Biomedical.R

ASUS

2022-05-06

library(ClusterR)

## Loading required package: gtools

library(cluster)  
library(neuralnet)  
library(party)

## Loading required package: grid

## Loading required package: mvtnorm

## Loading required package: modeltools

## Loading required package: stats4

## Loading required package: strucchange

## Loading required package: zoo

##   
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric

## Loading required package: sandwich

library(rpart)  
library(rpart.plot)  
library(randomForest)

## randomForest 4.7-1

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

library(ggplot2)

##   
## Attaching package: 'ggplot2'

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

library(e1071)

##   
## Attaching package: 'e1071'

## The following object is masked from 'package:gtools':  
##   
## permutations

library(MASS)  
library(caTools)  
library(class)  
  
setwd("E:/R/assignment/biomedical")  
  
minmax <- function(x)  
{  
 (x - min(x))/(max(x) - min(x))  
}  
  
# 1) Using logistic regression to find abnormal and normal cases  
  
data <- read.csv("column\_2C\_weka.csv")  
head(data)

## pelvic\_incidence pelvic\_tilt.numeric lumbar\_lordosis\_angle sacral\_slope  
## 1 63.02782 22.552586 39.60912 40.47523  
## 2 39.05695 10.060991 25.01538 28.99596  
## 3 68.83202 22.218482 50.09219 46.61354  
## 4 69.29701 24.652878 44.31124 44.64413  
## 5 49.71286 9.652075 28.31741 40.06078  
## 6 40.25020 13.921907 25.12495 26.32829  
## pelvic\_radius degree\_spondylolisthesis class  
## 1 98.67292 -0.254400 Abnormal  
## 2 114.40543 4.564259 Abnormal  
## 3 105.98514 -3.530317 Abnormal  
## 4 101.86850 11.211523 Abnormal  
## 5 108.16872 7.918501 Abnormal  
## 6 130.32787 2.230652 Abnormal

summary(data)

## pelvic\_incidence pelvic\_tilt.numeric lumbar\_lordosis\_angle sacral\_slope   
## Min. : 26.15 Min. :-6.555 Min. : 14.00 Min. : 13.37   
## 1st Qu.: 46.43 1st Qu.:10.667 1st Qu.: 37.00 1st Qu.: 33.35   
## Median : 58.69 Median :16.358 Median : 49.56 Median : 42.40   
## Mean : 60.50 Mean :17.543 Mean : 51.93 Mean : 42.95   
## 3rd Qu.: 72.88 3rd Qu.:22.120 3rd Qu.: 63.00 3rd Qu.: 52.70   
## Max. :129.83 Max. :49.432 Max. :125.74 Max. :121.43   
## pelvic\_radius degree\_spondylolisthesis class   
## Min. : 70.08 Min. :-11.058 Length:310   
## 1st Qu.:110.71 1st Qu.: 1.604 Class :character   
## Median :118.27 Median : 11.768 Mode :character   
## Mean :117.92 Mean : 26.297   
## 3rd Qu.:125.47 3rd Qu.: 41.287   
## Max. :163.07 Max. :418.543

response = data[,7]  
features <- data[-7]  
response\_number = as.factor(response)  
response\_number\_1 = ifelse(response == "Abnormal",1,0)  
response\_number\_1

## [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [38] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [75] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [112] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [149] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1  
## [186] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0  
## [223] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## [260] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## [297] 0 0 0 0 0 0 0 0 0 0 0 0 0 0

features\_norm = apply(features,2,minmax)  
data\_new = cbind(features\_norm,"class"=response\_number\_1)  
  
data\_new <- data.frame(data\_new)  
split <- sample.split(data\_new,SplitRatio = 0.70)  
traindata <- subset(data\_new,split = TRUE)  
testdata <- subset(data\_new,split = FALSE)  
model <- glm(class~.,data = testdata, family = 'binomial')

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred

pred <- predict(model, traindata, type = 'response')  
j<-1; TP=0; TN=0; FP=0; FN=0;  
for (i in pred)  
{  
 if (i>=0.5 && data\_new[j,7]==1)  
 TP <- TP + 1  
 if (i>=0.5 && data\_new[j,7]==0)  
 FP <- FP + 1  
 if (i<=0.5 && data\_new[j,7]==0)  
 TN <- TN + 1  
 if (i<=0.5 && data\_new[j,7]==1)  
 FN <- FN + 1  
 j <- j +1  
}  
accuracy <- (TP+TN)/(TN+TP+FP+FN)\*100  
accuracy

## [1] 84.83871

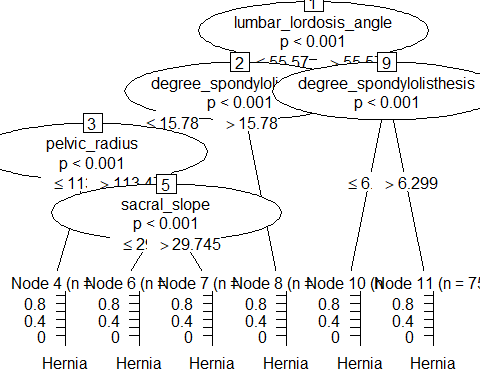
# 2) Using decision Trees and random forest for classification  
  
data\_more <- read.csv("column\_3C\_weka.csv")  
data\_more[,7] <- as.factor(data\_more[,7])  
head(data\_more)

## pelvic\_incidence pelvic\_tilt lumbar\_lordosis\_angle sacral\_slope pelvic\_radius  
## 1 63.02782 22.552586 39.60912 40.47523 98.67292  
## 2 39.05695 10.060991 25.01538 28.99596 114.40543  
## 3 68.83202 22.218482 50.09219 46.61354 105.98514  
## 4 69.29701 24.652878 44.31124 44.64413 101.86850  
## 5 49.71286 9.652075 28.31741 40.06078 108.16872  
## 6 40.25020 13.921907 25.12495 26.32829 130.32787  
## degree\_spondylolisthesis class  
## 1 -0.254400 Hernia  
## 2 4.564259 Hernia  
## 3 -3.530317 Hernia  
## 4 11.211523 Hernia  
## 5 7.918501 Hernia  
## 6 2.230652 Hernia

split <- sample.split(data\_more$class, SplitRatio = 0.7)  
train <- subset(data\_more, split == TRUE)  
test <- subset(data\_more, split == FALSE)  
  
