Final Project 2 Completed 1

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knitr::opts\_chunk$set(echo = TRUE)

library(MASS)

## Warning: package 'MASS' was built under R version 4.0.4

library(caret)

## Loading required package: lattice

## Loading required package: ggplot2

#Uploading data

library(mlbench)

## Warning: package 'mlbench' was built under R version 4.0.4

data("BreastCancer")

#Getting rid of the ID column

BreastCancer$Id <- NULL   
BCData <- BreastCancer  
str(BCData)

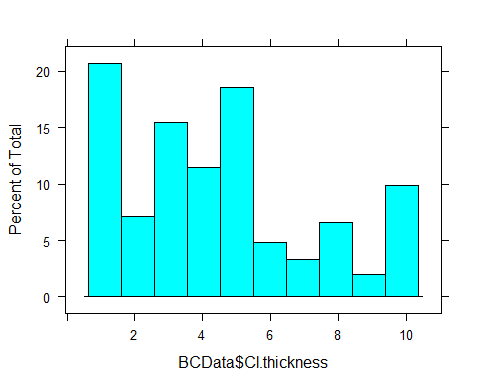
## 'data.frame': 699 obs. of 10 variables:  
## $ Cl.thickness : Ord.factor w/ 10 levels "1"<"2"<"3"<"4"<..: 5 5 3 6 4 8 1 2 2 4 ...  
## $ Cell.size : Ord.factor w/ 10 levels "1"<"2"<"3"<"4"<..: 1 4 1 8 1 10 1 1 1 2 ...  
## $ Cell.shape : Ord.factor w/ 10 levels "1"<"2"<"3"<"4"<..: 1 4 1 8 1 10 1 2 1 1 ...  
## $ Marg.adhesion : Ord.factor w/ 10 levels "1"<"2"<"3"<"4"<..: 1 5 1 1 3 8 1 1 1 1 ...  
## $ Epith.c.size : Ord.factor w/ 10 levels "1"<"2"<"3"<"4"<..: 2 7 2 3 2 7 2 2 2 2 ...  
## $ Bare.nuclei : Factor w/ 10 levels "1","2","3","4",..: 1 10 2 4 1 10 10 1 1 1 ...  
## $ Bl.cromatin : Factor w/ 10 levels "1","2","3","4",..: 3 3 3 3 3 9 3 3 1 2 ...  
## $ Normal.nucleoli: Factor w/ 10 levels "1","2","3","4",..: 1 2 1 7 1 7 1 1 1 1 ...  
## $ Mitoses : Factor w/ 9 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 5 1 ...  
## $ Class : Factor w/ 2 levels "benign","malignant": 1 1 1 1 1 2 1 1 1 1 ...

#Converting variables from charactors to numbers

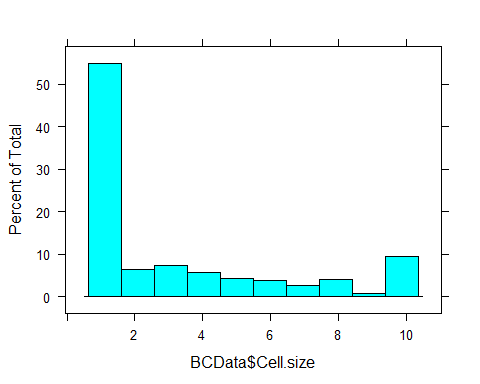
BCData$Cl.thickness<-as.numeric(BCData$Cl.thickness)  
BCData$Mitoses<-as.numeric(BCData$Mitoses)  
BCData$Cell.size<-as.numeric(BCData$Cell.size)  
BCData$Cell.shape<-as.numeric(BCData$Cell.shape)  
BCData$Marg.adhesion<-as.numeric(BCData$Marg.adhesion)  
BCData$Epith.c.size<-as.numeric(BCData$Epith.c.size)  
BCData$Bare.nuclei<-as.numeric(BCData$Bare.nuclei)  
BCData$Bl.cromatin<-as.numeric(BCData$Bl.cromatin)  
BCData$Normal.nucleoli<-as.numeric(BCData$Normal.nucleoli)

#data exploration

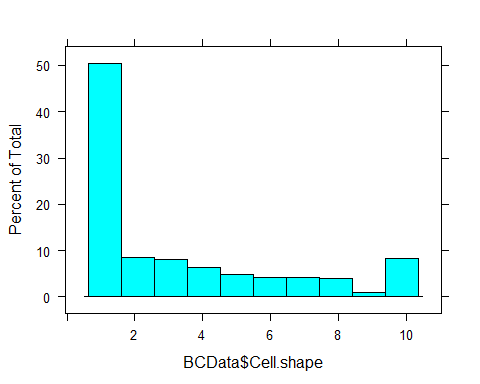
histogram(BCData$Cl.thickness)



