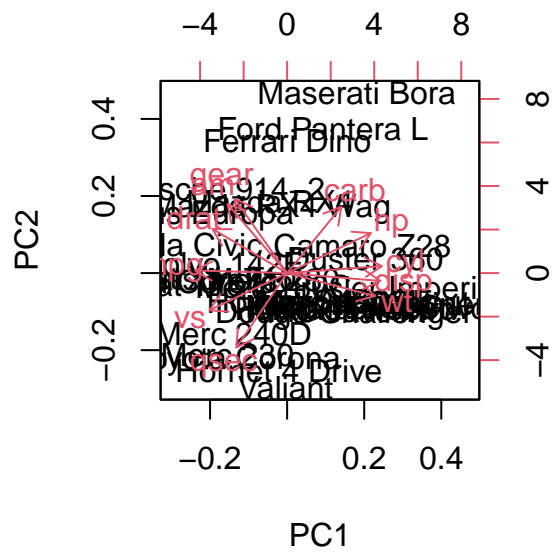
```
#lets plot
library(ggplot2)
ggplot(mtcars)+aes(mpg,disp)+geom_point()
```



```
ggplot(mtscale)+aes(mpg,disp)+geom_point()
```

```
pca2<-prcomp(mtscale)
biplot(pca2)
```

```r
library(dplyr)
```

```
Attaching package: 'dplyr'
```

```
The following objects are masked from 'package:stats':

    filter, lag
```

```
The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```r
# Save your input data file into your Project directory
fna.data <- "WisconsinCancer.csv"
# Complete the following code to input the data and store as wisc.df
wisc.df <- read.csv(fna.data, row.names=1)
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
```

```r
diagnosis <-as.factor(wisc.df$diagnosis)
# We can use -1 here to remove the first column
wisc.data <- wisc.df[,-1]


#Q1. How many observations are in this dataset? 569
```

```
nrow(wisc.data)
```

[1] 569

```
#Q2. How many of the observations have a malignant diagnosis?
malignentnumber<-wisc.data%>%filter(diagnosis=="M")
nrow(malignentnumber)
```

[1] 212

```
#Q3. How many variables/features in the data are suffixed with _mean? 10
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

```
# 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	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

```r
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=T)
summary(wisc.pr)
```

```
Importance of components:
                           PC1    PC2     PC3     PC4     PC5     PC6     PC7
Standard deviation      3.6444 2.3857 1.67867 1.40735 1.28403 1.09880 0.82172
Proportion of Variance  0.4427 0.1897 0.09393 0.06602 0.05496 0.04025 0.02251
Cumulative Proportion   0.4427 0.6324 0.72636 0.79239 0.84734 0.88759 0.91010
                           PC8    PC9    PC10    PC11    PC12    PC13    PC14
Standard deviation      0.69037 0.6457 0.59219 0.5421 0.51104 0.49128 0.39624
Proportion of Variance  0.01589 0.0139 0.01169 0.0098 0.00871 0.00805 0.00523
Cumulative Proportion   0.92598 0.9399 0.95157 0.9614 0.97007 0.97812 0.98335
                           PC15    PC16    PC17    PC18    PC19    PC20   PC21
Standard deviation      0.30681 0.28260 0.24372 0.22939 0.22244 0.17652 0.1731
Proportion of Variance  0.00314 0.00266 0.00198 0.00175 0.00165 0.00104 0.0010
Cumulative Proportion   0.98649 0.98915 0.99113 0.99288 0.99453 0.99557 0.9966
                           PC22    PC23   PC24    PC25    PC26    PC27    PC28
Standard deviation      0.16565 0.15602 0.1344 0.12442 0.09043 0.08307 0.03987
Proportion of Variance  0.00091 0.00081 0.0006 0.00052 0.00027 0.00023 0.00005
Cumulative Proportion   0.99749 0.99830 0.9989 0.99942 0.99969 0.99992 0.99997
                           PC29    PC30
Standard deviation      0.02736 0.01153
Proportion of Variance  0.00002 0.00000
Cumulative Proportion   1.00000 1.00000
```
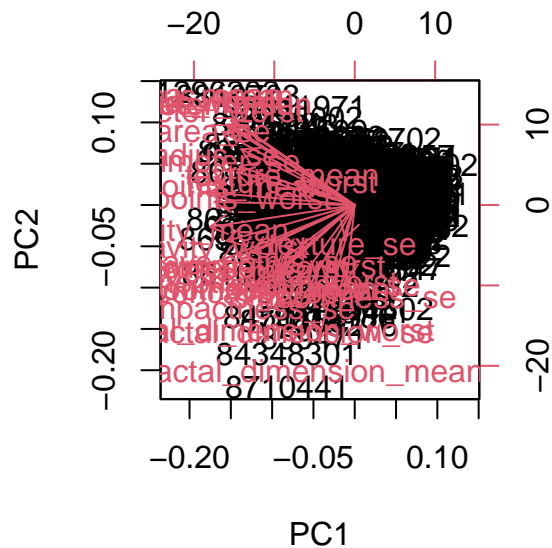
```
#Q4. From your results, what proportion of the original variance is captured by the first pr

#Q5. How many principal components (PCs) are required to describe at least 70% of the origina

#Q6. How many principal components (PCs) are required to describe at least 90% of the origina

biplot(wisc.pr)
```

