CMTH642 Assignment 3

Paul Ycay

25/07/2019

The following document was used to supplement this project https://rpubs.com/shradhit/winequality The RMD file for Lab 10 and Lab 10 solutions was used to supplement this assignment as well Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

1. Check data characteristics. Is there missing data?

```
wine<-read.csv(file="http://archive.ics.uci.edu/ml/machine-learning-
databases/wine-quality/winequality-white.csv", header = TRUE, sep= ";");
str(wine)

## 'data.frame':    4898 obs. of  12 variables:
##  $ fixed.acidity       : num  7 6.3 8.1 7.2 7.2 8.1 6.2 7 6.3 8.1 ...
##  $ volatile.acidity    : num  0.27 0.3 0.28 0.23 0.23 0.28 0.32 0.27 0.3
0.22 ...
##  $ citric.acid         : num  0.36 0.34 0.4 0.32 0.32 0.4 0.16 0.36 0.34
0.43 ...
##  $ residual.sugar      : num  20.7 1.6 6.9 8.5 8.5 6.9 7 20.7 1.6 1.5 ...
##  $ chlorides           : num  0.045 0.049 0.05 0.058 0.058 0.05 0.045
0.045 0.049 0.044 ...
##  $ free.sulfur.dioxide : num  45 14 30 47 47 30 30 45 14 28 ...
##  $ total.sulfur.dioxide: num  170 132 97 186 186 97 136 170 132 129 ...
##  $ density             : num  1.001 0.994 0.995 0.996 0.996 ...
##  $ pH                  : num  3 3.3 3.26 3.19 3.19 3.26 3.18 3 3.3 3.22
...
##  $ sulphates           : num  0.45 0.49 0.44 0.4 0.4 0.44 0.47 0.45 0.49
0.45 ...
##  $ alcohol             : num  8.8 9.5 10.1 9.9 9.9 10.1 9.6 8.8 9.5 11 ...
##  $ quality             : int  6 6 6 6 6 6 6 6 6 6 ...

head(wine)

##   fixed.acidity volatile.acidity citric.acid residual.sugar chlorides
## 1           7.0             0.27        0.36           20.7     0.045
## 2           6.3             0.30        0.34            1.6     0.049
## 3           8.1             0.28        0.40            6.9     0.050
## 4           7.2             0.23        0.32            8.5     0.058
## 5           7.2             0.23        0.32            8.5     0.058
## 6           8.1             0.28        0.40            6.9     0.050
##   free.sulfur.dioxide total.sulfur.dioxide density   pH sulphates alcohol
## 1                  45                  170  1.0010 3.00      0.45     8.8
## 2                  14                  132  0.9940 3.30      0.49     9.5
## 3                  30                   97  0.9951 3.26      0.44    10.1
## 4                  47                  186  0.9956 3.19      0.40     9.9
## 5                  47                  186  0.9956 3.19      0.40     9.9
## 6                  30                   97  0.9951 3.26      0.44    10.1
##   quality
## 1       6
## 2       6
## 3       6
## 4       6
## 5       6
## 6       6
```

```
tail(wine)
```

```
##      fixed.acidity volatile.acidity citric.acid residual.sugar chlorides
## 4893           6.5             0.23        0.38            1.3     0.032
## 4894           6.2             0.21        0.29            1.6     0.039
## 4895           6.6             0.32        0.36            8.0     0.047
## 4896           6.5             0.24        0.19            1.2     0.041
## 4897           5.5             0.29        0.30            1.1     0.022
## 4898           6.0             0.21        0.38            0.8     0.020
##      free.sulfur.dioxide total.sulfur.dioxide density   pH sulphates
## 4893                  29                  112 0.99298 3.29      0.54
## 4894                  24                   92 0.99114 3.27      0.50
## 4895                  57                  168 0.99490 3.15      0.46
## 4896                  30                  111 0.99254 2.99      0.46
## 4897                  20                  110 0.98869 3.34      0.38
## 4898                  22                   98 0.98941 3.26      0.32
##      alcohol quality
## 4893     9.7       5
## 4894    11.2       6
## 4895     9.6       5
## 4896     9.4       6
## 4897    12.8       7
## 4898    11.8       6
```

```
summary(wine)
```

```
##  fixed.acidity    volatile.acidity  citric.acid     residual.sugar
##  Min.   : 3.800   Min.   :0.0800   Min.   :0.0000   Min.   : 0.600
##  1st Qu.: 6.300   1st Qu.:0.2100   1st Qu.:0.2700   1st Qu.: 1.700
##  Median : 6.800   Median :0.2600   Median :0.3200   Median : 5.200
##  Mean   : 6.855   Mean   :0.2782   Mean   :0.3342   Mean   : 6.391
##  3rd Qu.: 7.300   3rd Qu.:0.3200   3rd Qu.:0.3900   3rd Qu.: 9.900
##  Max.   :14.200   Max.   :1.1000   Max.   :1.6600   Max.   :65.800
##    chlorides        free.sulfur.dioxide total.sulfur.dioxide
##  Min.   :0.00900   Min.   :  2.00      Min.   :  9.0
##  1st Qu.:0.03600   1st Qu.: 23.00      1st Qu.:108.0
##  Median :0.04300   Median : 34.00      Median :134.0
##  Mean   :0.04577   Mean   : 35.31      Mean   :138.4
##  3rd Qu.:0.05000   3rd Qu.: 46.00      3rd Qu.:167.0
##  Max.   :0.34600   Max.   :289.00      Max.   :440.0
##     density             pH          sulphates         alcohol
##  Min.   :0.9871   Min.   :2.720   Min.   :0.2200   Min.   : 8.00
##  1st Qu.:0.9917   1st Qu.:3.090   1st Qu.:0.4100   1st Qu.: 9.50
##  Median :0.9937   Median :3.180   Median :0.4700   Median :10.40
##  Mean   :0.9940   Mean   :3.188   Mean   :0.4898   Mean   :10.51
##  3rd Qu.:0.9961   3rd Qu.:3.280   3rd Qu.:0.5500   3rd Qu.:11.40
##  Max.   :1.0390   Max.   :3.820   Max.   :1.0800   Max.   :14.20
##     quality
##  Min.   :3.000
##  1st Qu.:5.000
##  Median :6.000
##  Mean   :5.878
##  3rd Qu.:6.000
##  Max.   :9.000
```

```
sum(is.na(wine))
```

```
## [1] 0
```

