2 d)

```
data1 <- data
in_train <- sample(nrow(data1))
data1 <- data1[in_train,]
train_data <- data1[1:300,]
test_data  <- data1[301:nrow(data1),]
library(C50)
 train_data$Class <- as.factor(train_data$Class)
vars=c("SpecimenNumber","Eccentricity","AspectRatio","Elongation","Solidity","StochasticConv
exity","IsoperimetricFactor","MaximalIndentationDepth","Lobedness","AvgIntensity","AvgCont
rast","Smoothness","ThirdMoment","Uniformity","Entropy")
tree_mod <- C5.0(x = train_data[, vars], y = train_data$Class)
summary(tree_mod)
```

```
C5.0 [Release 2.07 GPL Edition]         Thu Oct 10 20:36:59 2019
-------------------------------

Class specified by attribute `outcome'

Read 300 cases (16 attributes) from undefined.data

Decision tree:

IsoperimetricFactor <= -0.672474:
:...Eccentricity <= 0.2271452:
:   :...Entropy <= -0.1522775:
:   :   :...Solidity <= -2.84753: -0.682588428734203 (14)
:   :   :   Solidity > -2.84753: -1.13190391871652 (6)
:   :   Entropy > -0.1522775:
:   :   :...Elongation <= 0.7004622: -0.323136036748347 (9)
:   :       Elongation > 0.7004622: 1.5639890211774 (8)
:   Eccentricity > 0.2271452:
:   :...IsoperimetricFactor <= -1.415868:
:       :...Entropy > -1.18653: 1.38426282518447 (8)
:       :   Entropy <= -1.18653:
:       :   :...AspectRatio <= 3.883002: 1.11467353119508 (10)
:       :       AspectRatio > 3.883002: 1.38426282518447 (2)
:       IsoperimetricFactor > -1.415868:
:       :...Solidity > 0.005855562: -0.952177722723596 (10)
:           Solidity <= 0.005855562:
```

```
:         :...Lobedness <= 1.515022: -1.22176701671299 (9)
:             Lobedness > 1.515022: 0.305905649226901 (2)
IsoperimetricFactor > -0.672474:
:...AspectRatio <= -0.2190555:
   :...Solidity > 0.5491624:
   :   :...AspectRatio <= -0.4227173:
   :   :   :...Solidity <= 0.6371131:
   :   :   :   :...Lobedness <= -0.4706349: -1.31163011470945 (4)
   :   :   :   :   Lobedness > -0.4706349: 0.485631845219829 (4)
   :   :   :   Solidity > 0.6371131:
   :   :   :   :...Solidity <= 0.7194852: 0.665358041212757 (8/1)
   :   :   :       Solidity > 0.7194852: 0.755221139209222 (2)
   :   :   AspectRatio > -0.4227173:
   :   :   :...ThirdMoment <= -0.572836:
   :   :       :...Lobedness > -0.4813085: 0.485631845219829 (4/1)
   :   :       :   Lobedness <= -0.4813085:
   :   :       :   :...Entropy <= -0.5999333: -1.58121940869884 (9/1)
   :   :       :       Entropy > -0.5999333: 0.755221139209222 (6/1)
   :   :       ThirdMoment > -0.572836:
   :   :       :...AvgContrast <= -0.305275: 0.665358041212757 (6/3)
   :   :           AvgContrast > -0.305275:
   :   :           :...Uniformity <= 0.5477927: -0.502862232741275 (10/1)
   :   :               Uniformity > 0.5477927: 1.29439972718801 (11/2)
   :   Solidity <= 0.5491624:
   :   :...Eccentricity > -0.08188758:
   :       :...AvgIntensity > 0.6833655: 0.575494943216293 (9)
   :       :   AvgIntensity <= 0.6833655:
   :       :   :...Entropy <= -1.021177: 0.93494733520215 (2)
   :       :       Entropy > -1.021177:
   :       :       :...Eccentricity <= 0.2875425: -1.31163011470945 (2)
   :       :           Eccentricity > 0.2875425: -1.04204082072006 (5/1)
   :       Eccentricity <= -0.08188758:
   :       :...Entropy <= -0.7565104:
   :           :...StochasticConvexity <= 0.3980244: 0.395768747223365 (10)
   :           :   StochasticConvexity > 0.3980244: -1.40149321270592 (3/1)
   :           Entropy > -0.7565104:
   :           :...ThirdMoment > 0.8033538:
   :               :...MaximalIndentationDepth <= -0.08932234: -1.40149321270592 (6)
   :               :   MaximalIndentationDepth > -0.08932234: -0.772451526730668 (8)
   :               ThirdMoment <= 0.8033538:
   :               :...Solidity <= 0.2629958:
   :                   :...Uniformity <= 2.679753: -0.862314624727132 (12/1)
   :                   :   Uniformity > 2.679753: -0.772451526730668 (2)
   :                   Solidity > 0.2629958:
```