10

PC1 / PC2 biplot

```
#Q7. What stands out to you about this plot? Is it easy or difficult to understand? Why?
#this plot looks terrible it is impossible to read because there are so many values on it
```

```
# Scatter plot observations by components 1 and 2
wisc.pr$x
```

	PC1	PC2	PC3	PC4	PC5
842302	-9.18475521	-1.946870030	-1.122178766	3.630536408	1.1940594778
842517	-2.38570263	3.764859063	-0.528827374	1.117280773	-0.6212283647
84300903	-5.72885549	1.074228589	-0.551262540	0.911280840	0.1769302185
84348301	-7.11669126	-10.266555635	-3.229947535	0.152412923	2.9582754313
84358402	-3.93184247	1.946358977	1.388544953	2.938054169	-0.5462667446
843786	-2.37815462	-3.946456430	-2.932296681	0.940209586	1.0551135428
844359	-2.23691506	2.687666414	-1.638471247	0.149208600	-0.0403240371
84458202	-2.14141428	-2.338186649	-0.871180715	-0.126931171	1.4261817833
844981	-3.17213315	-3.388831138	-3.117243065	-0.600768440	1.5209521144
84501001	-6.34616284	-7.720380945	-4.338098744	-3.372234369	-1.7087596141
845636	0.80970132	2.656937673	-0.488400053	-1.671096176	-0.2755690974
84610002	-2.64876984	-0.066509405	-1.525113359	0.051216497	-0.3316592904
846226	-8.17783882	-2.698602007	5.725193241	-1.111278747	-1.0425531111
846381	-0.34182514	0.967428026	1.715661982	-0.594479872	-0.4675990720
84667401	-4.33856172	-4.856809832	-2.813639832	-1.453278303	-1.2889287269