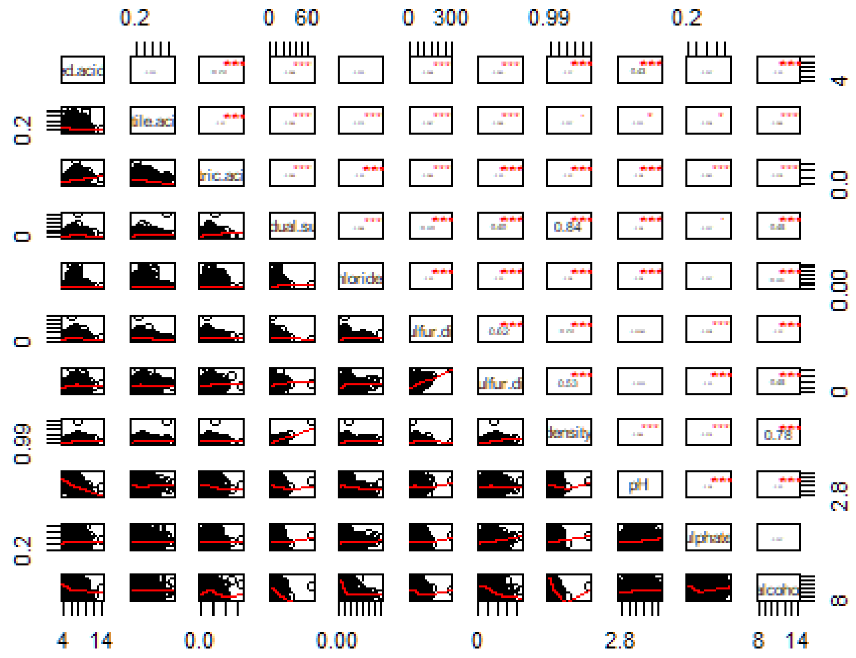
There is no missing data

2.What is the correlation between the attributes other than wine quality?

