CS513 HW6 - C50

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I plege my honor that I have abided by the Stevens Honor System

Creation (Copied from HW3 since the data setup is the same)

```
rm(list=ls())
library(caTools)
library(class)
library(e1071)
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
## Warning: package 'lattice' was built under R version 4.3.2
```

```
library(C50)
```

```
## Warning: package 'C50' was built under R version 4.3.2
```

```
data = read.csv("breast-cancer-wisconsin.csv")
data$F6 <- suppressWarnings(as.numeric(data$F6))
data = data[complete.cases(data), ]
#Convert categories to the factor data type

for(i in 1:9){
  col = paste("F",i,sep='')
  data[col] <- factor(data[[col]], levels = 1:10)
}

data$Class <- factor(data$Class, levels=c(2,4))
set.seed(255)
split = sample.split(data$Class, SplitRatio=0.7)
train = subset(data, split == TRUE)
test = subset(data, split == FALSE)
```

C50 Model

```
classifier = C5.0(formula = Class ~ ., data = train, trials = 1)
```

Evaluation

```
C5imp(classifier)
```

```
##        Overall
## F2       100.0
## F8        61.3
## F3        38.7
```

```
## Sample     0.0
## F1         0.0
## F4         0.0
## F5         0.0
## F6         0.0
## F7         0.0
## F9         0.0
```

```
train_pred <- predict(classifier, newdata=train, type="class")
test_pred  <- predict(classifier, newdata=test, type="class")

cm_train <- table(train$Class, train_pred)
cm_test <- table(test$Class, test_pred)
```

```
confusionMatrix(cm_train)
```

```
## Confusion Matrix and Statistics
##
##    train_pred
##       2   4
##   2 298  13
##   4   5 162
##
##                Accuracy : 0.9623
##                  95% CI : (0.9411, 0.9775)
##     No Information Rate : 0.6339
##     P-Value [Acc > NIR] : < 2e-16
##
##                   Kappa : 0.9181
##
##  Mcnemar's Test P-Value : 0.09896
##
##             Sensitivity : 0.9835
##             Specificity : 0.9257
##          Pos Pred Value : 0.9582
##          Neg Pred Value : 0.9701
##              Prevalence : 0.6339
##          Detection Rate : 0.6234
##    Detection Prevalence : 0.6506
##       Balanced Accuracy : 0.9546
##
##        'Positive' Class : 2
##
```

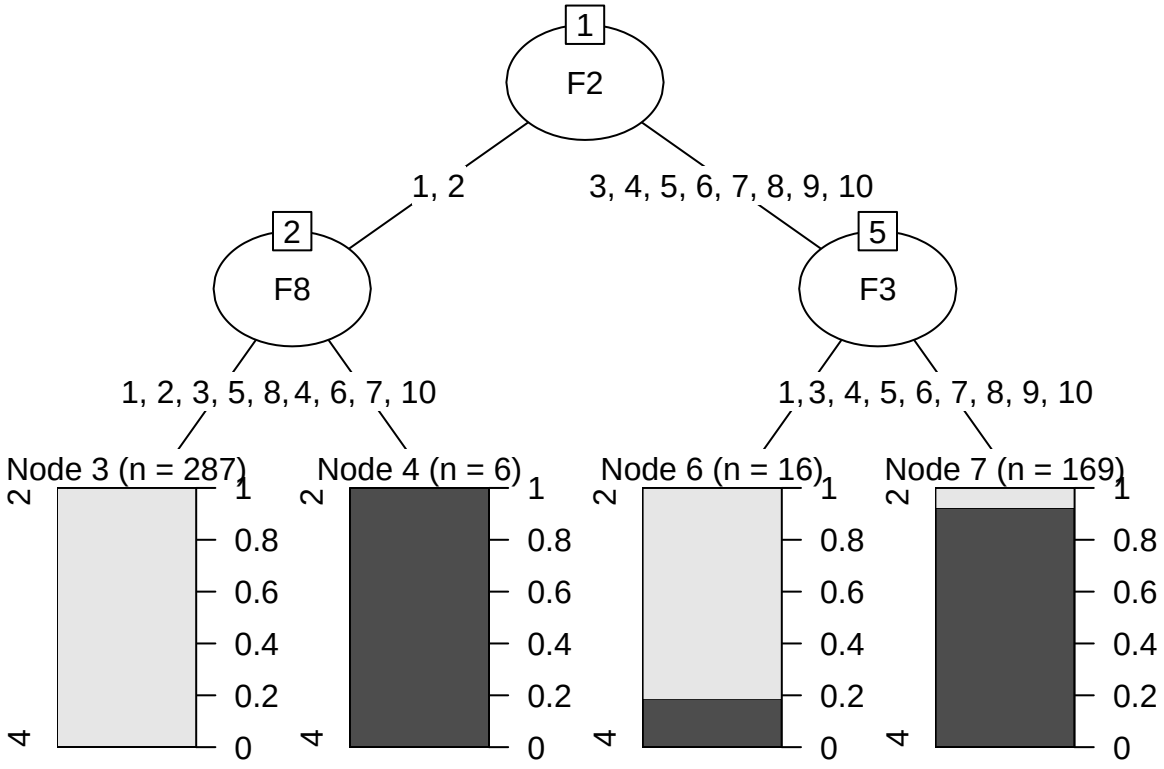
```
confusionMatrix(cm_test)
```

```
## Confusion Matrix and Statistics
##
##    test_pred
##       2   4
##   2 125   8
##   4   5  67
##
##                Accuracy : 0.9366
##                  95% CI : (0.894, 0.9658)
##     No Information Rate : 0.6341
```

```
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.8622
##
##  Mcnemar's Test P-Value : 0.5791
##
##             Sensitivity : 0.9615
##             Specificity : 0.8933
##          Pos Pred Value : 0.9398
##          Neg Pred Value : 0.9306
##              Prevalence : 0.6341
##          Detection Rate : 0.6098
##    Detection Prevalence : 0.6488
##       Balanced Accuracy : 0.9274
##
##        'Positive' Class : 2
##
```