84799002	-4.07207318	-2.974443983	-3.122526655	-2.455909915	0.4079831402
848406	-0.22985277	1.563382114	-0.801813642	-0.650010973	0.4942761390
84862001	-4.41412695	-1.417423150	-2.268323145	-0.186108659	1.4226094459
849014	-4.94435304	4.110716528	-0.314472408	-0.088128974	0.0566653163
8510426	1.23597583	0.188049490	-0.592761930	1.594942716	0.4417655273
8510653	1.57677384	-0.572304625	-1.799863016	1.124286473	0.3949222435
8510824	3.55420904	-1.661487969	0.450790799	2.071941593	0.4903150736
8511133	-4.72904972	-3.302058265	-1.465247427	2.039355666	0.0261970715
851509	-4.20482441	5.123858059	-0.751740573	-0.861951843	0.4705538779
852552	-4.94528075	1.542395143	-1.711687827	0.046718059	1.7377012054
852631	-7.09232236	-2.016835734	-0.028984132	2.585675482	2.0375470912
852763	-3.50717666	-2.169715994	-3.891122637	-1.294620549	0.0681580703
852781	-3.06136021	1.874902631	2.579478032	0.128371462	0.1165625639
852973	-4.00374127	-0.536769860	-2.759197831	-1.896718595	0.5252107652
853201	-1.71380176	1.522365502	0.146058578	1.909706071	-0.5356519265
853401	-6.05411853	0.756511800	-0.348932376	-1.063281958	0.7454493340
853612	-2.89968469	-4.001774373	-2.998823809	-0.325030387	0.8546038749
85382601	-4.55077848	-0.337239419	-0.753637681	-0.699714306	1.5471839770
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```
917080        0.0544002611   1.580256e-02  -1.613705e-03   8.423291e-04   9.014139e-04
917092        0.0074556575   9.663785e-02  -2.665164e-02  -3.072198e-02  -5.603826e-03
91762702      0.2131860543   1.741659e-01  -1.264691e-01   1.220225e-02  -8.726745e-03
91789        -0.0681589606  -9.361363e-03  -8.419239e-03   1.344440e-02   2.051314e-03
917896       -0.1061345671   4.966193e-03  -6.582652e-03   4.193781e-02   7.898565e-03
917897        0.0664531179  -2.655619e-02  -2.136312e-02  -9.637608e-03   2.497448e-03
91805         0.0886147194   1.155966e-01  -5.229288e-02   1.076846e-02   1.449954e-03
91813701      0.0330021360   8.336065e-02  -5.061548e-03   3.298927e-02   5.387830e-04
91813702      0.0181336410   4.282084e-02   3.040698e-02   1.508284e-02  -7.330015e-03
918192       -0.0934720894  -5.020254e-02   4.171083e-02  -7.809330e-03  -9.193665e-05
918465        0.0288790490  -5.652693e-02  -1.947227e-03   1.611639e-03  -4.255828e-03
91858         0.0424242869   9.025177e-03  -1.623234e-02   6.269355e-03  -8.871060e-04
91903901      0.0931826121  -3.654002e-02   4.324270e-03   4.165806e-03  -1.106227e-03
91903902     -0.0830740552   1.658681e-02   1.150422e-02  -1.563064e-02  -6.663151e-03
91930402      0.1480707171   8.699232e-03  -5.961362e-02  -1.044751e-02  -6.141284e-03
919537        0.0728753384   1.259825e-02  -9.518713e-03   9.373100e-03  -3.095154e-03
919555        0.1536070303  -3.265112e-02   2.996697e-02   8.171708e-03  -3.458037e-02
91979701     -0.0487762627   5.821042e-02   1.015633e-02   2.035367e-02   9.738559e-03
919812        0.0329233687  -1.804282e-02  -2.169062e-02  -2.378939e-02   8.893677e-03
921092        0.1468627182   7.253893e-02  -8.746899e-03  -1.161071e-02   9.286171e-03
921362        0.1812441331   7.132198e-03   1.665571e-03  -5.739799e-02   3.679201e-02
921385       -0.0295036155  -8.523727e-03  -8.796157e-03  -2.463757e-03   9.112497e-05
921386       -0.0987152511   2.575798e-03  -1.994940e-02   8.161193e-03  -1.262046e-02
921644       -0.0565374950   1.610918e-02  -1.295072e-02  -2.390649e-02   4.092165e-03
922296        0.0568923371  -7.840121e-02  -1.162042e-02   3.505356e-03  -6.121733e-03
922297       -0.0542291424  -8.247547e-02  -8.960736e-03   1.302883e-02   4.772981e-03
922576       -0.0678745818  -1.961314e-02  -6.487119e-03  -4.750888e-03  -3.114620e-03
922577        0.0125381679   4.498783e-02   5.470187e-03  -7.783998e-03  -4.507372e-03
922840        0.0313546289  -4.161718e-02  -2.705643e-03   9.706143e-03   3.657914e-03
923169        0.1006525985   5.511332e-02  -8.274135e-04  -2.590615e-02   8.789459e-04
923465       -0.0007909619   3.418774e-02   6.937288e-05  -2.145122e-02  -4.134624e-03
923748       -0.0163685109  -1.107701e-02   2.770954e-02   1.795767e-02   8.260042e-03
923780       -0.0014215153   5.637368e-02  -3.381745e-03   3.849594e-03  -1.779362e-03
924084       -0.1022492547  -9.323360e-03   5.913651e-04   1.263059e-02  -7.162542e-03
924342        0.0044220903   4.297202e-03  -9.650436e-03  -1.615592e-02  -1.435061e-03
924632        0.0024994349  -7.130661e-02   4.473723e-02   1.560585e-02   1.385123e-03
924934        0.0938320141   3.896512e-02  -1.164274e-02  -1.431460e-03   6.878081e-03
924964        0.0152530115  -3.226473e-03   2.268760e-03  -1.799952e-02  -4.947889e-05
925236        0.1510723322   1.702667e-01   3.413466e-02   3.102528e-02   8.728220e-03
925277        0.0407493494   3.978350e-02  -1.130892e-02   4.068695e-03  -6.920526e-03
925291        0.0599659983  -3.787753e-02   2.037519e-02  -3.413149e-04   1.269775e-02
925292        0.0968312180  -1.392626e-02   2.900866e-02   1.731854e-03   4.328273e-03
925311        0.0041827618   2.209661e-02   7.486086e-03  -3.107530e-04   5.831723e-03
```

```
925622      0.2037854413 -1.474368e-01 -1.245986e-01  9.015380e-03 -7.118296e-03
926125     -0.0729289516  1.450989e-01 -3.945551e-02  7.014761e-02  7.638391e-03
926424     -0.1227922446  1.590577e-01  9.843968e-03  7.112909e-03  1.413613e-03
926682      0.0658312978 -6.845211e-02 -2.355466e-02 -2.746212e-02  1.041027e-02
926954      0.0070890278 -2.367063e-02 -2.575490e-03  6.700316e-03 -3.767102e-03
927241     -0.1980178555 -2.738532e-02 -6.802653e-02 -8.408929e-02  2.376191e-02
92751       0.3468098821  1.272691e-01 -9.507513e-03 -6.085956e-02  1.945846e-02
```