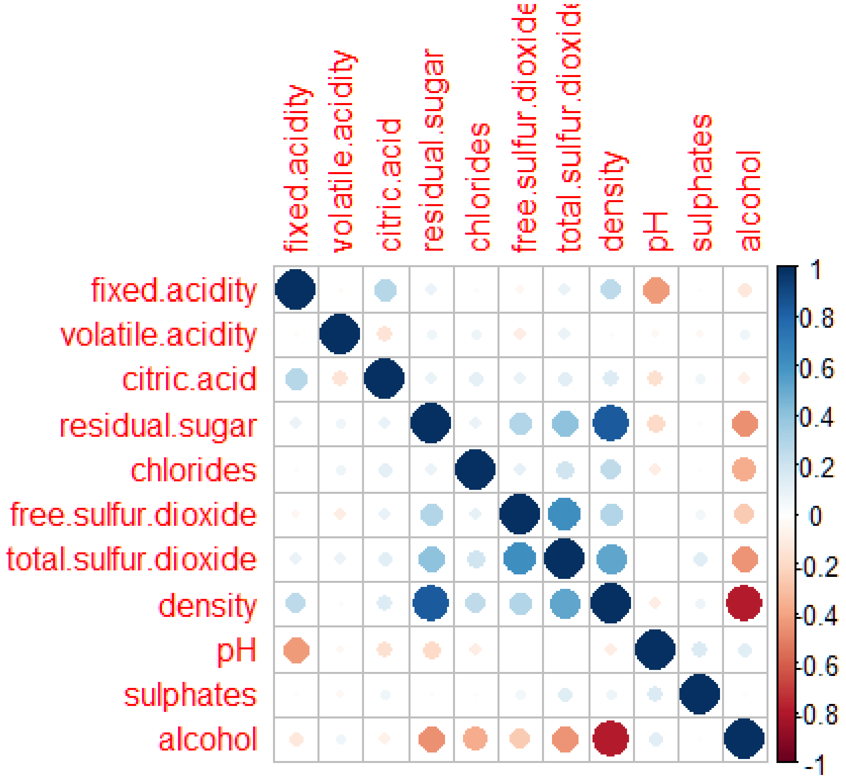
```
panel.cor <- function(x, y, digits=2, prefix="", cex.cor)
{
    usr <- par("usr"); on.exit(par(usr))
    par(usr = c(0, 1, 0, 1))
    r <- abs(cor(x, y))
    txt <- format(c(r, 0.123456789), digits=digits)[1]
    txt <- paste(prefix, txt, sep="")
    if(missing(cex.cor)) cex <- 0.8/strwidth(txt)

    test <- cor.test(x,y)
    # borrowed from printCoefmat
    Signif <- symnum(test$p.value, corr = FALSE, na = FALSE,
                  cutpoints = c(0, 0.001, 0.01, 0.05, 0.1, 1),
                  symbols = c("***", "**", "*", ".", " "))

    text(0.5, 0.5, txt, cex = cex * r)
    text(.8, .8, Signif, cex=cex, col=2)
}
wine_cor<-subset(wine, select=c(1:11))
pairs(wine_cor, lower.panel=panel.smooth, upper.panel=panel.cor)
```

