class08

AUTHOR
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```
#Import Wisconsin Cancer data

url <- "https://bioboot.github.io/bimm143_S20/class-material/WisconsinCancer.csv"
wisc.df <- read.csv(url, row.names=1)

#preview data
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
```

```
#remove first column
wisc.data <- wisc.df[,-1]

head(wisc.data)
```

```
         radius_mean texture_mean perimeter_mean area_mean smoothness_mean
842302         17.99        10.38         122.80    1001.0         0.11840
842517         20.57        17.77         132.90    1326.0         0.08474
84300903       19.69        21.25         130.00    1203.0         0.10960
84348301       11.42        20.38          77.58     386.1         0.14250
84358402       20.29        14.34         135.10    1297.0         0.10030
843786         12.45        15.70          82.57     477.1         0.12780
         compactness_mean concavity_mean concave.points_mean symmetry_mean
842302            0.27760         0.3001             0.14710        0.2419
842517            0.07864         0.0869             0.07017        0.1812
84300903          0.15990         0.1974             0.12790        0.2069
84348301          0.28390         0.2414             0.10520        0.2597
84358402          0.13280         0.1980             0.10430        0.1809
843786            0.17000         0.1578             0.08089        0.2087
         fractal_dimension_mean radius_se texture_se perimeter_se area_se
842302                  0.07871    1.0950     0.9053        8.589  153.40
842517                  0.05667    0.5435     0.7339        3.398   74.08
84300903                0.05999    0.7456     0.7869        4.585   94.03
84348301                0.09744    0.4956     1.1560        3.445   27.23
84358402                0.05883    0.7572     0.7813        5.438   94.44
843786                  0.07613    0.3345     0.8902        2.217   27.19
         smoothness_se compactness_se concavity_se concave.points_se
842302        0.006399        0.04904      0.05373           0.01587
842517        0.005225        0.01308      0.01860           0.01340
```

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

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

#Q1. How many observations are in this dataset?
num_observations <- nrow(wisc.data)
num_observations
```

```
[1] 569
```

```
#A1. 569 observations.

#Q2. How many of the observations have a malignant diagnosis?
num_malignant <- sum(diagnosis == "M")
num_malignant
```

```
[1] 212
```

```
#A2. 212.

#Q3. How many variables/features in the data are suffixed with _mean?
num_mean_vars <- length(grep("_mean$", names(wisc.data)))
num_mean_vars
```

```
[1] 10
```

```
#A3. 10.

#check column means and std
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)

summary(wisc.pr)
```

```
Importance of components:
                          PC1      PC2      PC3     PC4     PC5     PC6    PC7
Standard deviation     666.170 85.49912 26.52987 7.39248 6.31585 1.73337 1.347
Proportion of Variance   0.982  0.01618  0.00156 0.00012 0.00009 0.00001 0.000
Cumulative Proportion    0.982  0.99822  0.99978 0.99990 0.99999 0.99999 1.000
                           PC8    PC9    PC10    PC11    PC12    PC13    PC14
Standard deviation     0.6095 0.3944 0.2899 0.1778 0.08659 0.05623 0.04649
Proportion of Variance 0.0000 0.0000 0.0000 0.0000 0.00000 0.00000 0.00000
Cumulative Proportion  1.0000 1.0000 1.0000 1.0000 1.00000 1.00000 1.00000
                          PC15    PC16    PC17    PC18    PC19    PC20     PC21
Standard deviation     0.03642 0.0253 0.01936 0.01534 0.01359 0.01281 0.008838
Proportion of Variance 0.00000 0.0000 0.00000 0.00000 0.00000 0.00000 0.000000
Cumulative Proportion  1.00000 1.0000 1.00000 1.00000 1.00000 1.00000 1.000000
                          PC22     PC23     PC24     PC25     PC26     PC27
Standard deviation     0.00759 0.005909 0.005329 0.004018 0.003534 0.001918
Proportion of Variance 0.00000 0.000000 0.000000 0.000000 0.000000 0.000000
Cumulative Proportion  1.00000 1.000000 1.000000 1.000000 1.000000 1.000000
                          PC28     PC29      PC30
Standard deviation     0.001688 0.001416 0.0008379
Proportion of Variance 0.000000 0.000000 0.0000000
Cumulative Proportion  1.000000 1.000000 1.0000000
```

```
#Q4. From your results, what proportion of the original variance is captured by the first principa

#A4. The proportion of variance captured by the first principal component (PC1) is 0.4427 (44.27%

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

#Q5. Cumulative Proportion for PC1: 0.4427.  Cumulative Proportion for PC2: 0.6324. Cumulative Pr

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

#A6. Cumulative Proportion for PC1: 0.4427.  Cumulative Proportion for PC2: 0.6324.  Cumulative P


biplot(wisc.pr)
```

```
Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
arrow.len): zero-length arrow is of indeterminate angle and so skipped

Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
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arrow.len): zero-length arrow is of indeterminate angle and so skipped

Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
arrow.len): zero-length arrow is of indeterminate angle and so skipped
```

```
Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
arrow.len): zero-length arrow is of indeterminate angle and so skipped

Warning in arrows(0, 0, y[, 1L] * 0.8, y[, 2L] * 0.8, col = col[2L], length =
arrow.len): zero-length arrow is of indeterminate angle and so skipped

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arrow.len): zero-length arrow is of indeterminate angle and so skipped
```