```r
plot(wisc.pr$x, col = diagnosis ,
     xlab = "PC1", ylab = "PC2")
```
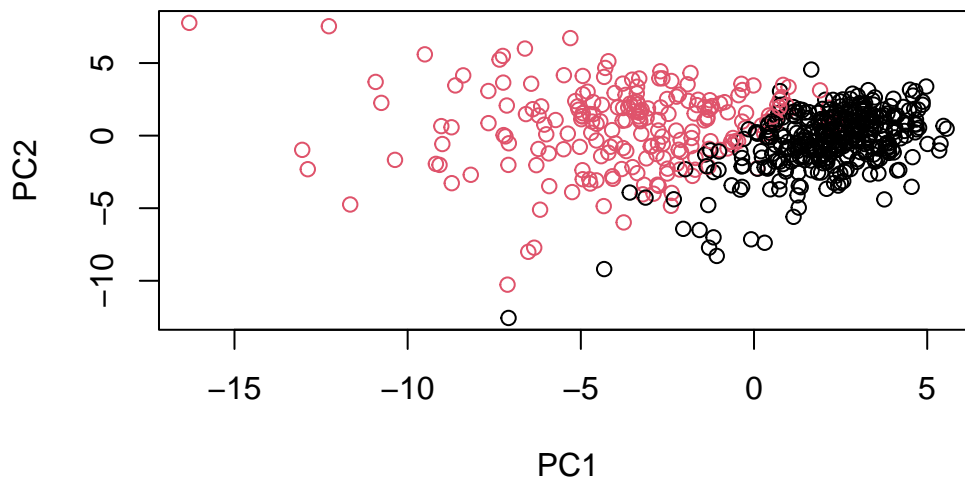


```r
# Repeat for components 1 and 3
plot(wisc.pr$x[,1:3], col = diagnosis,
     xlab = "PC1", ylab = "PC3")
```

91
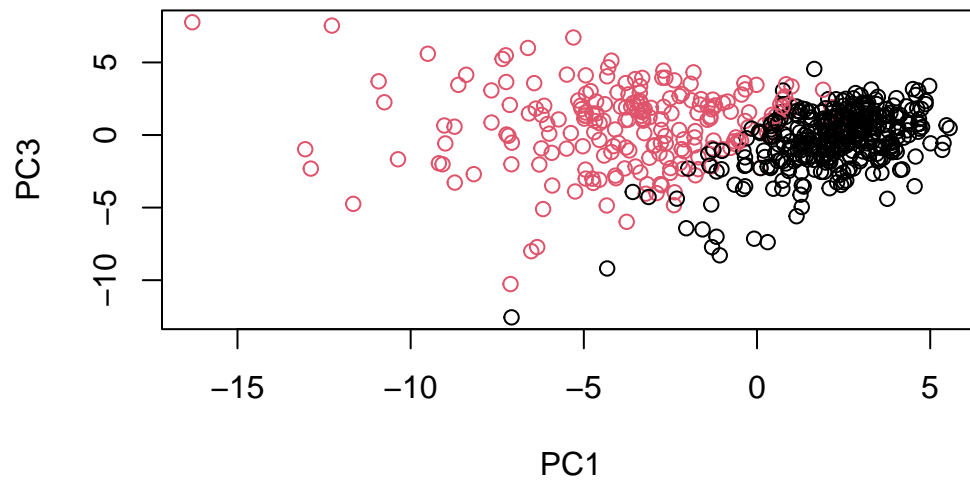
```
# Create a data.frame for ggplot
df <- as.data.frame(wisc.pr$x)
df$diagnosis <- diagnosis
# Load the ggplot2 package
library(ggplot2)
# Make a scatter plot colored by diagnosis
ggplot(df) +
  aes(PC1, PC2, col=diagnosis) +
  geom_point()
```
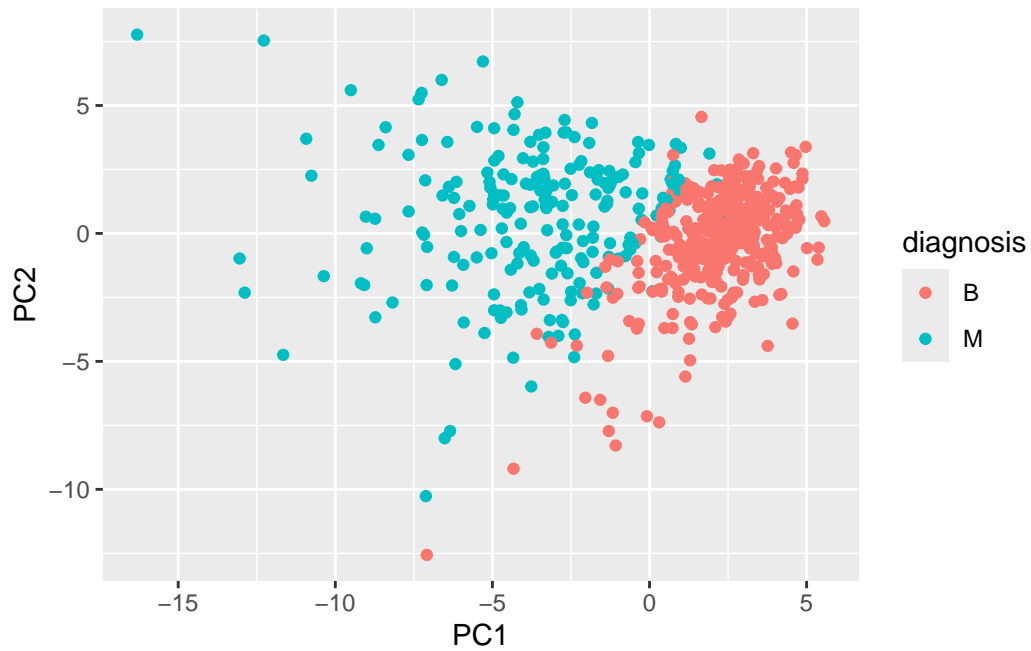
```
pr.var <- wisc.pr$sdev^2
head(pr.var)
```

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