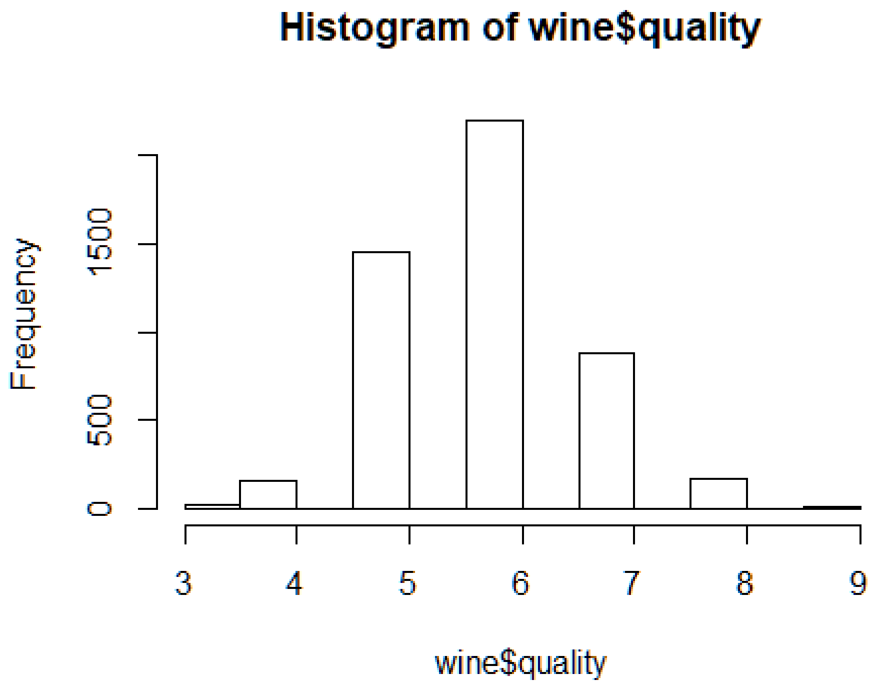


```
corrplot(cor(wine_cor))
```



3. Graph the frequency distribution of wine quality.

```
hist(wine$quality)
```



4. Reduce the levels of rating for quality to three levels as high, medium and low.

```
wine$quality = ifelse(wine$quality < 5, 'low', ifelse(wine$quality > 7,
'high', 'medium'))
wine$quality = ordered(wine$quality, c('low', 'medium', 'high'))
round(prop.table(table(wine$quality)) * 100, digits = 1)

##
##    low medium   high
##    3.7   92.6    3.7

head(wine$quality)

## [1] medium medium medium medium medium medium
## Levels: low < medium < high

tail(wine$quality)

## [1] medium medium medium medium medium medium
## Levels: low < medium < high

summary(wine$quality)

##    low medium   high
##    183   4535    180
```