  
#creating tree using party  
tree1 <- ctree(class~., data = train)  
tree1

##   
## Conditional inference tree with 6 terminal nodes  
##   
## Response: class   
## Inputs: pelvic\_incidence, pelvic\_tilt, lumbar\_lordosis\_angle, sacral\_slope, pelvic\_radius, degree\_spondylolisthesis   
## Number of observations: 217   
##   
## 1) lumbar\_lordosis\_angle <= 55.57014; criterion = 1, statistic = 89.319  
## 2) degree\_spondylolisthesis <= 15.7797; criterion = 1, statistic = 35.321  
## 3) pelvic\_radius <= 113.477; criterion = 0.999, statistic = 18.082  
## 4)\* weights = 19   
## 3) pelvic\_radius > 113.477  
## 5) sacral\_slope <= 29.74488; criterion = 1, statistic = 21.963  
## 6)\* weights = 29   
## 5) sacral\_slope > 29.74488  
## 7)\* weights = 53   
## 2) degree\_spondylolisthesis > 15.7797  
## 8)\* weights = 33   
## 1) lumbar\_lordosis\_angle > 55.57014  
## 9) degree\_spondylolisthesis <= 6.298971; criterion = 1, statistic = 23.699  
## 10)\* weights = 8   
## 9) degree\_spondylolisthesis > 6.298971  
## 11)\* weights = 75

plot(tree1)



#predicting training and testing values and calculating accuracy  
train\_pd\_party <- predict(tree1, train)  
train\_pd\_party

## [1] Hernia Hernia Hernia Hernia   
## [5] Hernia Hernia Hernia Hernia   
## [9] Normal Hernia Hernia Hernia   
## [13] Hernia Hernia Normal Hernia   
## [17] Normal Hernia Hernia Hernia   
## [21] Hernia Hernia Hernia Hernia   
## [25] Hernia Hernia Hernia Hernia   
## [29] Normal Hernia Normal Normal   
## [33] Hernia Hernia Hernia Hernia   
## [37] Hernia Hernia Hernia Hernia   
## [41] Hernia Normal Spondylolisthesis Spondylolisthesis  
## [45] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [49] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [53] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [57] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [61] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [65] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [69] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [73] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [77] Spondylolisthesis Normal Spondylolisthesis Spondylolisthesis  
## [81] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [85] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [89] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [93] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [97] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [101] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [105] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [109] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [113] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [117] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [121] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [125] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [129] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [133] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [137] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [141] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [145] Spondylolisthesis Spondylolisthesis Spondylolisthesis Hernia   
## [149] Normal Normal Normal Normal   
## [153] Normal Normal Hernia Hernia   
## [157] Normal Spondylolisthesis Normal Normal   
## [161] Normal Hernia Normal Normal   
## [165] Hernia Normal Normal Normal   
## [169] Normal Normal Normal Normal   
## [173] Normal Normal Normal Normal   
## [177] Normal Spondylolisthesis Normal Spondylolisthesis  
## [181] Normal Normal Normal Hernia   
## [185] Hernia Normal Hernia Normal   
## [189] Normal Normal Hernia Normal   
## [193] Normal Normal Normal Normal   
## [197] Normal Normal Normal Normal   
## [201] Normal Normal Normal Normal   
## [205] Normal Hernia Normal Normal   
## [209] Spondylolisthesis Hernia Hernia Normal   
## [213] Normal Normal Normal Normal   
## [217] Hernia   
## Levels: Hernia Normal Spondylolisthesis

test\_pd1\_party <- predict(tree1,test)  
test\_pd1\_party

## [1] Hernia Hernia Normal Normal   
## [5] Normal Hernia Normal Hernia   
## [9] Hernia Hernia Hernia Normal   
## [13] Normal Hernia Hernia Normal   
## [17] Hernia Normal Normal Spondylolisthesis  
## [21] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [25] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [29] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [33] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [37] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [41] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [45] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [49] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [53] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [57] Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis  
## [61] Spondylolisthesis Spondylolisthesis Spondylolisthesis Hernia   
## [65] Normal Normal Normal Normal   
## [69] Hernia Normal Hernia Normal   
## [73] Normal Normal Hernia Normal   
## [77] Normal Normal Normal Hernia   
## [81] Normal Normal Normal Normal   
## [85] Normal Normal Normal Normal   
## [89] Normal Normal Normal Normal   
## [93] Normal   
## Levels: Hernia Normal Spondylolisthesis

t1 <- table(Acutal = train$class, Predicted = train\_pd\_party)  
t1

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 35 7 0  
## Normal 13 53 4  
## Spondylolisthesis 0 1 104

train\_accuracy\_party = sum(diag(t1)/sum(t1)) \*100  
train\_accuracy\_party

## [1] 88.47926

t1\_tested <- table(Acutal = test$class, Predicted = test\_pd1\_party)  
t1\_tested

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 10 8 0  
## Normal 5 25 0  
## Spondylolisthesis 0 1 44

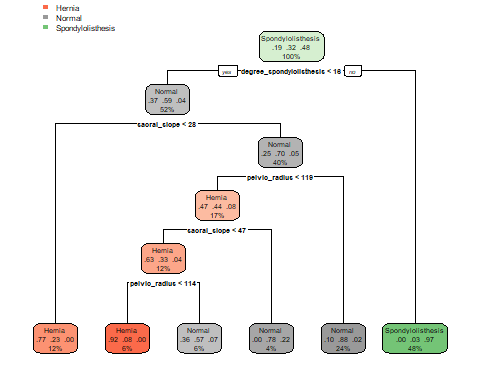
test\_accuracy\_party = sum(diag(t1\_tested)/sum(t1\_tested)) \*100  
test\_accuracy\_party

## [1] 84.94624

### using rpart package  
tree2 <- rpart(class~., data = train)  
tree2

## n= 217   
##   
## node), split, n, loss, yval, (yprob)  
## \* denotes terminal node  
##   
## 1) root 217 112 Spondylolisthesis (0.19354839 0.32258065 0.48387097)   
## 2) degree\_spondylolisthesis< 16.07889 113 46 Normal (0.37168142 0.59292035 0.03539823)   
## 4) sacral\_slope< 28.13647 26 6 Hernia (0.76923077 0.23076923 0.00000000) \*  
## 5) sacral\_slope>=28.13647 87 26 Normal (0.25287356 0.70114943 0.04597701)   
## 10) pelvic\_radius< 119.3285 36 19 Hernia (0.47222222 0.44444444 0.08333333)   
## 20) sacral\_slope< 46.64911 27 10 Hernia (0.62962963 0.33333333 0.03703704)   
## 40) pelvic\_radius< 113.6416 13 1 Hernia (0.92307692 0.07692308 0.00000000) \*  
## 41) pelvic\_radius>=113.6416 14 6 Normal (0.35714286 0.57142857 0.07142857) \*  
## 21) sacral\_slope>=46.64911 9 2 Normal (0.00000000 0.77777778 0.22222222) \*  
## 11) pelvic\_radius>=119.3285 51 6 Normal (0.09803922 0.88235294 0.01960784) \*  
## 3) degree\_spondylolisthesis>=16.07889 104 3 Spondylolisthesis (0.00000000 0.02884615 0.97115385) \*

rpart.plot(tree2)