```
# Variance explained by each principal component: pve
pve <- (wisc.pr$sdev^2) / sum(pr.var)

# Plot variance explained for each principal component
plot(pve, xlab = "Principal Component",
     ylab = "Proportion of Variance Explained",
     ylim = c(0, 1), type = "o")
```
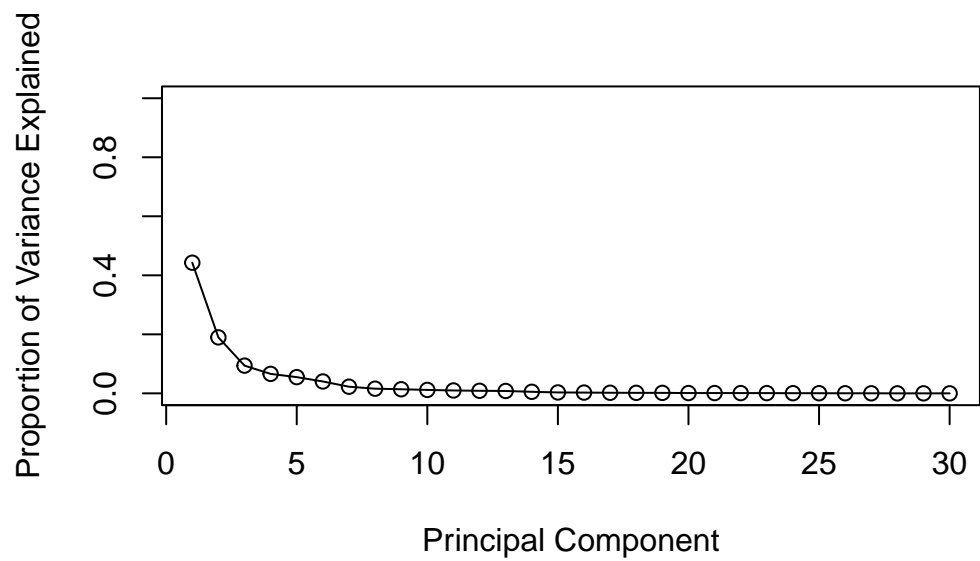
```
# Alternative scree plot of the same data, note data driven y-axis
barplot(pve, ylab = "Precent of Variance Explained",
    names.arg=paste0("PC",1:length(pve)), las=2, axes = FALSE)
axis(2, at=pve, labels=round(pve,2)*100 )
```
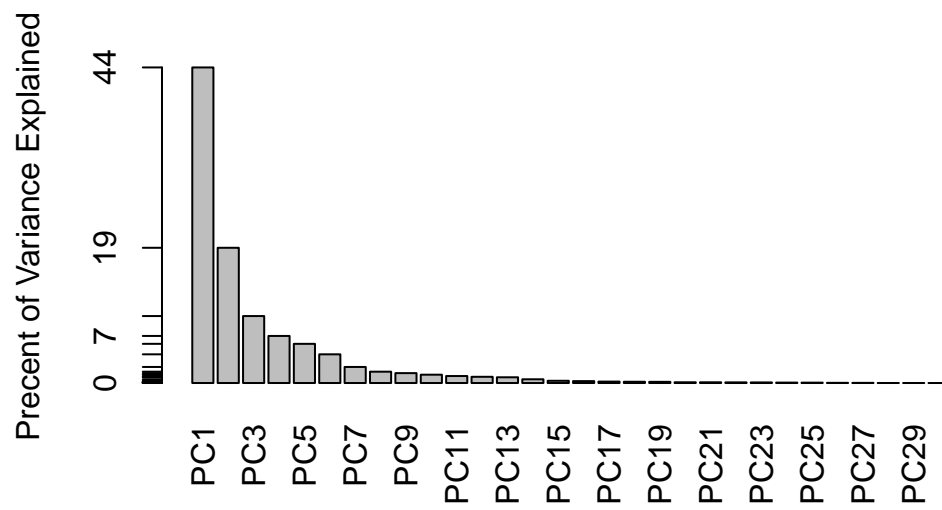
```
## ggplot based graph
#install.packages("factoextra")
library(factoextra)
```

Welcome! Want to learn more? See two factoextra-related books at https://goo.gl/ve3WBa