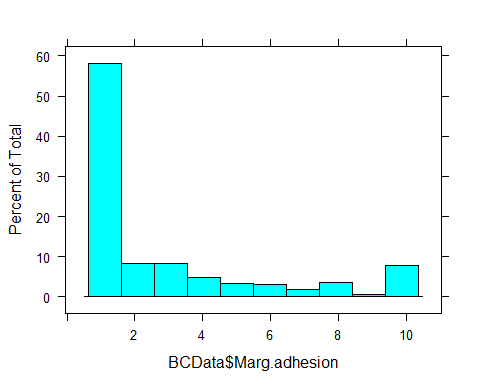
histogram(BCData$Cell.size)



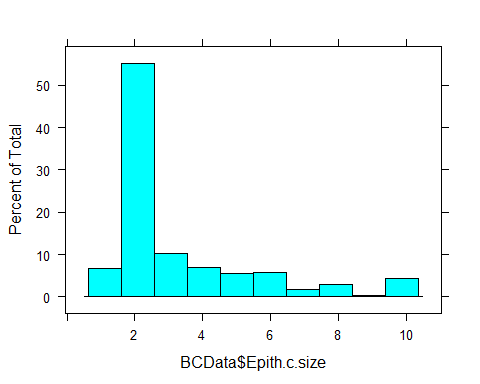
histogram(BCData$Cell.shape)



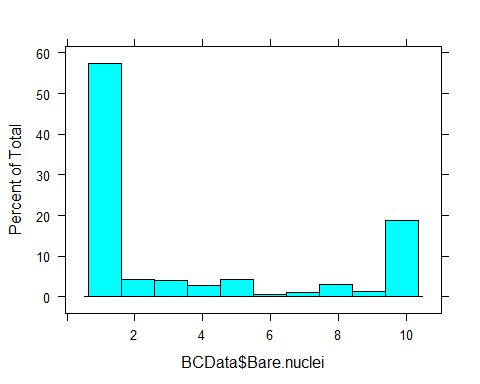
histogram(BCData$Marg.adhesion)



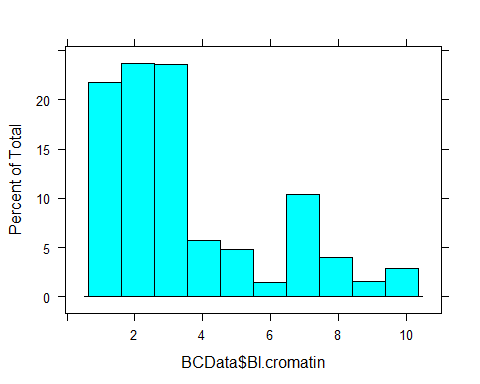
histogram(BCData$Epith.c.size)



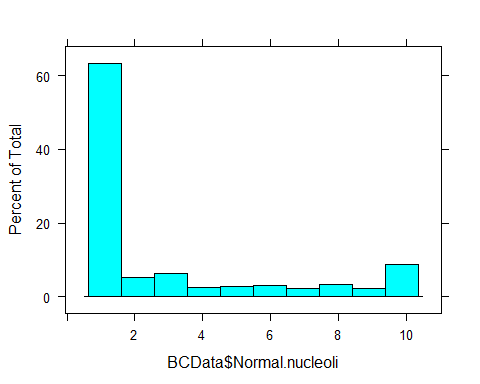
histogram(BCData$Bare.nuclei)



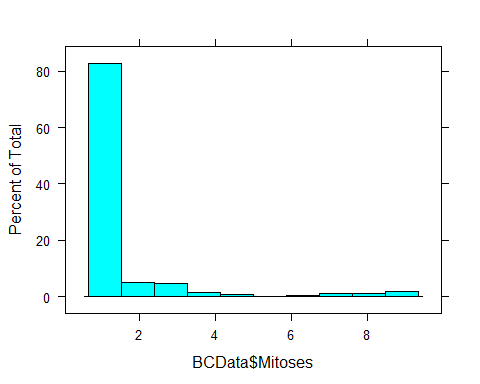
histogram(BCData$Bl.cromatin)