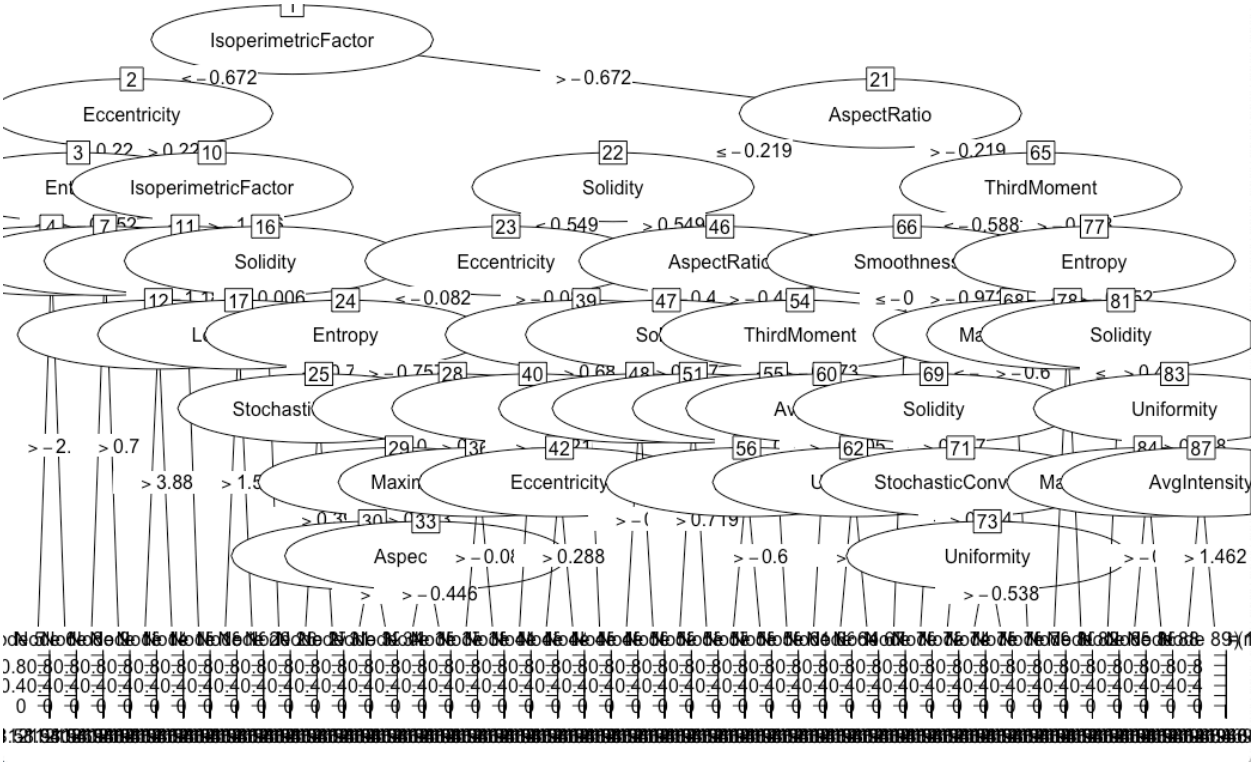
```
:                :...AspectRatio <= -0.4459655: 1.02481043319861 (13/1)
:                   AspectRatio > -0.4459655: 0.485631845219829 (3)
   AspectRatio > -0.2190555:
   :...ThirdMoment > -0.5880573:
      :...Entropy <= -0.1522775:
      :   :...MaximalIndentationDepth <= -0.4591765: 1.20453662919154 (6/3)
      :   :   MaximalIndentationDepth > -0.4591765: 0.305905649226901 (10/1)
      :   Entropy > -0.1522775:
      :   :...Solidity <= 0.4255608: -0.592725330737739 (12/2)
      :       Solidity > 0.4255608:
      :       :...Uniformity <= 0.5477927:
      :           :...MaximalIndentationDepth <= -0.6881944: -0.412999134744811 (9/1)
      :           :   MaximalIndentationDepth > -0.6881944: 0.845084237205686 (6)
      :           Uniformity > 0.5477927:
      :           :...AvgIntensity <= 1.461875: 1.47412592318093 (10)
      :               AvgIntensity > 1.461875: 0.845084237205686 (4/1)
      ThirdMoment <= -0.5880573:
      :...Smoothness <= -0.9722522: 0.93494733520215 (10/1)
          Smoothness > -0.9722522:
          :...Entropy > -0.5999333: -1.49135631070238 (6)
              Entropy <= -0.5999333:
              :...Solidity <= 0.6169777: -1.04204082072006 (2/1)
                  Solidity > 0.6169777:
                  :...StochasticConvexity <= 0.4742557: 1.20453662919154 (3)
                      StochasticConvexity > 0.4742557:
                      :...Uniformity <= -0.5376995: -1.49135631070238 (3)
                          Uniformity > -0.5376995: 1.20453662919154 (2)


Evaluation on training data (300 cases):

          Decision Tree
        ----------------
        Size      Errors

         45   24( 8.0%)   <<


        Class             Cases   False   False
                                  Pos     Neg
        -----            -----   -----   -----
        -1.58121940869884     9      1      1
        -1.49135631070238     9      0      0
        -1.40149321270592     8      1      0
```