#pd\_rpart <- predict(tree2, train, type="prob")  
#pd  
pd\_rpart\_train <- predict(tree2, train,type = "class")  
pd\_rpart\_train

## 1 3 5 6   
## Hernia Hernia Hernia Hernia   
## 10 12 13 14   
## Hernia Hernia Normal Hernia   
## 16 17 18 19   
## Normal Hernia Hernia Hernia   
## 20 21 22 23   
## Normal Normal Normal Hernia   
## 24 25 26 27   
## Normal Hernia Hernia Hernia   
## 28 29 30 32   
## Hernia Hernia Hernia Hernia   
## 34 35 37 39   
## Hernia Hernia Hernia Hernia   
## 40 41 43 45   
## Normal Hernia Normal Normal   
## 46 48 50 52   
## Hernia Hernia Hernia Hernia   
## 53 55 56 57   
## Hernia Hernia Hernia Hernia   
## 59 60 61 62   
## Hernia Normal Spondylolisthesis Spondylolisthesis   
## 63 64 65 66   
## Spondylolisthesis Spondylolisthesis Normal Spondylolisthesis   
## 67 68 70 71   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 72 74 77 81   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 82 84 85 86   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 87 89 90 91   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 92 93 95 96   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 97 98 99 100   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 101 102 103 104   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 105 106 109 110   
## Spondylolisthesis Normal Spondylolisthesis Spondylolisthesis   
## 111 112 115 116   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 117 118 119 120   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 121 122 123 124   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 127 129 130 131   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 132 133 135 139   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 140 142 144 146   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 147 149 150 154   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 158 159 160 161   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 162 164 165 166   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 167 168 170 171   
## Spondylolisthesis Normal Spondylolisthesis Spondylolisthesis   
## 172 173 174 177   
## Normal Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 178 179 181 183   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 184 186 188 190   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 191 192 193 195   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 197 198 199 201   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 202 203 205 206   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 208 209 210 211   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Hernia   
## 212 213 214 215   
## Normal Normal Normal Normal   
## 218 219 220 221   
## Normal Normal Hernia Hernia   
## 222 223 224 226   
## Normal Spondylolisthesis Normal Normal   
## 227 229 230 231   
## Normal Normal Normal Normal   
## 235 239 240 241   
## Normal Normal Normal Normal   
## 242 245 246 247   
## Normal Normal Normal Normal   
## 249 250 251 252   
## Normal Normal Normal Normal   
## 253 254 255 256   
## Normal Normal Normal Spondylolisthesis   
## 258 260 261 262   
## Normal Normal Normal Normal   
## 263 264 265 266   
## Normal Normal Normal Normal   
## 267 269 272 273   
## Normal Normal Hernia Normal   
## 275 276 277 278   
## Normal Normal Normal Normal   
## 279 280 283 284   
## Normal Normal Normal Normal   
## 286 287 288 289   
## Normal Normal Normal Normal   
## 290 291 292 293   
## Normal Hernia Normal Normal   
## 294 297 298 300   
## Spondylolisthesis Hernia Hernia Normal   
## 301 303 305 308   
## Normal Normal Normal Normal   
## 310   
## Normal   
## Levels: Hernia Normal Spondylolisthesis

pd\_rpart\_test <- predict(tree2,test, type = "class")  
pd\_rpart\_test

## 2 4 7 8   
## Normal Hernia Normal Normal   
## 9 11 15 31   
## Normal Hernia Normal Hernia   
## 33 36 38 42   
## Hernia Hernia Hernia Normal   
## 44 47 49 51   
## Normal Hernia Hernia Normal   
## 54 58 69 73   
## Hernia Normal Normal Spondylolisthesis   
## 75 76 78 79   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 80 83 88 94   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 107 108 113 114   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 125 126 128 134   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 136 137 138 141   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 143 145 148 151   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 152 153 155 156   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 157 163 169 175   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 176 180 182 185   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 187 189 194 196   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Spondylolisthesis   
## 200 204 207 216   
## Spondylolisthesis Spondylolisthesis Spondylolisthesis Hernia   
## 217 225 228 232   
## Normal Normal Normal Normal   
## 233 234 236 237   
## Normal Normal Hernia Normal   
## 238 243 244 248   
## Normal Normal Hernia Normal   
## 257 259 268 270   
## Normal Normal Normal Hernia   
## 271 274 281 282   
## Normal Normal Normal Normal   
## 285 295 296 299   
## Normal Normal Normal Normal   
## 302 304 306 307   
## Normal Normal Normal Normal   
## 309   
## Normal   
## Levels: Hernia Normal Spondylolisthesis

t\_rpart\_train <- table(Acutal = train$class, Predicted = pd\_rpart\_train)  
t\_rpart\_train

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 32 10 0  
## Normal 7 60 3  
## Spondylolisthesis 0 4 101

accuracy1\_train = sum (diag(t\_rpart\_train)/sum(t\_rpart\_train)) \* 100  
accuracy1\_train

## [1] 88.94009

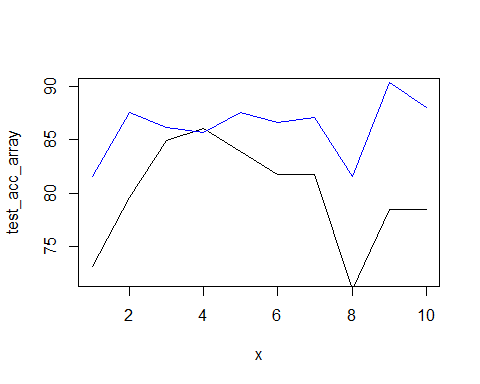
t\_rpart\_test <- table(Acutal = test$class, Predicted = pd\_rpart\_test)  
t\_rpart\_test