5. Normalize the data set.

```
normalize <- function(x) {
               return ((x - min(x)) / (max(x) - min(x))) }
wine_n <- as.data.frame(lapply(wine[-12],normalize))
wine_n <- cbind(wine_n,wine$quality)
head(wine_n)
```

```
##   fixed.acidity volatile.acidity citric.acid residual.sugar chlorides
## 1     0.3076923        0.1862745   0.2168675     0.30828221 0.1068249
## 2     0.2403846        0.2156863   0.2048193     0.01533742 0.1186944
## 3     0.4134615        0.1960784   0.2409639     0.09662577 0.1216617
## 4     0.3269231        0.1470588   0.1927711     0.12116564 0.1454006
## 5     0.3269231        0.1470588   0.1927711     0.12116564 0.1454006
## 6     0.4134615        0.1960784   0.2409639     0.09662577 0.1216617
##   free.sulfur.dioxide total.sulfur.dioxide   density        pH sulphates
## 1          0.14982578            0.3735499 0.2677848 0.2545455 0.2674419
## 2          0.04181185            0.2853828 0.1328321 0.5272727 0.3139535
## 3          0.09756098            0.2041763 0.1540389 0.4909091 0.2558140
## 4          0.15679443            0.4106729 0.1636784 0.4272727 0.2093023
## 5          0.15679443            0.4106729 0.1636784 0.4272727 0.2093023
## 6          0.09756098            0.2041763 0.1540389 0.4909091 0.2558140
##     alcohol wine$quality
## 1 0.1290323       medium
## 2 0.2419355       medium
## 3 0.3387097       medium
## 4 0.3064516       medium
## 5 0.3064516       medium
## 6 0.3387097       medium
```

```
tail(wine_n)
```

```
##      fixed.acidity volatile.acidity citric.acid residual.sugar  chlorides
## 4893     0.2596154        0.1470588   0.2289157    0.010736196 0.06824926
## 4894     0.2307692        0.1274510   0.1746988    0.015337423 0.08902077
## 4895     0.2692308        0.2352941   0.2168675    0.113496933 0.11275964
## 4896     0.2596154        0.1568627   0.1144578    0.009202454 0.09495549
## 4897     0.1634615        0.2058824   0.1807229    0.007668712 0.03857567
## 4898     0.2115385        0.1274510   0.2289157    0.003067485 0.03264095
##      free.sulfur.dioxide total.sulfur.dioxide    density        pH
## 4893          0.09407666            0.2389791 0.11316753 0.5181818
## 4894          0.07665505            0.1925754 0.07769424 0.5000000
## 4895          0.19163763            0.3689095 0.15018315 0.3909091
## 4896          0.09756098            0.2366589 0.10468479 0.2454545
## 4897          0.06271777            0.2343387 0.03046077 0.5636364
## 4898          0.06968641            0.2064965 0.04434162 0.4909091
##      sulphates   alcohol wine$quality
## 4893 0.3720930 0.2741935       medium
## 4894 0.3255814 0.5161290       medium
## 4895 0.2790698 0.2580645       medium
## 4896 0.2790698 0.2258065       medium
## 4897 0.1860465 0.7741935       medium
## 4898 0.1162791 0.6129032       medium
```

```
summary(wine_n)
```

```
##  fixed.acidity    volatile.acidity  citric.acid     residual.sugar
##  Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.00000
##  1st Qu.:0.2404   1st Qu.:0.1275   1st Qu.:0.1627   1st Qu.:0.01687
##  Median :0.2885   Median :0.1765   Median :0.1928   Median :0.07055
##  Mean   :0.2937   Mean   :0.1944   Mean   :0.2013   Mean   :0.08883
##  3rd Qu.:0.3365   3rd Qu.:0.2353   3rd Qu.:0.2349   3rd Qu.:0.14264
##  Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.00000
##    chlorides        free.sulfur.dioxide total.sulfur.dioxide
##  Min.   :0.00000   Min.   :0.00000     Min.   :0.0000
##  1st Qu.:0.08012   1st Qu.:0.07317     1st Qu.:0.2297
##  Median :0.10089   Median :0.11150     Median :0.2900
##  Mean   :0.10912   Mean   :0.11606     Mean   :0.3001
##  3rd Qu.:0.12166   3rd Qu.:0.15331     3rd Qu.:0.3666
##  Max.   :1.00000   Max.   :1.00000     Max.   :1.0000
##     density              pH           sulphates         alcohol
##  Min.   :0.00000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000
##  1st Qu.:0.08892   1st Qu.:0.3364   1st Qu.:0.2209   1st Qu.:0.2419
##  Median :0.12782   Median :0.4182   Median :0.2907   Median :0.3871
##  Mean   :0.13336   Mean   :0.4257   Mean   :0.3138   Mean   :0.4055
##  3rd Qu.:0.17332   3rd Qu.:0.5091   3rd Qu.:0.3837   3rd Qu.:0.5484
##  Max.   :1.00000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000
##  wine$quality
##  low   : 183
##  medium:4535
##  high  : 180
##
##
##
```

6. Divide the data to training and testing groups.

```
set.seed(1)
index <- sample(1:nrow(wine_n), 0.65 *nrow(wine_n))
wine_train <- wine_n[index,]
wine_test <- wine_n[-index,]
wine_train_labels <- wine_train[,12]
wine_test_labels <- wine_test[,12]
summary(wine_train_labels)
```

```
##    low medium   high
##    124   2925    134
```

```
summary(wine_test_labels)
```

```
##    low medium   high
##     59   1610     46
```