-1.31163011470945	8	0	2
-1.22176701671299	10	0	1
-1.13190391871652	6	0	0
-1.04204082072006	6	2	1
-0.952177722723596	10	0	0
-0.862314624727132	12	1	1
-0.772451526730668	10	0	0
-0.682588428734203	14	0	0
-0.592725330737739	11	2	1
-0.502862232741275	12	1	3
-0.412999134744811	11	1	3
-0.323136036748347	9	0	0
0.305905649226901	12	1	1
0.395768747223365	10	0	0
0.485631845219829	11	1	1
0.575494943216293	9	0	0
0.665358041212757	11	4	1
0.755221139209222	10	1	3
0.845084237205686	10	1	1
0.93494733520215	11	1	0
1.02481043319861	12	1	0
1.11467353119508	10	0	0
1.20453662919154	10	3	2
1.29439972718801	10	2	1
1.38426282518447	10	0	0
1.47412592318093	11	0	1
1.5639890211774	8	0	0

Attribute usage:

100.00%	IsoperimetricFactor
78.00%	AspectRatio
77.00%	Solidity
70.33%	Entropy
57.67%	ThirdMoment
51.00%	Eccentricity
23.00%	Uniformity
15.00%	MaximalIndentationDepth
12.67%	Lobedness
10.67%	AvgIntensity
9.00%	AvgContrast
8.67%	Smoothness
7.00%	StochasticConvexity

5.67%Elongation



predicted <- predict(tree_mod, newdata = test_data[, vars])
predicted

[1] 1.5639890211774 0.845084237205686 0.93494733520215 -1.31163011470945 1.38426282518447
[6] 0.665358041212757 -1.13190391871652 1.29439972718801 -1.22176701671299 0.755221139209222
[11] -0.502862232741275 0.755221139209222 1.20453662919154 -1.22176701671299 0.395768747223365
[16] -1.13190391871652 -1.04204082072006 0.485631845219829 -0.862314624727132 -1.22176701671299
[21] -0.323136036748347 -1.04204082072006 -1.58121940869884 -1.22176701671299 -0.412999134744811
[26] -1.40149321270592 -0.952177722723596 0.845084237205686 -0.862314624727132 -0.682588428734203
[31] -0.682588428734203 1.5639890211774 1.38426282518447 -1.31163011470945 -0.862314624727132
[36] -1.58121940869884 -0.592725330737739 0.665358041212757 -1.31163011470945

```
test_data$Class <- as.factor(test_data$Class)
cm <- confusionMatrix(test_data$Class,predicted)
cm
```