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 9 9 0  
## Normal 4 26 0  
## Spondylolisthesis 0 1 44

accuracy1\_test = sum (diag(t\_rpart\_test)/sum(t\_rpart\_test)) \* 100  
accuracy1\_test

## [1] 84.94624

train\_acc\_array = c()  
test\_acc\_array = c()  
  
#For 10 fold cross validation  
for (i in 1:10)  
{  
 split <- sample.split(data\_more$class, SplitRatio = 0.7)  
 train <- subset(data\_more, split == TRUE)  
 test <- subset(data\_more, split == FALSE)  
 tree1 <- ctree(class~., data = train)  
 train\_pd\_party <- predict(tree1, train)  
 test\_pd1\_party <- predict(tree1,test)  
 t1 <- table(Acutal = train$class, Predicted = train\_pd\_party)  
 train\_acc\_array[i] = sum(diag(t1)/sum(t1)) \*100  
 t1\_tested <- table(Acutal = test$class, Predicted = test\_pd1\_party)  
 test\_acc\_array[i] = sum(diag(t1\_tested)/sum(t1\_tested)) \*100  
}  
  
x <- c(1:10)  
plot(test\_acc\_array~x,t="l",ylim=c(72,90))  
lines(train\_acc\_array,t='l',col="blue")



# using random forest for better accuracy and importance  
# Creating random trees  
  
random\_forest\_classifier <- randomForest(x = train[-7],  
 y=train$class,  
 ntree=500)  
  
# Predicting training data and testing data  
random\_forest\_classifier

##   
## Call:  
## randomForest(x = train[-7], y = train$class, ntree = 500)   
## Type of random forest: classification  
## Number of trees: 500  
## No. of variables tried at each split: 2  
##   
## OOB estimate of error rate: 12.44%  
## Confusion matrix:  
## Hernia Normal Spondylolisthesis class.error  
## Hernia 29 12 1 0.30952381  
## Normal 11 57 2 0.18571429  
## Spondylolisthesis 0 1 104 0.00952381

train\_pred\_RF <- predict(random\_forest\_classifier,train[-7])  
test\_pred\_RF <- predict(random\_forest\_classifier,test[-7])  
  
# Finding accuracy of training data adn testing data  
table\_RF\_train <- table(Acutal = train$class, Predicted = train\_pred\_RF)  
table\_RF\_train

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 42 0 0  
## Normal 0 70 0  
## Spondylolisthesis 0 0 105

train\_accuracy\_RF = sum(diag(table\_RF\_train)/sum(table\_RF\_train)) \*100  
train\_accuracy\_RF

## [1] 100

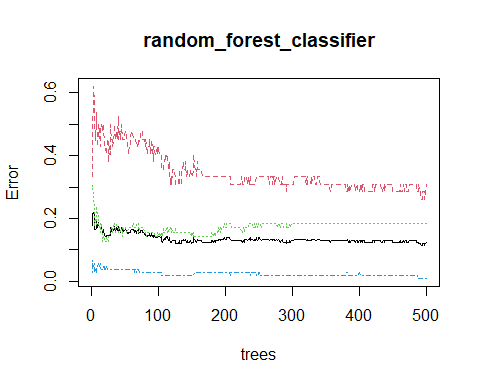
table\_RF\_test <- table(Acutal = test$class, Predicted = test\_pred\_RF)  
table\_RF\_test

## Predicted  
## Acutal Hernia Normal Spondylolisthesis  
## Hernia 11 6 1  
## Normal 6 21 3  
## Spondylolisthesis 0 1 44

test\_accuracy\_RF = sum(diag(table\_RF\_test)/sum(table\_RF\_test)) \*100  
test\_accuracy\_RF

## [1] 81.72043

# Plotting the error of random trees and importance of features  
plot(random\_forest\_classifier)



importance(random\_forest\_classifier)

## MeanDecreaseGini  
## pelvic\_incidence 15.09326  
## pelvic\_tilt 13.43869  
## lumbar\_lordosis\_angle 18.03142  
## sacral\_slope 15.98425  
## pelvic\_radius 15.76036  
## degree\_spondylolisthesis 56.38590

# 3) Using KNN  
  
data <- read.csv("column\_3C\_weka.csv")  
data[,7] <- as.factor(data[,7])  
head(data)

## pelvic\_incidence pelvic\_tilt lumbar\_lordosis\_angle sacral\_slope pelvic\_radius  
## 1 63.02782 22.552586 39.60912 40.47523 98.67292  
## 2 39.05695 10.060991 25.01538 28.99596 114.40543  
## 3 68.83202 22.218482 50.09219 46.61354 105.98514  
## 4 69.29701 24.652878 44.31124 44.64413 101.86850  
## 5 49.71286 9.652075 28.31741 40.06078 108.16872  
## 6 40.25020 13.921907 25.12495 26.32829 130.32787  
## degree\_spondylolisthesis class  
## 1 -0.254400 Hernia  
## 2 4.564259 Hernia  
## 3 -3.530317 Hernia  
## 4 11.211523 Hernia  
## 5 7.918501 Hernia  
## 6 2.230652 Hernia

features = data[-7]  
response <- data[7]  
response

## class  
## 1 Hernia  
## 2 Hernia  
## 3 Hernia  
## 4 Hernia  
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summary(features)

## pelvic\_incidence pelvic\_tilt lumbar\_lordosis\_angle sacral\_slope   
## Min. : 26.15 Min. :-6.555 Min. : 14.00 Min. : 13.37   
## 1st Qu.: 46.43 1st Qu.:10.667 1st Qu.: 37.00 1st Qu.: 33.35   
## Median : 58.69 Median :16.358 Median : 49.56 Median : 42.40   
## Mean : 60.50 Mean :17.543 Mean : 51.93 Mean : 42.95   
## 3rd Qu.: 72.88 3rd Qu.:22.120 3rd Qu.: 63.00 3rd Qu.: 52.70   
## Max. :129.83 Max. :49.432 Max. :125.74 Max. :121.43   
## pelvic\_radius degree\_spondylolisthesis  
## Min. : 70.08 Min. :-11.058   
## 1st Qu.:110.71 1st Qu.: 1.604   
## Median :118.27 Median : 11.768   
## Mean :117.92 Mean : 26.297   
## 3rd Qu.:125.47 3rd Qu.: 41.287   
## Max. :163.07 Max. :418.543

features\_norm = apply(features,2,minmax)  
data\_new = cbind(features\_norm,"class"=response)  
data\_new