```
fviz_eig(wisc.pr, addlabels = TRUE)
```

Scree plot
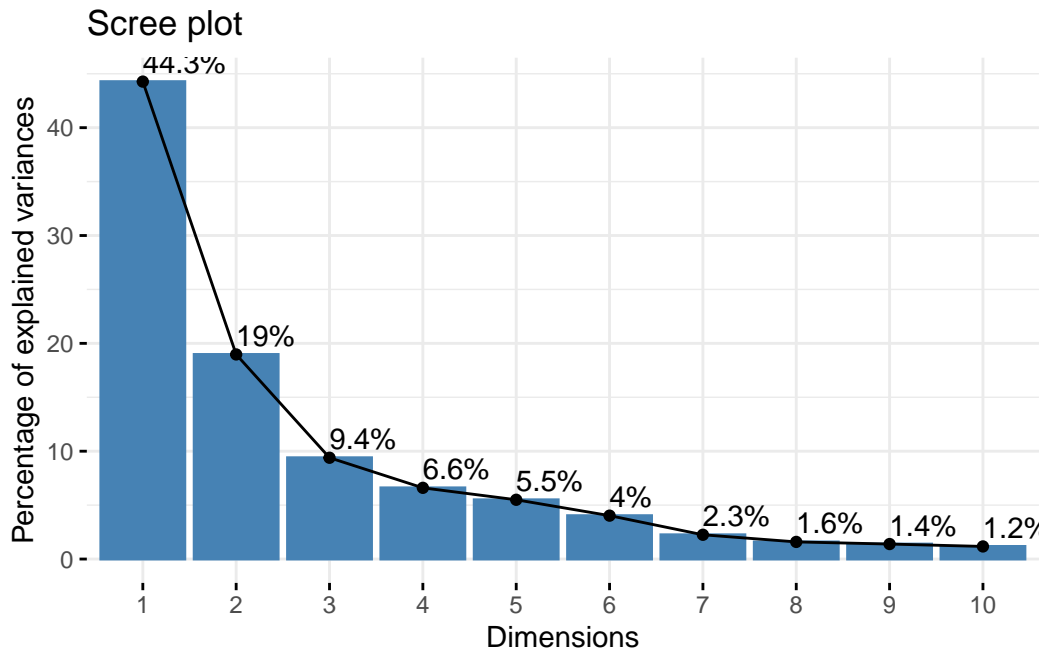
#Q9. For the first principal component, what is the component of the loading vector (i.e. wis
#it contributes 44.3 percent to the first PC

```r
# Scale the wisc.data data using the "scale()" function
data.scaled <- scale(wisc.data)
data.dist <- dist(data.scaled)
wisc.hclust <- hclust(data.dist,"complete")
#Q10. Using the plot() and abline() functions, what is the height at which the clustering mod
plot(wisc.hclust)
abline(h=19, col="red", lty=2)
```

Cluster Dendrogram
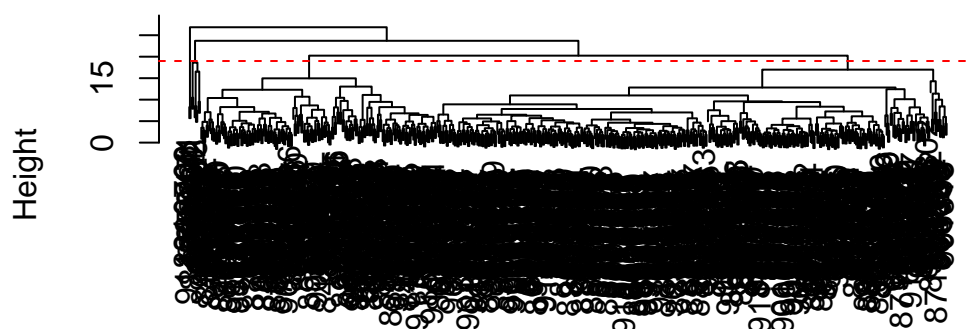
data.dist
hclust (*, "complete")