Class	Cases	False Pos	False Neg
-1.58121940869884	9	1	1
-1.49135631070238	9	0	0
-1.40149321270592	8	1	0
-1.31163011470945	8	0	2
-1.22176701671299	10	0	1
-1.13190391871652	6	0	0
-1.04204082072006	6	2	1
-0.952177722723596	10	0	0
-0.862314624727132	12	1	1
-0.772451526730668	10	0	0
-0.682588428734203	14	0	0
-0.592725330737739	11	2	1
-0.502862232741275	12	1	3
-0.412999134744811	11	1	3
-0.323136036748347	9	0	0
0.305905649226901	12	1	1
0.395768747223365	10	0	0
0.485631845219829	11	1	1
0.575494943216293	9	0	0
0.665358041212757	11	4	1
0.755221139209222	10	1	3
0.845084237205686	10	1	1
0.93494733520215	11	1	0
1.02481043319861	12	1	0
1.11467353119508	10	0	0
1.20453662919154	10	3	2
1.29439972718801	10	2	1
1.38426282518447	10	0	0
1.47412592318093	11	0	1
1.5639890211774	8	0	0

Attribute usage:

100.00%	IsoperimetricFactor
78.00%	AspectRatio

77.00% Solidity
70.33% Entropy
57.67% ThirdMoment
51.00% Eccentricity
23.00% Uniformity
15.00% MaximalIndentationDepth
12.67% Lobedness
10.67% AvgIntensity
9.00% AvgContrast
8.67% Smoothness
7.00% StochasticConvexity
5.67% Elongation

```
Error rate
accuracy_rpart <- cm$overall["Accuracy"]
test_Dat <- test_data$Class
count = 0
for (i in 1:length(test_Dat)){
  if (predicted[i] == test_Dat[i]){
    count = count+1
  }
}
error_rate_C5.0 = 1- (count/length(test_Dat))
error_rate_C5.0
```
[1] 0.3846154

```
2e)
in_train <- sample(nrow(data1))
data1 <- data1[in_train,]
train_data <- data1[1:300,]
test_data  <- data1[301:nrow(data1),]
train_data$Class <- as.factor(train_data$Class)
vars =
c("SpecimenNumber","Eccentricity","AspectRatio","Elongation","Solidity","StochasticConvexity
","IsoperimetricFactor","MaximalIndentationDepth","Lobedness","AvgIntensity","AvgContrast",
"Smoothness","ThirdMoment","Uniformity","Entropy")
#colnames(train_data)
#crossvalidation
caret.control <- trainControl(method = "repeatedcv",
                              number = 3,
```

```
                    repeats = 2)
rpart.cv <- train(Class ~ .,
                  data = train_data,
                  method = "rpart",
                  trControl = caret.control,
                  tuneLength = 15)
summary(rpart.cv)
```

variable importance

Variable importance

Solidity	Elongation	IsoperimetricFactor	MaximalIndentationDepth	
15	11	10	9	
Lobedness	AspectRatio	StochasticConvexity	Eccentricity	
8	8	8	8	
Uniformity	Entropy	AvgIntensity	AvgContrast	
6	5	4	3	
Smoothness	ThirdMoment			
3	3			

Node number 1: 300 observations, complexity param=0.04577465
predicted class=-0.682588428734203 expected loss=0.9466667 P(node) =1
class counts: 9 9 9 8 8 7 9 11 13 10 16 10 13 10 10 12 8 11 8 9 9 9 12 11 10 10 10 9 10 10