7. Use the KNN algorithm to predict quality of wine using its attributes

```
wine_test_pred <- knn(train = wine_train[,1:11], test = wine_test[,1:11],cl =
wine_train[,1], k=10)
head(wine_test_pred)

## [1] 0.336538461538462 0.326923076923077 0.365384615384615
0.394230769230769
## [5] 0.442307692307692 0.25
## 64 Levels: 0 0.00961538461538462 0.0384615384615385 ... 1

tail(wine_test_pred)

## [1] 0.221153846153846 0.25              0.259615384615385
0.182692307692308
## [5] 0.269230769230769 0.298076923076923
## 64 Levels: 0 0.00961538461538462 0.0384615384615385 ... 1

summary(wine_test_pred)

##                   0 0.00961538461538462  0.0384615384615385
##                   0                   0                   0
##  0.0576923076923078  0.0865384615384616  0.0961538461538462
##                   0                   0                   0
##   0.105769230769231   0.115384615384615               0.125
##                   0                   3                   4
##   0.134615384615385   0.144230769230769   0.153846153846154
##                   3                   5                   8
##   0.163461538461538   0.173076923076923   0.182692307692308
##                   6                  12                  24
##   0.192307692307692   0.201923076923077   0.211538461538462
##                  30                  22                  49
##   0.221153846153846   0.225961538461539   0.230769230769231
##                  51                   0                  92
##   0.240384615384615                0.25   0.259615384615385
##                  62                 105                  74
##   0.269230769230769   0.278846153846154   0.288461538461538
##                 155                 121                 118
##   0.298076923076923   0.307692307692308   0.317307692307692
##                 102                  88                  66
##   0.322115384615385   0.326923076923077   0.336538461538462
##                   0                  94                  88
##   0.346153846153846   0.355769230769231   0.365384615384615
##                  72                  48                  34
##               0.375   0.384615384615385   0.394230769230769
##                  35                  26                  16
##   0.403846153846154   0.413461538461538   0.423076923076923
##                  15                  12                  15
##   0.432692307692308   0.442307692307692   0.451923076923077
##                  11                   9                   7
##   0.461538461538462   0.471153846153846   0.480769230769231
##                   7                   3                   2
##   0.490384615384616                 0.5   0.509615384615385
##                   5                   1                   0
##   0.519230769230769   0.528846153846154   0.538461538461539
##                  12                   0                   3
##   0.557692307692308   0.567307692307692   0.576923076923077
##                   0                   0                   0
##   0.586538461538462   0.596153846153846   0.615384615384615
##                   0                   0                   0
##               0.625   0.663461538461539   0.769230769230769
##                   0                   0                   0
##                   1
##                   0
```