## pelvic\_incidence pelvic\_tilt lumbar\_lordosis\_angle sacral\_slope  
## 1 0.35568788 0.51989984 0.22917997 0.250857300  
## 2 0.12450104 0.29678310 0.09857833 0.144629352  
## 3 0.41166648 0.51393229 0.32299466 0.307660537  
## 4 0.41615104 0.55741388 0.27125999 0.289435840  
## 5 0.22727187 0.28947930 0.12812869 0.247022051  
## 6 0.13600932 0.36574426 0.09955891 0.119943054  
## 7 0.26315004 0.40043867 0.20731555 0.223959571  
## 8 0.18535588 0.30918995 0.13458053 0.196591648  
## 9 0.17015073 0.35881131 0.25675856 0.156293676  
## 10 0.10163782 0.20658137 0.25011772 0.169425242  
## 11 0.22721159 0.35000961 0.15512914 0.215603708  
## 12 0.04903709 0.43350866 0.01342373 0.001384728  
## 13 0.21958224 0.47367413 0.23503878 0.144213257  
## 14 0.26449296 0.48253822 0.17092887 0.182712658  
## 15 0.30044817 0.54912634 0.29532214 0.182712658  
## 16 0.17524993 0.34102567 0.19776527 0.170401031  
## 17 0.36347257 0.48078207 0.36291004 0.278593465  
## 18 0.04945783 0.17324826 0.16612314 0.136628277  
## 19 0.12103829 0.35722158 0.15213565 0.109993919  
## 20 0.15028088 0.33595452 0.14428354 0.149070567  
## 21 0.17143007 0.37031769 0.21328117 0.151559793  
## 22 0.27748672 0.49328190 0.25236619 0.189613917  
## 23 0.35612954 0.55314368 0.35796623 0.234057568  
## 24 0.18703437 0.35052087 0.14585621 0.176788782  
## 25 0.09623045 0.52358225 0.13423733 0.000000000  
## 26 0.26982396 0.59309390 0.19088323 0.130549296  
## 27 0.00000000 0.30925858 0.00000000 0.018707087  
## 28 0.16813285 0.41195116 0.29532214 0.126825980  
## 29 0.17748846 0.50880009 0.11442315 0.085625658  
## 30 0.39283262 0.56168491 0.31571365 0.264849009  
## 31 0.23794262 0.39218452 0.25530991 0.204049481  
## 32 0.19522708 0.31496694 0.16230684 0.203070032  
## 33 0.18120799 0.42865070 0.12332452 0.130719617  
## 34 0.12070406 0.34903559 0.23267805 0.113914352  
## 35 0.32258531 0.68861204 0.29138676 0.131686269  
## 36 0.05146588 0.25686709 0.09204044 0.095232421  
## 37 0.05731785 0.24191994 0.19686530 0.108591448  
## 38 0.09215830 0.46436296 0.05995934 0.026774046  
## 39 0.28639672 0.63233456 0.30150192 0.126120446  
## 40 0.25337493 0.45665234 0.19574183 0.185456276  
## 41 0.09012320 0.32608788 0.01423241 0.096461123  
## 42 0.19572685 0.26702689 0.13457051 0.228387100  
## 43 0.26721877 0.46056546 0.16805673 0.196712068  
## 44 0.38710555 0.58733105 0.29979671 0.246066721  
## 45 0.28819958 0.40818297 0.43202295 0.243982318  
## 46 0.23884122 0.52816220 0.29532214 0.134462207  
## 47 0.21396033 0.51409843 0.19851011 0.117875372  
## 48 0.14664048 0.41317430 0.14950631 0.105570347  
## 49 0.13897169 0.43818770 0.17898311 0.085252797  
## 50 0.15064514 0.43678769 0.05397134 0.097178820  
## 51 0.28102055 0.48216831 0.17898311 0.198762530  
## 52 0.46569080 0.85935023 0.12260343 0.180537251  
## 53 0.23206335 0.64863616 0.19781220 0.065541775  
## 54 0.03859740 0.32994187 0.17898311 0.045025372  
## 55 0.14489653 0.42646033 0.17423472 0.097013581  
## 56 0.20745118 0.35423223 0.20296672 0.194455873  
## 57 0.16590152 0.25045929 0.12587419 0.208353300  
## 58 0.19971679 0.39127897 0.21477974 0.167840957  
## 59 0.16448936 0.46829053 0.18793227 0.094140852  
## 60 0.21180574 0.38376311 0.19298570 0.183334239  
## 61 0.46515152 0.68959191 0.57965483 0.267970910  
## 62 0.61274013 0.70122555 0.61866168 0.403554862  
## 63 0.17727667 0.28557051 0.34006791 0.201076775  
## 64 0.49710276 0.49896738 0.45130092 0.397389919  
## 65 0.48221778 0.50889009 0.61714722 0.377966870  
## 66 0.55730784 0.85450934 0.42955947 0.270951865  
## 67 0.50482947 0.51327706 0.41166116 0.397389919  
## 68 0.47741984 0.46251512 0.44878839 0.397389919  
## 69 0.44295569 0.45548449 0.33111876 0.367964114  
## 70 0.31297928 0.11240950 0.33559334 0.420997479  
## 71 0.44762771 0.42760319 0.34006791 0.386892104  
## 72 0.58593063 0.70522172 0.30243087 0.375760742  
## 73 0.56734895 0.70688295 0.41935629 0.357070941  
## 74 0.28320368 0.47600683 0.26847467 0.204049481  
## 75 0.44436433 0.52927927 0.68908498 0.331082923  
## 76 0.42506684 0.82836781 0.48431401 0.157610418  
## 77 0.58451110 0.76085712 0.49418172 0.345574235  
## 78 0.31474441 0.25402398 0.35205030 0.349321233  
## 79 0.39797628 0.42863211 0.41295557 0.338718467  
## 80 0.20828976 0.33301234 0.22372889 0.206254432  
## 81 0.49147032 0.66131543 0.49650478 0.307873729  
## 82 0.46156246 0.49435482 0.38820992 0.365678744  
## 83 0.60254919 0.63665711 0.30037181 0.427229305  
## 84 0.53002446 0.55993751 0.57173489 0.397389919  
## 85 0.48394212 0.87433363 0.38660352 0.190286557  
## 86 0.18609847 0.29401603 