model splitting

```
Node number 1: 300 observations,    complexity param=0.04577465
  predicted class=-0.682588428734203  expected loss=0.9466667  P(node) =1
    class counts:    9    9    9    8    8    7    9   11   13   10   16   10   13   10   10   12    8   11    8    9    9    9   12   11   10   10   10    9   10   10
   probabilities: 0.030 0.030 0.030 0.027 0.027 0.023 0.030 0.037 0.043 0.033 0.053 0.033 0.043 0.033 0.033 0.040 0.027 0.037 0.027 0.030 0.030 0.030 0.040 0.037 0.033 0.033
0.033 0.030 0.033 0.033
  left son=2 (17 obs) right son=3 (283 obs)
  Primary splits:
      Solidity          < -2.584724   to the left,  improve=14.76625, (0 missing)
      StochasticConvexity < -1.010907   to the right, improve=11.26157, (0 missing)
      IsoperimetricFactor < -1.380788   to the right, improve=11.21164, (0 missing)
      Eccentricity       < 1.222598    to the left,  improve=10.09556, (0 missing)
      AspectRatio        < 0.9147263   to the left,  improve=10.09556, (0 missing)
  Surrogate splits:
      MaximalIndentationDepth < 2.061471    to the right, agree=0.963, adj=0.353, (0 split)
      Lobedness            < 1.889209    to the right, agree=0.963, adj=0.353, (0 split)
      SpecimenNumber         < 2.083967    to the right, agree=0.950, adj=0.118, (0 split)
      StochasticConvexity    < -2.44276    to the left,  agree=0.950, adj=0.118, (0 split)

Node number 2: 17 observations
  predicted class=-0.682588428734203  expected loss=0.05882353  P(node) =0.05666667
    class counts:    0    0    0    0    0    0    0    0    0    0   16    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    1
   probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.941 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.059

Node number 3: 283 observations,    complexity param=0.04107981
  predicted class=-0.862314624727132  expected loss=0.9540636  P(node) =0.9433333
    class counts:    9    9    9    8    8    7    9   11   13   10    0   10   13   10   10   12    8   11    8    9    9    9   12   11   10   10   10    9   10    9
   probabilities: 0.032 0.032 0.032 0.028 0.028 0.025 0.032 0.039 0.046 0.035 0.000 0.035 0.046 0.035 0.035 0.042 0.028 0.039 0.028 0.032 0.032 0.032 0.042 0.039 0.035 0.035
0.035 0.032 0.035 0.032
```

left son=6 (253 obs) right son=7 (30 obs)
Primary splits:
Eccentricity < 1.222598 to the left, improve=10.055830, (0 missing)
AspectRatio < 0.9147263 to the left, improve=10.055830, (0 missing)
Elongation < 1.577409 to the left, improve=10.055830, (0 missing)
IsoperimetricFactor < -1.528173 to the right, improve= 9.106622, (0 missing)
Solidity < 0.4055997 to the left, improve= 8.268192, (0 missing)
Surrogate splits:
AspectRatio < 0.9147263 to the left, agree=1.000, adj=1.000, (0 split)
Elongation < 1.577409 to the left, agree=1.000, adj=1.000, (0 split)
IsoperimetricFactor < -1.528173 to the right, agree=0.933, adj=0.367, (0 split)
MaximalIndentationDepth < 2.942378 to the left, agree=0.908, adj=0.133, (0 split)
Lobedness < 3.482949 to the left, agree=0.908, adj=0.133, (0 split)

Node number 6: 253 observations, complexity param=0.04107981
predicted class=-0.862314624727132 expected loss=0.9486166 P(node) =0.8433333
class counts: 9 9 9 8 8 7 9 0 13 10 0 10 13 10 10 12 8 11 8 9 9 9 12 11 0 10 10 0 10 9
probabilities: 0.036 0.036 0.036 0.032 0.032 0.028 0.036 0.000 0.051 0.040 0.000 0.040 0.051 0.040 0.040 0.047 0.032 0.043 0.032 0.036 0.036 0.036 0.047 0.043 0.000 0.040 0.040 0.000 0.040 0.036
left son=12 (234 obs) right son=13 (19 obs)
Primary splits:
AvgIntensity < -1.128751 to the right, improve=8.770616, (0 missing)
Eccentricity < 0.1986962 to the left, improve=8.535636, (0 missing)
AspectRatio < -0.3386204 to the left, improve=8.497006, (0 missing)
Elongation < -0.343127 to the left, improve=8.235573, (0 missing)
StochasticConvexity < 0.01725909 to the left, improve=8.221951, (0 missing)
Surrogate splits:
Entropy < -1.384398 to the right, agree=0.992, adj=0.895, (0 split)
AvgContrast < -1.476747 to the right, agree=0.984, adj=0.789, (0 split)
Smoothness < -1.11697 to the right, agree=0.984, adj=0.789, (0 split)
ThirdMoment < -0.9743526 to the right, agree=0.984, adj=0.789, (0 split)
Uniformity < -0.8098677 to the right, agree=0.976, adj=0.684, (0 split)