Some information on the tree

```
plot(classifier, trial = 0)
```




```
summary(classifier)
```

```
##
## Call:
## C5.0.formula(formula = Class ~ ., data = train, trials = 1)
##
```

```
##
## C5.0 [Release 2.07 GPL Edition]      Mon Nov 27 23:18:02 2023
## -------------------------------
##
## Class specified by attribute `outcome'
##
## Read 478 cases (11 attributes) from undefined.data
##
## Decision tree:
##
## F2 in {1,2}:
## :...F8 in {1,2,3,5,8,9}: 2 (287/2)
## :   F8 in {4,6,7,10}: 4 (6)
## F2 in {3,4,5,6,7,8,9,10}:
## :...F3 in {1,2}: 2 (16/3)
##     F3 in {3,4,5,6,7,8,9,10}: 4 (169/13)
##
##
## Evaluation on training data (478 cases):
##
##      Decision Tree
##    ----------------
##    Size      Errors
##
##       4   18( 3.8%)   <<
##
##
##     (a)   (b)    <-classified as
##    ----  ----
##     298    13    (a): class 2
##       5   162    (b): class 4
##
##
##  Attribute usage:
##
##  100.00% F2
##   61.30% F8
##   38.70% F3
##
##
## Time: 0.0 secs
```

Random Forest

```
classifier = C5.0(formula = Class ~ ., data = train, trials = 100)
```

Evaluation

```
C5imp(classifier)
```

```
##        Overall
## F1      100.00
## F2      100.00
## F3      100.00
## F5      100.00
## F6      100.00
```

```
## F7      100.00
## F8      100.00
## F4       99.79
## F9       77.82
## Sample   35.15
```

```
train_pred <- predict(classifier, newdata=train, type="class")
test_pred  <- predict(classifier, newdata=test, type="class")

cm_train <- table(train$Class, train_pred)
cm_test <- table(test$Class, test_pred)
```

```
confusionMatrix(cm_train)
```

```
## Confusion Matrix and Statistics
##
##    train_pred
##       2   4
##   2 311   0
##   4   1 166
##
##                Accuracy : 0.9979
##                  95% CI : (0.9884, 0.9999)
##     No Information Rate : 0.6527
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9954
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9968
##             Specificity : 1.0000
##          Pos Pred Value : 1.0000
##          Neg Pred Value : 0.9940
##              Prevalence : 0.6527
##          Detection Rate : 0.6506
##    Detection Prevalence : 0.6506
##       Balanced Accuracy : 0.9984
##
##        'Positive' Class : 2
##
```