8. Evaluate the model performance

```
CrossTable(x=wine_test_labels, y=wine_test_pred, prop.chisq=FALSE)

## 
## 
##    Cell Contents
## |-------------------------|
## |                       N |
## |           N / Row Total |
## |           N / Col Total |
## |         N / Table Total |
## |-------------------------|
## 
## 
## Total Observations in Table:  1715 
## 
## 
##                  | wine_test_pred 
## wine_test_labels | 0.115384615384615 |             0.125 | 
0.134615384615385 | 0.144230769230769 | 0.153846153846154 | 0.163461538461538 
| 0.173076923076923 | 0.182692307692308 | 0.192307692307692 | 
0.201923076923077 | 0.211538461538462 | 0.221153846153846 | 0.230769230769231 
| 0.240384615384615 |              0.25 | 0.259615384615385 | 
0.269230769230769 | 0.278846153846154 | 0.288461538461538 | 0.298076923076923 
| 0.307692307692308 | 0.317307692307692 | 0.326923076923077 | 
0.336538461538462 | 0.346153846153846 | 0.355769230769231 | 0.365384615384615 
|             0.375 | 0.384615384615385 | 0.394230769230769 | 
0.403846153846154 | 0.413461538461538 | 0.423076923076923 | 0.432692307692308 
| 0.442307692307692 | 0.451923076923077 | 0.461538461538462 | 
0.471153846153846 | 0.480769230769231 | 0.490384615384616 |               0.5 
| 0.519230769230769 | 0.538461538461539 |         Row Total | 
## -----------------|-------------------|-------------------|----------------
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---------------|-------------------|-------------------|-------------------|-
```

```
------------------|-------------------|-------------------|------------------
-|-------------------|-------------------|-------------------|---------------
----|-------------------|-------------------|-------------------|------------
-------|-------------------|-------------------|-------------------|---------
----------|-------------------|-------------------|-------------------|------
-------------|-------------------|-------------------|
##              low |                 0 |                 0 |
0 |                 0 |                 0 |                 0 |
0 |                 0 |                 1 |                 0 |
2 |                 2 |                 1 |                 3 |
8 |                 1 |                 5 |                 3 |
4 |                 3 |                 1 |                 4 |
3 |                 0 |                 0 |                 2 |
3 |                 2 |                 0 |                 0 |
2 |                 1 |                 1 |                 1 |
0 |                 0 |                 1 |                 1 |
0 |                 1 |                 0 |                 2 |
1 |                59 |
##                  |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.017 |             0.000 |
0.034 |             0.034 |             0.017 |             0.051 |
0.136 |             0.017 |             0.085 |             0.051 |
0.068 |             0.051 |             0.017 |             0.068 |
0.051 |             0.000 |             0.000 |             0.034 |
0.051 |             0.034 |             0.000 |             0.000 |
0.034 |             0.017 |             0.017 |             0.017 |
0.000 |             0.000 |             0.017 |             0.017 |
0.000 |             0.017 |             0.000 |             0.034 |
0.017 |             0.034 |
##                  |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.033 |             0.000 |
0.041 |             0.039 |             0.011 |             0.048 |
0.076 |             0.014 |             0.032 |             0.025 |
0.034 |             0.029 |             0.011 |             0.061 |
0.032 |             0.000 |             0.000 |             0.042 |
0.088 |             0.057 |             0.000 |             0.000 |
0.133 |             0.083 |             0.067 |             0.091 |
0.000 |             0.000 |             0.143 |             0.333 |
0.000 |             0.200 |             0.000 |             0.167 |
0.333 |                   |
##                  |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.001 |             0.000 |
0.001 |             0.001 |             0.001 |             0.002 |
0.005 |             0.001 |             0.003 |             0.002 |
0.002 |             0.002 |             0.001 |             0.002 |
0.002 |             0.000 |             0.000 |             0.001 |
0.002 |             0.001 |             0.000 |             0.000 |
0.001 |             0.001 |             0.001 |             0.001 |
0.000 |             0.000 |             0.001 |             0.001 |
0.000 |             0.001 |             0.000 |             0.001 |
0.001 |                   |
## -----------------|-------------------|-------------------|----------------
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----------|-------------------|-------------------|-------------------|------
-------------|-------------------|-------------------|
##           medium |                 3 |                 4 |
3 |                 4 |                 8 |                 6 |
11 |                23 |                29 |                21 |
46 |                46 |                89 |                57 |
93 |                66 |               146 |               114 |
112 |                99 |                82 |                62 |
90 |                87 |                70 |                46 |
31 |                32 |                25 |                16 |
12 |                11 |                14 |                 9 |
9 |                 7 |                 6 |                 2 |
2 |                 4 |                 1 |               10 |
2 |              1610 |
##                  |             0.002 |             0.002 |
0.002 |             0.002 |             0.005 |             0.004 |
0.007 |             0.014 |             0.018 |             0.013 |
0.029 |             0.029 |             0.055 |             0.035 |
0.058 |             0.041 |             0.091 |             0.071 |
0.070 |             0.061 |             0.051 |             0.039 |
0.056 |             0.054 |             0.043 |             0.029 |
0.019 |             0.020 |             0.016 |             0.010 |
0.007 |             0.007 |             0.009 |             0.006 |