Node number 7: 30 observations, complexity param=0.03521127
predicted class=-0.952177722723596 expected loss=0.6333333 P(node) =0.1
class counts: 0 0 0 0 0 0 0 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 0 0 9 0 0
probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.367 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.333 0.000 0.000 0.300 0.000 0.000
left son=14 (11 obs) right son=15 (19 obs)
Primary splits:
Solidity < 0.3646316 to the right, improve=10.45965, (0 missing)
IsoperimetricFactor < -1.369072 to the right, improve=10.45965, (0 missing)
Elongation < 1.879686 to the left, improve=10.45965, (0 missing)
AspectRatio < 2.160906 to the left, improve=10.45965, (0 missing)
Eccentricity < 1.301618 to the left, improve=10.45965, (0 missing)
Surrogate splits:
Eccentricity < 1.301618 to the left, agree=1.000, adj=1.000, (0 split)
AspectRatio < 2.160906 to the left, agree=1.000, adj=1.000, (0 split)
Elongation < 1.879686 to the left, agree=1.000, adj=1.000, (0 split)
IsoperimetricFactor < -1.369072 to the right, agree=1.000, adj=1.000, (0 split)
Uniformity < -0.7081709 to the right, agree=0.967, adj=0.909, (0 split)

Node number 12: 234 observations, complexity param=0.04107981
predicted class=-0.862314624727132 expected loss=0.9444444 P(node) =0.78
class counts: 4 9 9 8 8 6 9 0 13 10 0 10 13 10 10 12 8 10 8 9 9 9 0 11 0 10 10 0 10 9
probabilities: 0.017 0.038 0.038 0.034 0.034 0.026 0.038 0.000 0.056 0.043 0.000 0.043 0.056 0.043 0.043 0.051 0.034 0.043 0.034 0.038 0.038 0.038 0.000 0.047 0.000 0.043 0.043 0.000 0.043 0.038
left son=24 (92 obs) right son=25 (142 obs)
Primary splits:
Eccentricity < 0.4905925 to the right, improve=8.883145, (0 missing)
AspectRatio < -0.2176529 to the left, improve=8.635775, (0 missing)
Solidity < 0.4447373 to the left, improve=8.348772, (0 missing)
Elongation < -0.3432292 to the left, improve=8.277567, (0 missing)
StochasticConvexity < 0.01725909 to the left, improve=8.080937, (0 missing)
Surrogate splits:
AspectRatio < -0.2865905 to the right, agree=0.962, adj=0.902, (0 split)
Elongation < -0.1439184 to the right, agree=0.893, adj=0.728, (0 split)
IsoperimetricFactor < 0.2875897 to the left, agree=0.628, adj=0.054, (0 split)
MaximalIndentationDepth < -0.881687 to the left, agree=0.620, adj=0.033, (0 split)
Lobedness < -0.502737 to the left, agree=0.620, adj=0.033, (0 split)

Node number 13: 19 observations
predicted class=0.93494733520215 expected loss=0.3684211 P(node) =0.06333333
class counts: 5 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 12 0 0 0 0 0 0 0
probabilities: 0.263 0.000 0.000 0.000 0.000 0.053 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.053 0.000 0.000 0.000 0.000 0.632 0.000 0.000 0.000 0.000 0.000 0.000 0.000

Node number 14: 11 observations
predicted class=-0.952177722723596 expected loss=0 P(node) =0.03666667
class counts: 0 0 0 0 0 0 0 11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.000 0.000

Node number 15: 19 observations
predicted class=1.11467353119508 expected loss=0.4736842 P(node) =0.06333333
class counts: 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 10 0 0 9 0 0
probabilities: 0.000 0.526 0.000 0.000 0.474 0.000 0.000