0.27742382 0.205165709  
## 87 0.32441511 0.43642906 0.40455966 0.264096940  
## 88 0.18099074 0.29960527 0.27412082 0.197369080  
## 89 0.29375050 0.41715446 0.25057636 0.244660334  
## 90 0.43437723 0.54389861 0.26576008 0.313926080  
## 91 0.53534756 0.63057382 0.39584640 0.365901054  
## 92 0.43211962 0.47716379 0.43724777 0.346334937  
## 93 0.57099633 0.40009169 0.51608581 0.519517913  
## 94 0.30818024 0.38210048 0.58751062 0.276666997  
## 95 0.65608494 0.39180152 0.48062086 0.605455548  
## 96 0.30259050 0.71806238 0.33031207 0.097243142  
## 97 0.68002732 0.46469032 0.68202856 0.590664880  
## 98 0.46846025 0.46996586 0.61512343 0.384932993  
## 99 0.49676078 0.51776298 0.71497291 0.387323870  
## 100 0.31222792 0.36575104 0.24581411 0.289021326  
## 101 0.56360182 0.65938088 0.46069793 0.378086205  
## 102 0.51878351 0.45241046 0.44129929 0.442313557  
## 103 0.42678217 0.35767235 0.42240015 0.403121685  
## 104 0.22793986 0.23258608 0.34901707 0.277139133  
## 105 0.49439030 0.64214219 0.44058754 0.320609032  
## 106 0.37478539 0.61010004 0.33064910 0.222449008  
## 107 0.37484142 0.29280486 0.39139881 0.386892104  
## 108 0.50419507 0.71411281 0.55733050 0.292729021  
## 109 0.35708797 0.23015883 0.43850863 0.402314319  
## 110 0.40955414 0.38646929 0.43864015 0.371671808  
## 111 0.36410574 0.36189151 0.43067215 0.340797707  
## 112 0.56758836 0.64595652 0.62064358 0.388866394  
## 113 0.15309151 0.00000000 0.48235949 0.325824034  
## 114 0.42058420 0.46143447 0.30874587 0.343416002  
## 115 0.52890544 0.77514898 0.65293578 0.284816041  
## 116 1.00000000 0.26719548 0.30770828 1.000000000  
## 117 0.42759999 0.34015932 0.43329254 0.412979807  
## 118 0.57764105 0.80921947 0.30312047 0.313926080  
## 119 0.37987805 0.54856554 0.28436094 0.259216191  
## 120 0.33375704 0.39846601 0.26130781 0.292729021  
## 121 0.27577321 0.33311453 0.24162720 0.270951865  
## 122 0.55679603 0.52927420 0.65455478 0.438963785  
## 123 0.52009848 0.97566690 0.34367835 0.172478235  
## 124 0.38112551 0.30535090 0.38024189 0.386421643  
## 125 0.46842631 0.37288473 0.16555938 0.435197778  
## 126 0.21133692 0.21865829 0.38532524 0.268424546  
## 127 0.42945938 0.50475013 0.40433324 0.329490071  
## 128 0.52355616 0.42069599 0.47015300 0.463324054  
## 129 0.62077778 0.62206524 0.49948766 0.452279632  
## 130 0.49272725 0.41603674 0.32016083 0.436157648  
## 131 0.23068531 0.27998180 0.16259240 0.255217866  
## 132 0.42081896 0.36316434 0.39376285 0.394554604  
## 133 0.41932673 0.49436106 0.34692829 0.325150326  
## 134 0.53629645 0.47651247 0.50616818 0.446630078  
## 135 0.25130434 0.42452178 0.57359585 0.200116252  
## 136 0.49161279 0.65916993 0.56810209 0.309122011  
## 137 0.59676819 0.82875977 0.60652431 0.322154827  
## 138 0.55213451 0.72992078 0.57653408 0.330536879  
## 139 0.44274116 0.55826872 0.58951682 0.314506177  
## 140 0.56851950 0.49341700 0.69566075 0.468789933  
## 141 0.41872109 0.39216535 0.54087352 0.377516395  
## 142 0.61104636 0.99056544 0.51908166 0.252023875  
## 143 0.57039700 0.44356585 0.77628752 0.496419068  
## 144 0.33252566 0.48495181 0.45224793 0.246739575  
## 145 0.32691218 0.37266999 0.39411066 0.299526199  
## 146 0.57380743 0.87956684 0.57946377 0.273801031  
## 147 0.57320873 0.66108402 0.57481661 0.386421643  
## 148 0.27904260 0.04992280 0.37586454 0.420809328  
## 149 0.38199672 0.29270862 0.32953382 0.393807481  
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## 177 0.32942621 0.1048584310 Spondylolisthesis  
## 178 0.20851252 0.1285512537 Spondylolisthesis  
## 179 0.53792605 0.1478713782 Spondylolisthesis  
## 180 0.59078233 0.1530476606 Spondylolisthesis  
## 181 0.94383990 0.1039689809 Spondylolisthesis  
## 182 0.21740216 0.0986603015 Spondylolisthesis  
## 183 0.39517821 0.1536866246 Spondylolisthesis  
## 184 0.59234935 0.1834942671 Spondylolisthesis  
## 185 0.59520932 0.1146178210 Spondylolisthesis  
## 186 0.50786215 0.1482333298 Spondylolisthesis  
## 187 0.21496543 0.1401709216 Spondylolisthesis  
## 188 0.41887453 0.0961914402 Spondylolisthesis  
## 189 0.54585407 0.1699650807 Spondylolisthesis  
## 190 0.50500531 0.1718419700 Spondylolisthesis  
## 191 0.19735423 0.1209007187 Spondylolisthesis  
## 192 0.29381724 0.1555172348 Spondylolisthesis  
## 193 0.82142904 0.3166717531 Spondylolisthesis  
## 194 0.52860784 0.1017796852 Spondylolisthesis  
## 195 0.50415760 0.0848284881 Spondylolisthesis  
## 196 0.43683409 0.1147995755 Spondylolisthesis  
## 197 0.21228618 0.1560834165 Spondylolisthesis  
## 198 0.70489219 0.2988186332 Spondylolisthesis  
## 199 