0.006 |             0.004 |             0.004 |             0.001 |
0.001 |             0.002 |             0.001 |             0.006 |
0.001 |             0.939 |
##                  |             1.000 |             1.000 |
1.000 |             0.800 |             1.000 |             1.000 |
0.917 |             0.958 |             0.967 |             0.955 |
0.939 |             0.902 |             0.967 |             0.919 |
0.886 |             0.892 |             0.942 |             0.942 |
0.949 |             0.971 |             0.932 |             0.939 |
0.957 |             0.989 |             0.972 |             0.958 |
0.912 |             0.914 |             0.962 |             1.000 |
0.800 |             0.917 |             0.933 |             0.818 |
1.000 |             1.000 |             0.857 |             0.667 |
1.000 |             0.800 |             1.000 |             0.833 |
0.667 |                   |
##                  |             0.002 |             0.002 |
0.002 |             0.002 |             0.005 |             0.003 |
0.006 |             0.013 |             0.017 |             0.012 |
0.027 |             0.027 |             0.052 |             0.033 |
0.054 |             0.038 |             0.085 |             0.066 |
0.065 |             0.058 |             0.048 |             0.036 |
0.052 |             0.051 |             0.041 |             0.027 |
0.018 |             0.019 |             0.015 |             0.009 |
0.007 |             0.006 |             0.008 |             0.005 |
0.005 |             0.004 |             0.003 |             0.001 |
0.001 |             0.002 |             0.001 |             0.006 |
0.001 |                   |
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##             high |                 0 |                 0 |
0 |                 1 |                 0 |                 0 |
1 |                 1 |                 0 |                 1 |
1 |                 3 |                 2 |                 2 |
4 |                 7 |                 4 |                 4 |
2 |                 0 |                 5 |                 0 |
1 |                 1 |                 2 |                 0 |
0 |                 1 |                 1 |                 0 |
1 |                 0 |                 0 |                 1 |
0 |                 0 |                 0 |                 0 |
0 |                 0 |                 0 |                 0 |
0 |                46 |
##                  |             0.000 |             0.000 |
0.000 |             0.022 |             0.000 |             0.000 |
0.022 |             0.022 |             0.000 |             0.022 |
0.022 |             0.065 |             0.043 |             0.043 |
0.087 |             0.152 |             0.087 |             0.087 |
0.043 |             0.000 |             0.109 |             0.000 |
0.022 |             0.022 |             0.043 |             0.000 |
0.000 |             0.022 |             0.022 |             0.000 |
0.022 |             0.000 |             0.000 |             0.022 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.027 |
##                  |             0.000 |             0.000 |
0.000 |             0.200 |             0.000 |             0.000 |
0.083 |             0.042 |             0.000 |             0.045 |
0.020 |             0.059 |             0.022 |             0.032 |
0.038 |             0.095 |             0.026 |             0.033 |
0.017 |             0.000 |             0.057 |             0.000 |
0.011 |             0.011 |             0.028 |             0.000 |
0.000 |             0.029 |             0.038 |             0.000 |
0.067 |             0.000 |             0.000 |             0.091 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |                   |
##                  |             0.000 |             0.000 |
0.000 |             0.001 |             0.000 |             0.000 |
0.001 |             0.001 |             0.000 |             0.001 |
0.001 |             0.002 |             0.001 |             0.001 |
0.002 |             0.004 |             0.002 |             0.002 |
0.001 |             0.000 |             0.003 |             0.000 |
0.001 |             0.001 |             0.001 |             0.000 |
0.000 |             0.001 |             0.001 |             0.000 |
0.001 |             0.000 |             0.000 |             0.001 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |             0.000 |             0.000 |             0.000 |
0.000 |                   |
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##     Column Total |                 3 |                 4 |
3 |                 5 |                 8 |                 6 |
12 |                24 |                30 |                22 |
49 |                51 |                92 |                62 |
105 |                74 |               155 |               121 |
118 |               102 |                88 |                66 |
94 |                88 |                72 |                48 |
34 |                35 |                26 |                16 |
15 |                12 |                15 |                11 |
9 |                 7 |                 7 |                 3 |
2 |                 5 |                 1 |                12 |
3 |              1715 |
##                  |             0.002 |             0.002 |
0.002 |             0.003 |             0.005 |             0.003 |
0.007 |             0.014 |             0.017 |             0.013 |
0.029 |             0.030 |             0.054 |             0.036 |
0.061 |             0.043 |             0.090 |             0.071 |
0.069 |             0.059 |             0.051 |             0.038 |
0.055 |             0.051 |             0.042 |             0.028 |
0.020 |             0.020 |             0.015 |             0.009 |
0.009 |             0.007 |             0.009 |             0.006 |
0.005 |             0.004 |             0.004 |             0.002 |
0.001 |             0.003 |             0.001 |             0.007 |
0.002 |                   |
## -----------------|-------------------|-------------------|----------------
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##
##
```

There were 1715 observations