Node number 24: 92 observations, complexity param=0.02992958
predicted class=0.305905649226901 expected loss=0.8695652 P(node) =0.3066667
class counts: 0 9 0 0 8 0 9 0 0 0 0 10 0 10 0 12 0 0 2 3 1 9 0 0 0 9 0 0 10 0
probabilities: 0.000 0.098 0.000 0.000 0.087 0.000 0.098 0.000 0.000 0.000 0.000 0.109 0.000 0.109 0.000 0.130 0.000 0.000 0.022 0.033 0.011 0.098 0.000 0.000 0.000 0.098 0.000 0.000 0.109 0.000
left son=48 (9 obs) right son=49 (83 obs)
Primary splits:
StochasticConvexity < -0.0970009 to the left, improve=7.171148, (0 missing)
Entropy < -0.1429726 to the left, improve=6.913685, (0 missing)
Solidity < 0.4328391 to the left, improve=6.879745, (0 missing)
MaximalIndentationDepth < -0.4549398 to the right, improve=6.557539, (0 missing)
Lobedness < -0.4356423 to the right, improve=6.557539, (0 missing)
Surrogate splits:
IsoperimetricFactor < -0.7316076 to the left, agree=0.967, adj=0.667, (0 split)
Solidity < -0.4032589 to the left, agree=0.957, adj=0.556, (0 split)

Node number 25: 142 observations, complexity param=0.04049296
predicted class=-0.862314624727132 expected loss=0.9084507 P(node) =0.4733333
class counts: 4 0 9 8 0 6 0 0 13 10 0 0 13 0 10 0 8 10 6 6 8 0 0 11 0 1 10 0 0 9
probabilities: 0.028 0.000 0.063 0.056 0.000 0.042 0.000 0.000 0.092 0.070 0.000 0.000 0.092 0.000 0.070 0.000 0.056 0.070 0.042 0.042 0.056 0.000 0.000 0.077 0.000 0.007 0.070 0.000 0.000 0.063
left son=50 (117 obs) right son=51 (25 obs)
Primary splits:
Solidity < -0.6637115 to the right, improve=8.838661, (0 missing)
IsoperimetricFactor < -0.6627143 to the right, improve=8.838661, (0 missing)
StochasticConvexity < 0.09340348 to the right, improve=8.508147, (0 missing)
Elongation < 1.004247 to the left, improve=8.216859, (0 missing)
MaximalIndentationDepth < 0.6377276 to the left, improve=8.161989, (0 missing)
Surrogate splits:
IsoperimetricFactor < -0.6627143 to the right, agree=1.000, adj=1.00, (0 split)
MaximalIndentationDepth < 0.697392 to the left, agree=0.972, adj=0.84, (0 split)
Lobedness < 0.2195748 to the left, agree=0.972, adj=0.84, (0 split)
Elongation < -0.1635504 to the left, agree=0.965, adj=0.80, (0 split)
StochasticConvexity < -0.2569302 to the right, agree=0.958, adj=0.76, (0 split)

Node number 48: 9 observations
predicted class=-1.22176701671299 expected loss=0.1111111 P(node) =0.03
class counts: 0 0 0 0 8 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
probabilities: 0.000 0.000 0.000 0.000 0.889 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.111 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
0.000 0.000 0.000 0.000

Node number 49: 83 observations, complexity param=0.02992958
predicted class=0.305905649226901 expected loss=0.8674699 P(node) =0.2766667
class counts: 0 9 0 0 0 0 9 0 0 0 0 10 0 10 0 11 0 0 2 3 1 9 0 0 0 9 0 0 10 0
probabilities: 0.000 0.108 0.000 0.000 0.000 0.000 0.108 0.000 0.000 0.000 0.000 0.120 0.000 0.120 0.000 0.133 0.000 0.000 0.024 0.036 0.012 0.108 0.000 0.000 0.000 0.108 0.000 0.000 0.120 0.000
left son=98 (37 obs) right son=99 (46 obs)
Primary splits:
Entropy < -0.1429726 to the left, improve=6.904775, (0 missing)
Solidity < 0.4328391 to the left, improve=6.634522, (0 missing)
MaximalIndentationDepth < -0.7322384 to the left, improve=6.265811, (0 missing)
Lobedness < -0.4900403 to the left, improve=6.265811, (0 missing)
Uniformity < 0.5085713 to the left, improve=6.263621, (0 missing)
Surrogate splits:
AvgIntensity < -0.1182853 to the left, agree=0.904, adj=0.784, (0 split)
Uniformity < -0.1970669 to the left, agree=0.843, adj=0.649, (0 split)
AvgContrast < -0.04601334 to the left, agree=0.819, adj=0.595, (0 split)
Smoothness < -0.2160844 to the left, agree=0.819, adj=0.595, (0 split)
ThirdMoment < -0.3410002 to the left, agree=0.783, adj=0.514, (0 split)