0.48528735 0.1029569459 Spondylolisthesis  
## 200 0.52480502 0.0992408670 Spondylolisthesis  
## 201 0.65509934 0.1131628061 Spondylolisthesis  
## 202 0.81212715 0.2312834567 Spondylolisthesis  
## 203 0.66873574 0.2613515641 Spondylolisthesis  
## 204 0.30805278 0.0885331803 Spondylolisthesis  
## 205 0.34026542 0.0857338085 Spondylolisthesis  
## 206 0.59696704 0.2591945034 Spondylolisthesis  
## 207 0.28607127 0.2056354547 Spondylolisthesis  
## 208 0.62720851 0.1965692435 Spondylolisthesis  
## 209 0.54697379 0.2043495113 Spondylolisthesis  
## 210 0.26669718 0.0917175563 Spondylolisthesis  
## 211 0.61889719 0.0443314851 Normal  
## 212 0.59968805 0.0303998669 Normal  
## 213 0.63597250 0.0373657515 Normal  
## 214 0.63338751 0.0236201311 Normal  
## 215 0.64627090 0.0178520628 Normal  
## 216 0.77781187 0.0210725773 Normal  
## 217 0.51693461 0.0232778487 Normal  
## 218 0.66709596 0.0404942434 Normal  
## 219 0.63774289 0.0280897849 Normal  
## 220 0.38816832 0.0329989719 Normal  
## 221 0.46990687 0.0250791845 Normal  
## 222 0.61177215 0.0242703564 Normal  
## 223 0.49625433 0.0983026583 Normal  
## 224 0.36025936 0.0247078368 Normal  
## 225 0.32712247 0.0328191586 Normal  
## 226 0.59245678 0.0332711730 Normal  
## 227 0.77727435 0.0404029298 Normal  
## 228 0.52268518 0.0369487038 Normal  
## 229 0.57771507 0.0347856338 Normal  
## 230 0.72435994 0.0184909322 Normal  
## 231 0.58120570 0.0162357071 Normal  
## 232 0.51738095 0.0375523382 Normal  
## 233 0.62841285 0.0280006279 Normal  
## 234 0.74241355 0.0198941690 Normal  
## 235 0.70609135 0.0575911377 Normal  
## 236 0.46224404 0.0000000000 Normal  
## 237 0.55595313 0.0287577598 Normal  
## 238 0.67964622 0.0372747610 Normal  
## 239 0.60791461 0.0509546682 Normal  
## 240 0.74317944 0.0214116926 Normal  
## 241 0.49976729 0.0116471742 Normal  
## 242 0.60906415 0.0581620954 Normal  
## 243 0.66139219 0.0239727353 Normal  
## 244 0.57969734 0.0162365470 Normal  
## 245 0.47773703 0.0430586457 Normal  
## 246 0.59478950 0.0248035944 Normal  
## 247 0.53011981 0.0468405523 Normal  
## 248 0.55225111 0.0301942450 Normal  
## 249 0.54301785 0.0295363243 Normal  
## 250 0.56201531 0.0310675681 Normal  
## 251 0.70819896 0.0208697529 Normal  
## 252 0.74379736 0.0272967901 Normal  
## 253 0.55409328 0.0179145983 Normal  
## 254 0.53197798 0.0545640447 Normal  
## 255 0.44254383 0.0276341596 Normal  
## 256 0.57587449 0.0861924495 Normal  
## 257 0.56948379 0.0449101866 Normal  
## 258 0.66373734 0.0064431265 Normal  
## 259 0.62295202 0.0268087668 Normal  
## 260 0.50551616 0.0249076706 Normal  
## 261 0.56056962 0.0260979865 Normal  
## 262 0.38244340 0.0294527217 Normal  
## 263 0.63258506 0.0275027098 Normal  
## 264 0.62634414 0.0216062388 Normal  
## 265 0.44853517 0.0154827517 Normal  
## 266 0.70482650 0.0382173674 Normal  
## 267 0.55023042 0.0244788775 Normal  
## 268 0.57005634 0.0300623834 Normal  
## 269 0.47020458 0.0374146117 Normal  
## 270 0.59073763 0.0428876862 Normal  
## 271 0.60641589 0.0207497872 Normal  
## 272 0.54360899 0.0440755442 Normal  
## 273 0.51335598 0.0301726928 Normal  
## 274 0.61127292 0.0219411377 Normal  
## 275 0.57410158 0.0297931999 Normal  
## 276 0.72599545 0.0372869541 Normal  
## 277 0.65839937 0.0299045871 Normal  
## 278 0.63783177 0.0211267039 Normal  
## 279 0.52966870 0.0113698545 Normal  
## 280 0.74275698 0.0500488297 Normal  
## 281 0.52750679 0.0329320801 Normal  
## 282 0.48721842 0.0395940017 Normal  
## 283 0.47136091 0.0321116701 Normal  
## 284 0.60561934 0.0269870025 Normal  
## 285 0.54795041 0.0323292412 Normal  
## 286 0.53343251 0.0370709308 Normal  
## 287 0.54670893 0.0329279868 Normal  
## 288 0.54099222 0.0475150924 Normal  
## 289 0.37999045 0.0271354552 Normal  
## 290 0.66282455 0.0173507948 Normal  
## 291 0.60216378 0.0261588984 Normal  
## 292 0.49168610 0.0418138173 Normal  
## 293 0.61359518 0.0246677220 Normal  
## 294 0.72079600 0.0719572792 Normal  
## 295 0.62352943 0.0138689661 Normal  
## 296 0.64811824 0.0314420890 Normal  
## 297 0.66502263 0.0141740710 Normal  
## 298 0.50236803 0.0330308355 Normal  
## 299 0.63255512 0.0292722186 Normal  
## 300 0.43689701 0.0398916811 Normal  
## 301 0.50012004 0.0252407733 Normal  
## 302 0.44520037 0.0398501788 Normal  
## 303 0.51899713 0.0223163018 Normal  
## 304 0.62607361 0.0179065189 Normal  
## 305 0.83679263 0.0049265899 Normal  
## 306 0.50938024 0.0158583874 Normal  
## 307 0.47622326 0.0247605611 Normal  
## 308 0.59779618 0.0194373246 Normal  
## 309 0.52117504 0.0262404463 Normal  
## 310 0.57924032 0.0252767637 Normal