```
wisc.hclust.clusters <- cutree(wisc.hclust, h=19)
table(wisc.hclust.clusters)
```

```
wisc.hclust.clusters
  1   2   3   4
177   7 383   2
```

```
table(wisc.hclust.clusters, diagnosis)
```

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

```
#Q11. OPTIONAL: Can you find a better cluster vs diagnoses match by cutting into a different
wisc.hclust.clusters2 <- cutree(wisc.hclust, h=8)
table(wisc.hclust.clusters2, diagnosis)
```

```
                     diagnosis
```

```
wisc.hclust.clusters2   B   M
                 1   0   3
                 2   0  41
                 3   0   1
                 4   0  11
                 5   9  40
                 6   3   6
                 7   0   2
                 8   9  15
                 9   0   2
                10   0  21
                11 182   6
                12   0   4
                13   2  15
                14  49   3
                15  40   0
                16   8   0
                17  11   0
                18   9   0
                19   1   0
                20   3   0
                21   0  12
                22   0   1
                23   0   4
                24   0   2
                25   4   0
                26   2   0
                27   0   1
                28  15   0
                29   0   1
                30   3   0
                31   1   0
                32   0   4
                33   0   6
                34   4   0
                35   0   1
                36   0   1
                37   0   2
                38   0   6
                39   0   1
                40   2   0
```

```
#looking at the amount of trees with few numbers is a good indicator of quality
wisc.pr.hclust <- hclust(data.dist,method="ward.D2")
#Q12. Which method gives your favorite results for the same data.dist dataset? Explain your
#my favorite mode of clustering is single because I appreaciate the chaos and I find it funny
```
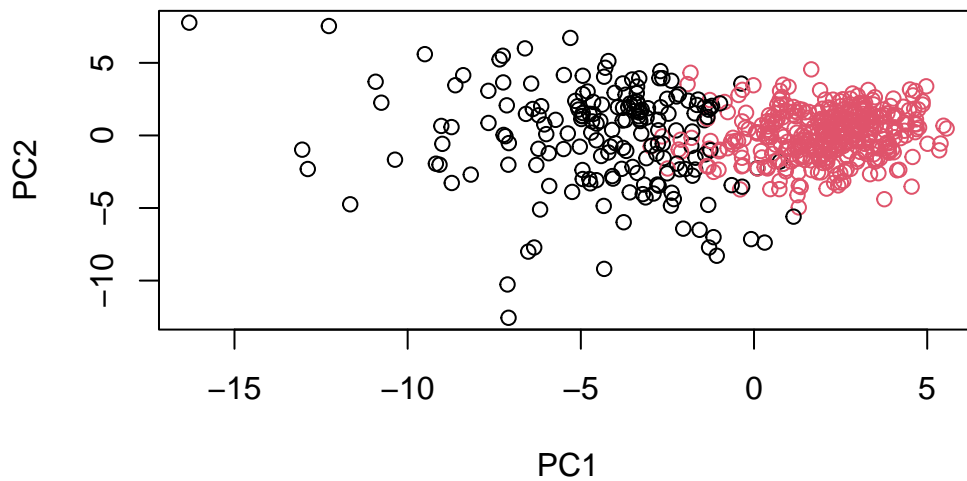
```
grps <- cutree(wisc.pr.hclust, k=2)
table(grps)
```
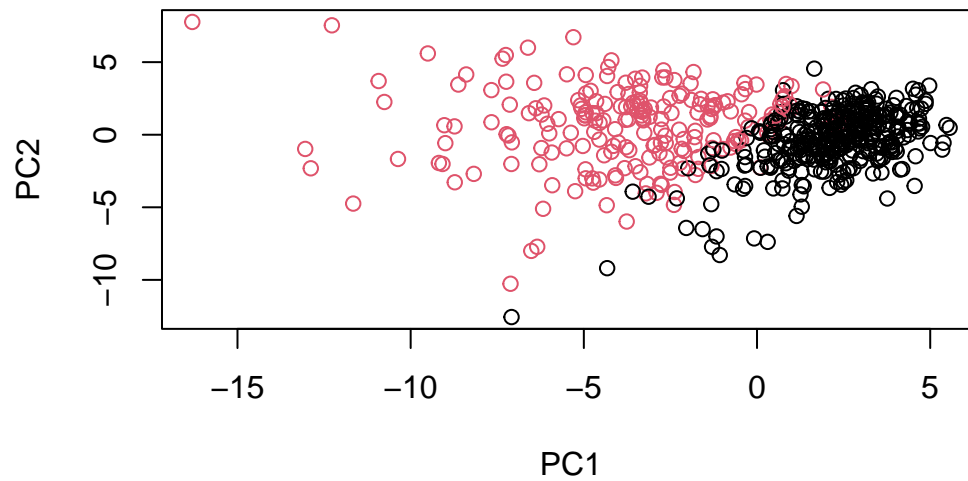
```
grps
  1   2
184 385
```

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