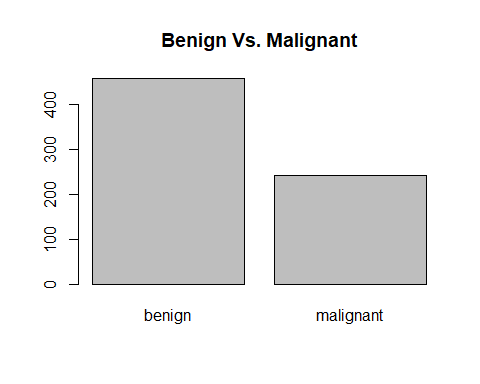
histogram(BCData$Normal.nucleoli)



histogram(BCData$Mitoses)



library(ggplot2)  
Counts <- table(BCData$Class)  
barplot(Counts, main ="Benign Vs. Malignant")



#During the decsion varaible into 1 and 0

BCData$Class<-ifelse(BCData$Class=="malignant",1,0)  
BCData$Class<-as.factor(BCData$Class)

#Imputing data/missing values

library(mice)

##   
## Attaching package: 'mice'

## The following object is masked from 'package:stats':  
##   
## filter

## The following objects are masked from 'package:base':  
##   
## cbind, rbind

library(VIM)

## Loading required package: colorspace

## Loading required package: grid

## VIM is ready to use.

## Suggestions and bug-reports can be submitted at: https://github.com/statistikat/VIM/issues

##   
## Attaching package: 'VIM'

## The following object is masked from 'package:datasets':  
##   
## sleep

imputed.data <- mice(BCData, m=5, maxit = 50, method = 'pmm', seed = 500)

##   
## iter imp variable  
## 1 1 Bare.nuclei  
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imputed.data$imp$Bare.nuclei

## 1 2 3 4 5  
## 24 7 10 10 10 10  
## 41 5 5 2 4 2  
## 140 1 1 1 1 1  
## 146 1 4 1 1 1  
## 159 1 1 1 1 1  
## 165 1 1 1 1 3  
## 236 1 1 3 3 1  
## 250 1 1 1 1 1  
## 276 4 1 1 5 1  
## 293 6 2 10 1 10  
## 295 1 1 1 1 1  
## 298 1 1 1 1 1  
## 316 1 1 2 2 1  
## 322 1 2 1 1 1  
## 412 1 1 1 1 1  
## 618 1 1 1 1 1

BCData <- complete(imputed.data,2)  
summary(BCData$Bare.nuclei)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 1.000 1.000 1.000 3.512 5.500 10.000

#Support Vector

library(e1071)  
mysvm <- svm(Class ~ ., BCData)  
mysvm.pred <- predict(mysvm, BCData)  
table(mysvm.pred, BCData$Class)

##   
## mysvm.pred 0 1  
## 0 446 5  
## 1 12 236

#Naive Bayes

library(klaR)

## Warning: package 'klaR' was built under R version 4.0.4

mynb <- NaiveBayes(Class ~ ., BCData)  
mynb.pred <- predict(mynb,BCData)

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with  
## observation 2

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with  
## observation 4

## Warning in FUN(X[[i]], ...): Numerical 0 probability for all classes with  
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## observation 699

table(mynb.pred$class,BCData$Class)

##   
## 0 1  
## 0 436 6  
## 1 22 235

#Neural net

library(nnet)

## Warning: package 'nnet' was built under R version 4.0.4

set.seed(123)  
mynnet <- nnet(Class ~ ., BCData, size=1)

## # weights: 12  
## initial value 578.020082   
## final value 450.263728   
## converged

mynnet.pred <- predict(mynnet,BCData,type="class")  
table(mynnet.pred,BCData$Class)

##   
## mynnet.pred 0 1  
## 0 458 241

#Decsion Tree

library(rpart)  
mytree <- rpart(Class ~ ., BCData)  
mytree.pred <- predict(mytree,BCData,type="class")  
table(mytree.pred,BCData$Class)

##   
## mytree.pred 0 1  
## 0 439 5  
## 1 19 236

#Had to create new lable to override  
mytree.pred2 <- mytree.pred

# Leave-1-Out Cross Validation (LOOCV)

ans <- numeric(length(BCData[,1]))  
for (i in 1:length(BCData[,1])) {  
 mytree <- rpart(Class ~ ., BCData[-i,])  
 mytree.pred <- predict(mytree,BCData[i,],type="class")  
 ans[i] <- mytree.pred  
}  
ans <- factor(ans,labels=levels(BCData$Class))  
table(ans,BCData$Class)

##   
## ans 0 1  
## 0 436 23  
## 1 22 218

#QDA

myqda <- qda(Class ~ ., BCData)  
myqda.pred <- predict(myqda, BCData)  
table(myqda.pred$class,BCData$Class)