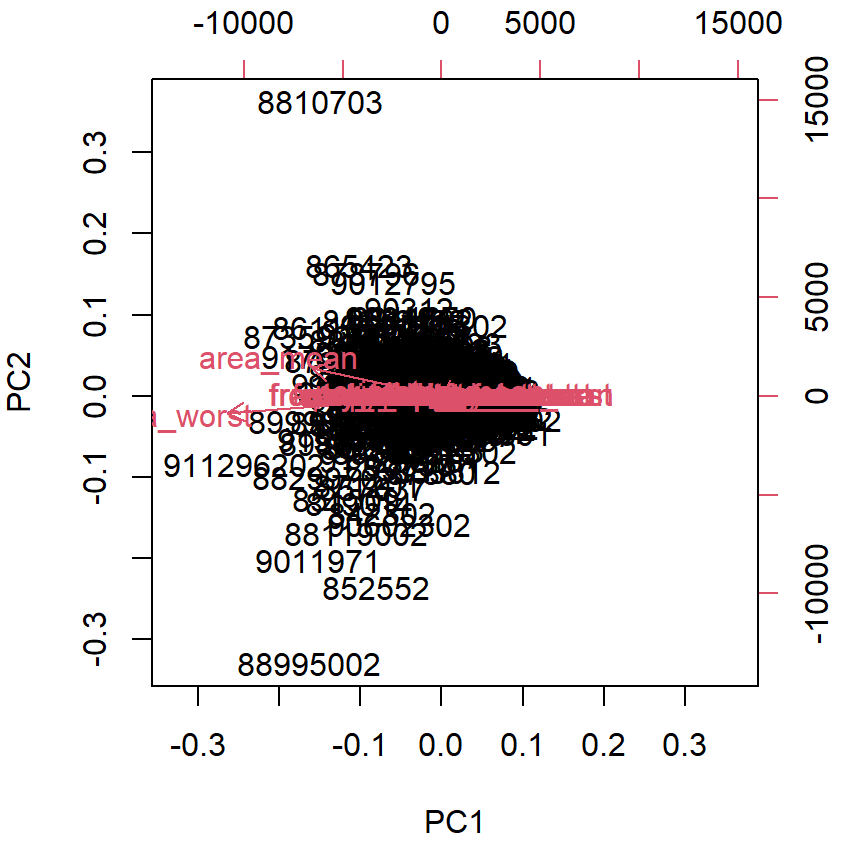


```
#Q7. What stands out to you about this plot? Is it easy or difficult to understand? Why?

#A7. Need to generate own plots to gain usable insight of PCA results.
```