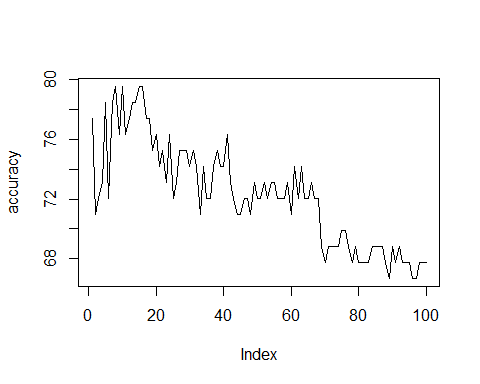
accuracy <- c()  
  
split <- sample.split(data\_new$class, SplitRatio = 0.7)  
train <- subset(data\_new, split == TRUE)  
test <- subset(data\_new, split == FALSE)  
  
predict = knn(train[,-7],test[,-7],train[,7],k=4)  
table1 = table(Actual = test[,7],predicted = predict)  
table1

## predicted  
## Actual Hernia Normal Spondylolisthesis  
## Hernia 9 8 1  
## Normal 6 22 2  
## Spondylolisthesis 5 5 35

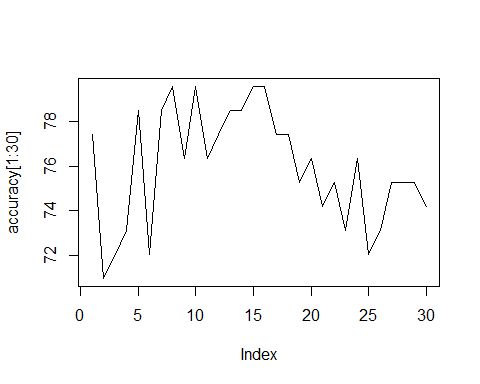
accuracy1 = sum (diag(table1)/sum(table1))  
accuracy1

## [1] 0.7096774

for (i in 1:100)  
{  
 predict = knn(train[,-7],test[,-7],train[,7],k=i)  
 table1 = table(actual = test[,7],predicted = predict)  
 accuracy1 = sum (diag(table1)/sum(table1))  
 accuracy[i]=accuracy1\*100  
}  
  
plot(accuracy, t="l")



plot(accuracy[1:30],t="l")



# 4) using SVM  
  
data <- read.csv("column\_3C\_weka.csv")  
kernellist <- c("linear","radial","polynomial",  
 "sigmoid")  
data[,7] <- as.factor(data[,7])  
#using different kernels to see which one gives best model  
accuracy\_kernel <- c()  
for( i in 1:4)  
{  
 model <- svm(class~.,  
 data = data,kernel = kernellist[i])  
 summary(model)  
 pred <- predict(model,data=data)  
 t <- table(actual = data$class, Predicted = pred)  
 accuracy\_kernel[i] = sum(diag(t))/sum(t) \*100  
   
}  
  
  
accuracy\_kernel

## [1] 87.74194 86.12903 82.58065 82.90323

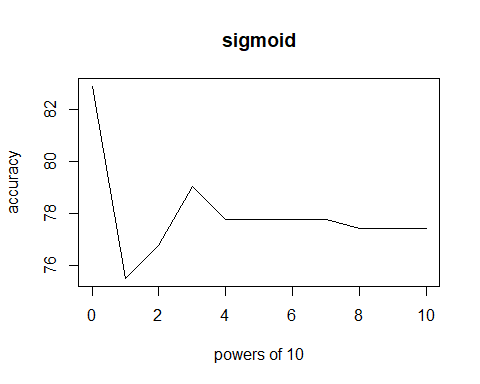
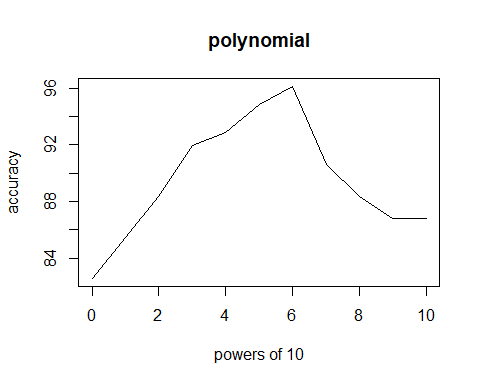
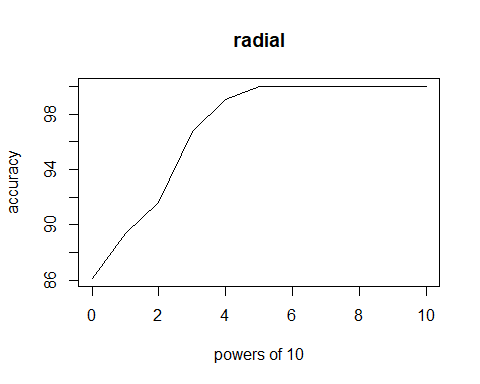
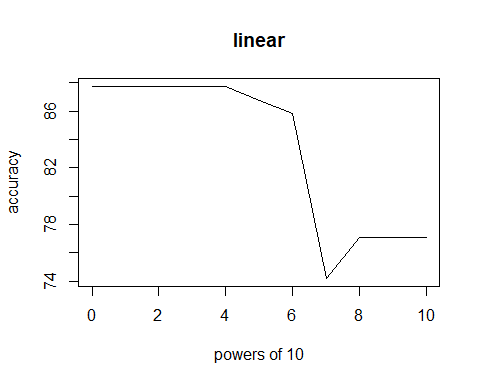
accuracy\_cost <- c()  
  
# Checking what is the best cost  
# For different kernels using different values  
  
gp <- c(10^seq(0,10))  
gp

## [1] 1e+00 1e+01 1e+02 1e+03 1e+04 1e+05 1e+06 1e+07 1e+08 1e+09 1e+10

gp\_length <- c(0:10)  
gp\_length

## [1] 0 1 2 3 4 5 6 7 8 9 10

j=1  
for (k in 1:4)   
{  
 for( i in gp)  
 {  
 model <- svm(class~.,  
 data = data,kernel = kernellist[k],cost = i)  
 pred <- predict(model,data=data)  
 t <- table(actual = data$class, Predicted = pred)  
 accuracy\_cost[j] = sum(diag(t))/sum(t) \*100  
 j <- j+1  
 #plot(model,data,Petal.Length~Petal.Width)  
 }  
   
 plot(gp\_length,accuracy\_cost[(j-11):(j-1)], t="l",  
 xlab="powers of 10",ylab="accuracy",main=kernellist[k])  
   
}



length(accuracy\_cost)

## [1] 44

accuracy\_cost

## [1] 87.74194 87.74194 87.74194 87.74194 87.74194 86.77419 85.80645  
## [8] 74.19355 77.09677 77.09677 77.09677 86.12903 89.35484 91.61290  
## [15] 96.77419 99.03226 100.00000 100.00000 100.00000 100.00000 100.00000  
## [22] 100.00000 82.58065 85.48387 88.38710 91.93548 92.90323 94.83871  
## [29] 96.12903 90.64516 88.38710 86.77419 86.77419 82.90323 75.48387  
## [36] 76.77419 79.03226 77.74194 77.74194 77.74194 77.74194 77.41935  
## [43] 77.41935 77.41935