##   
## 0 1  
## 0 435 6  
## 1 23 235

#Rds

set.seed(123)  
myrda <- rda(Class ~ ., BCData)  
myrda.pred <- predict(myrda, BCData)  
table(myrda.pred$class,BCData$Class)

##   
## 0 1  
## 0 447 10  
## 1 11 231

#Random Forest

library(randomForest)

## Warning: package 'randomForest' was built under R version 4.0.4

## randomForest 4.6-14

## Type rfNews() to see new features/changes/bug fixes.

##   
## Attaching package: 'randomForest'

## The following object is masked from 'package:ggplot2':  
##   
## margin

myrf <- randomForest(Class ~ .,BCData)  
myrf.pred <- predict(myrf, BCData)  
table(myrf.pred, BCData$Class)

##   
## myrf.pred 0 1  
## 0 458 0  
## 1 0 241

#Creating Ensemble

Ensemble <- as.data.frame(cbind(  
 as.data.frame(mysvm.pred),  
 mynb.pred$class,  
 as.factor(mynnet.pred),  
 mytree.pred2,  
 myqda.pred$class,  
 myrda.pred$class,  
 myrf.pred,  
 BCData$Class))

#Ensemble Performance

Ensemble

## mysvm.pred mynb.pred$class as.factor(mynnet.pred) mytree.pred2  
## 1 0 0 0 0  
## 2 1 1 0 1  
## 3 0 0 0 0  
## 4 1 1 0 1  
## 5 0 0 0 0  
## 6 1 1 0 1  
## 7 0 1 0 1  
## 8 0 0 0 0  
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str(Ensemble)

## 'data.frame': 699 obs. of 8 variables:  
## $ mysvm.pred : Factor w/ 2 levels "0","1": 1 2 1 2 1 2 1 1 1 1 ...  
## $ mynb.pred$class : Factor w/ 2 levels "0","1": 1 2 1 2 1 2 2 1 2 1 ...  
## $ as.factor(mynnet.pred): Factor w/ 1 level "0": 1 1 1 1 1 1 1 1 1 1 ...  
## $ mytree.pred2 : Factor w/ 2 levels "0","1": 1 2 1 2 1 2 2 1 1 1 ...  
## $ myqda.pred$class : Factor w/ 2 levels "0","1": 1 2 1 2 1 2 2 1 2 1 ...  
## $ myrda.pred$class : Factor w/ 2 levels "0","1": 1 2 1 2 1 2 1 1 1 1 ...  
## $ myrf.pred : Factor w/ 2 levels "0","1": 1 1 1 1 1 2 1 1 1 1 ...  
## $ BCData$Class : Factor w/ 2 levels "0","1": 1 1 1 1 1 2 1 1 1 1 ...

Ensemble$mysvm.pred <- as.numeric(Ensemble$mysvm.pred)  
Ensemble$`mynb.pred$class` <- as.numeric(Ensemble$`mynb.pred$class`)  
Ensemble$`as.factor(mynnet.pred)` <- as.numeric(Ensemble$`as.factor(mynnet.pred)`)  
Ensemble$mytree.pred2 <- as.numeric(Ensemble$mytree.pred2)  
Ensemble$`myqda.pred$class` <- as.numeric(Ensemble$`myqda.pred$class`)  
Ensemble$`myrda.pred$class` <- as.numeric(Ensemble$`myrda.pred$class`)  
Ensemble$myrf.pred <- as.numeric(Ensemble$myrf.pred)  
Ensemble$`BCData$Class` <- as.numeric(Ensemble$`BCData$Class`)  
  
sum(Ensemble$mysvm.pred) #947 predicted

## [1] 947

sum(Ensemble$`mynb.pred$class`) #956 predicted

## [1] 956

sum(Ensemble$`as.factor(mynnet.pred)`) #699 predcited

## [1] 699

sum(Ensemble$mytree.pred2) #954 predicted

## [1] 954

sum(Ensemble$`myqda.pred$class`) #957 predicted

## [1] 957

sum(Ensemble$`myrda.pred$class`) #941 predicted

## [1] 941

sum(Ensemble$myrf.pred) #940 predicted

## [1] 940

sum(Ensemble$`BCData$Class`) #940 predicted

## [1] 940

NBandclass <- Ensemble [c(2,8)]  
NBandclass #over predicting

## mynb.pred$class BCData$Class  
## 1 1 1  
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rfandclass <- Ensemble [c(7,8)]  
rfandclass #perfect prediction

## myrf.pred BCData$Class  
## 1 1 1  
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