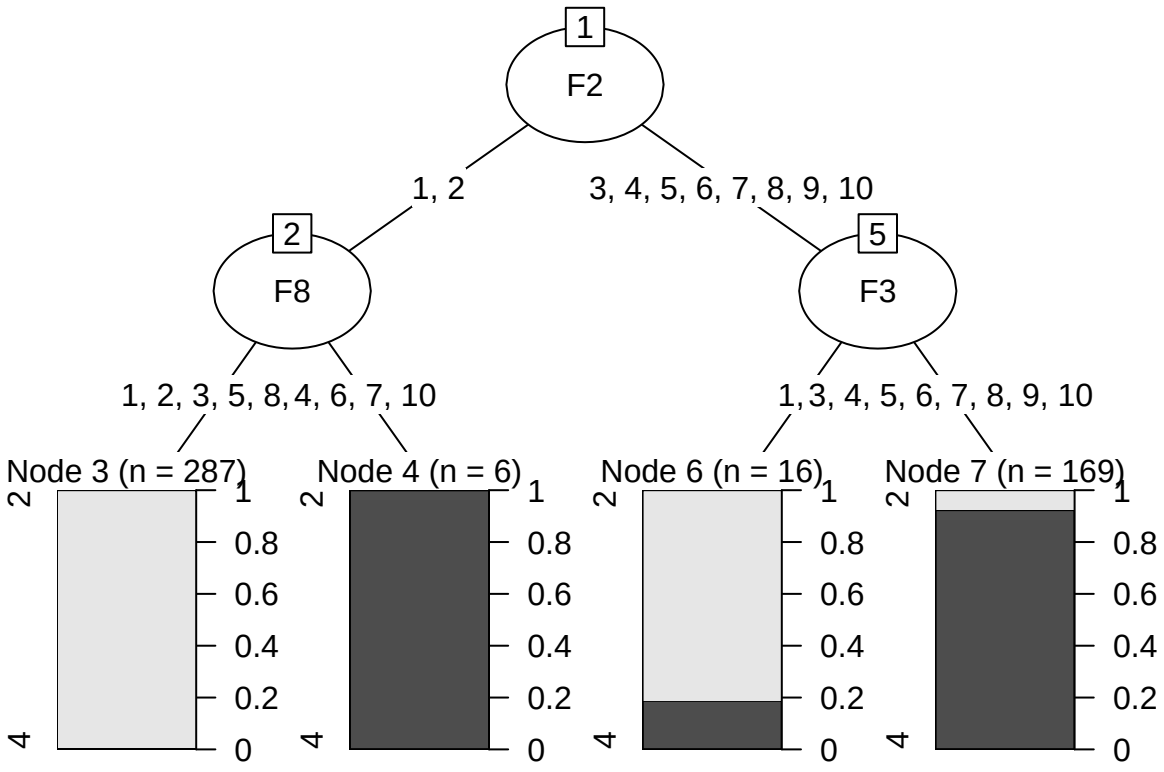
```
confusionMatrix(cm_test)
```

```
## Confusion Matrix and Statistics
##
##    test_pred
##       2   4
##   2 130   3
##   4   3  69
##
##                Accuracy : 0.9707
##                  95% CI : (0.9374, 0.9892)
##     No Information Rate : 0.6488
##     P-Value [Acc > NIR] : <2e-16
##
```

```
##                   Kappa : 0.9358
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9774
##             Specificity : 0.9583
##          Pos Pred Value : 0.9774
##          Neg Pred Value : 0.9583
##              Prevalence : 0.6488
##          Detection Rate : 0.6341
##    Detection Prevalence : 0.6488
##       Balanced Accuracy : 0.9679
##
##        'Positive' Class : 2
##
```