Node number 50: 117 observations, complexity param=0.04049296
predicted class=-0.862314624727132 expected loss=0.8888889 P(node) =0.39
class counts: 4 0 9 8 0 0 0 0 13 10 0 0 13 0 0 0 8 10 6 6 8 0 0 11 0 1 10 0 0 0
probabilities: 0.034 0.000 0.077 0.068 0.000 0.000 0.000 0.000 0.111 0.085 0.000 0.000 0.111 0.000 0.000 0.000 0.068 0.085 0.051 0.051 0.068 0.000 0.000 0.094 0.000 0.009 0.085 0.000 0.000 0.000
left son=100 (60 obs) right son=101 (57 obs)
Primary splits:
Solidity < 0.4447373 to the left, improve=8.843365, (0 missing)
IsoperimetricFactor < 0.7959684 to the left, improve=8.308926, (0 missing)
MaximalIndentationDepth < -0.5046925 to the right, improve=7.429417, (0 missing)
Lobedness < -0.4483533 to the right, improve=7.429417, (0 missing)
StochasticConvexity < 0.09340348 to the right, improve=7.036985, (0 missing)

Surrogate splits:
IsoperimetricFactor < 0.7959684 to the left, agree=0.957, adj=0.912, (0 split)
MaximalIndentationDepth < -0.5077631 to the right, agree=0.932, adj=0.860, (0 split)
Lobedness < -0.4490931 to the right, agree=0.932, adj=0.860, (0 split)
StochasticConvexity < 0.4513776 to the left, agree=0.803, adj=0.596, (0 split)
AspectRatio < -0.4178564 to the left, agree=0.752, adj=0.491, (0 split)

0.000 0.000 0.000 0.000 0.562 0.000 0.062 0.000 0.000 0.000 0.000 0.063 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

0.733, adj=0.429, (0 split)

Node number 200: 44 observations, complexity param=0.02464789
predicted class=-0.862314624727132 expected loss=0.7272727 P(node) =0.1466667
class counts: 0 0 9 2 0 0 0 0 12 7 0 0 0 0 0 0 8 0 6 0 0 0 0 0 0 0 0 0 0 0
probabilities: 0.000 0.000 0.205 0.045 0.000 0.000 0.000 0.000 0.273 0.159 0.000 0.000 0.000 0.000 0.000 0.000 0.182 0.000 0.136 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
left son=400 (37 obs) right son=401 (7 obs)
Primary splits:
StochasticConvexity < 0.09340348 to the right, improve=6.922604, (0 missing)
Uniformity < -0.3195687 to the left, improve=6.812141, (0 missing)
AvgIntensity < -0.647194 to the right, improve=6.503209, (0 missing)
Node number 201: 16 observations
class counts: 0 0 0 0 0 0 0 0 0 0 0 0 11 0 0 0 0 0 0 2 6 0 0 0 0 0 1 0 0 0
probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.550 0.000 0.000 0.000 0.000 0.000 0.000 0.100 0.300 0.000 0.000 0.000 0.000 0.000 0.050 0.000 0.000 0.000

Node number 398: 14 observations
predicted class=-0.412999134744811 expected loss=0.5 P(node) =0.04666667
class counts: 0 0 0 0 0 0 0 0 0 0 0 0 0 7 0 0 0 0 0 0 0 7 0 0 0 0 0 0 0 0
probabilities: 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.500 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.500 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.00