```
     diagnosis
grps   B   M
   1  20 164
   2 337  48
```

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

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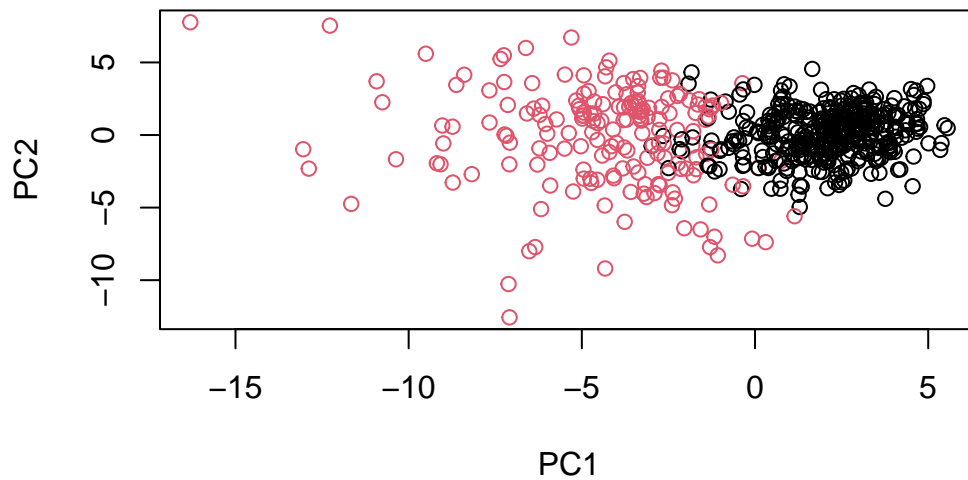


```
g <- as.factor(grps)
levels(g)
```

```
[1] "1" "2"
```

```
g <- relevel(g,2)
levels(g)
```

```
[1] "2" "1"
```

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

```
## Use the distance along the first 7 PCs for clustering i.e. wisc.pr$x[, 1:7]
wisc.pr.hclust <- hclust(dist(wisc.pr$x[, 1:7]), method="ward.D2")
wisc.pr.hclust.clusters <- cutree(wisc.pr.hclust, k=2)
table(wisc.pr.hclust.clusters, diagnosis)
```

```
                         diagnosis
wisc.pr.hclust.clusters   B   M
                      1  28 188
                      2 329  24
```

```
#Q13. How well does the newly created model with four clusters separate out the two diagnoses
#It does well, it separates them out into disease and non-disease
#barry said to skip 13-15
```

```
#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
```

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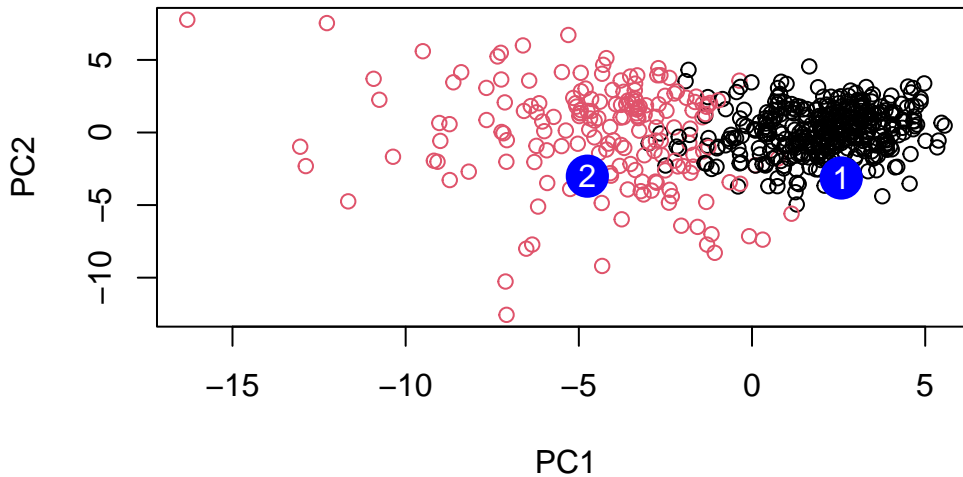


```
#Q16. Which of these new patients should we prioritize for follow up based on your results?
#I would want to investigate patient 2 because it follows the pattern of malignent cells
```