Some information on the tree

```
plot(classifier, trial = 0)
```




```
summary(classifier)
```

```
##
## Call:
## C5.0.formula(formula = Class ~ ., data = train, trials = 100)
##
##
## C5.0 [Release 2.07 GPL Edition]      Mon Nov 27 23:18:03 2023
```

```
## ------------------------------
##
## Class specified by attribute `outcome'
##
## Read 478 cases (11 attributes) from undefined.data
##
## -----  Trial 0:  -----
##
## Decision tree:
##
## F2 in {1,2}:
## :...F8 in {1,2,3,5,8,9}: 2 (287/2)
## :   F8 in {4,6,7,10}: 4 (6)
## F2 in {3,4,5,6,7,8,9,10}:
## :...F3 in {1,2}: 2 (16/3)
##     F3 in {3,4,5,6,7,8,9,10}: 4 (169/13)
##
## -----  Trial 1:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (67.9)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {7,8,9,10}: 4 (54.5/7.9)
##     F1 in {1,2,3,4,5,6}:
##     :...F4 in {1,2,3,4,5,6}: 2 (340.8/30.2)
##         F4 in {7,8,9,10}: 4 (14.7/0.8)
##
## -----  Trial 2:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (191.1/25.6)
## F7 in {1,2,3}:
## :...F6 in {1,2,8}: 2 (200.1/2.3)
##     F6 in {3,4,5,6,7,9,10}: 4 (86.7/36.6)
##
## -----  Trial 3:  -----
##
## Decision tree:
##
## F2 in {5,6,7,8,10}: 4 (105.9/12.3)
## F2 in {1,2,3,4,9}:
## :...F6 in {1,2}: 2 (165.1/1.4)
##     F6 in {3,4,5,6,7,8,9,10}:
##     :...F2 in {1,4,9}: 2 (118/26.1)
##         F2 in {2,3}: 4 (89/27.9)
##
## -----  Trial 4:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (150.8/15.8)
## F7 in {1,2,3,4}:
```

```
## :...F5 = 9: 2 (0)
##     F5 in {6,8,10}: 4 (19.4)
##     F5 in {1,2,3,4,5,7}:
##     :...F8 in {1,2,5,7}: 2 (251.1/26.4)
##         F8 in {3,4,6,8,9,10}: 4 (56.7/21)
##
## -----  Trial 5:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (76.3)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F6 = 6: 2 (0)
##     F6 in {1,2,3}:
##     :...F5 in {1,2,3,5,7,9}: 2 (179.8/5.1)
##     :   F5 in {4,6,8,10}: 4 (15/0.3)
##     F6 in {4,5,7,8,9,10}:
##     :...F8 in {1,2,3,4,5,7}: 2 (162.8/71.2)
##         F8 in {6,8,9,10}: 4 (44)
##
## -----  Trial 6:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (160.4/11.9)
## F6 in {1,2,3,4,5,8}:
## :...F8 in {1,2,3,6,7}: 2 (245.3/59.1)
##     F8 in {4,5,8,9,10}: 4 (72.3/16.3)
##
## -----  Trial 7:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (139.1/4.9)
## F1 in {1,2,3,4,5,6}:
## :...F5 in {2,7}: 2 (132.4/17.7)
##     F5 in {1,3,4,5,6,8,9,10}:
##     :...F7 in {1,3}: 2 (66.9/17.6)
##         F7 in {2,4,5,6,7,8,9,10}: 4 (139.6/25)
##
## -----  Trial 8:  -----
##
## Decision tree:
##
## F3 in {3,4,5,6,7,8,9,10}: 4 (296.2/71.5)
## F3 in {1,2}:
## :...F6 in {1,2,3,7,8,9}: 2 (123.6/1.4)
##     F6 in {4,5,6,10}: 4 (58.2/23)
##
## -----  Trial 9:  -----
##
## Decision tree:
##
## F3 in {5,6,8,9,10}: 4 (117.1/15)
```

```
## F3 in {1,2,3,4,7}:
## :...F6 = 1: 2 (126.3/1.1)
##     F6 in {2,3,4,5,6,7,8,9,10}:
##     :...F1 in {7,9,10}: 4 (30.7)
##         F1 in {1,2,3,4,5,6,8}:
##         :...F8 in {6,8,9,10}: 4 (19)
##             F8 in {1,2,3,4,5,7}:
##             :...F2 in {1,2,4,7,9}: 2 (105.2/12.1)
##                 F2 in {3,5,6,8,10}: 4 (79.6/30.4)
##
## -----  Trial 10:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (62)
## F2 in {1,2,3,4,7,8,9}:
## :...F7 in {1,2,3,4}: 2 (335.2/71.2)
##     F7 in {5,6,7,8,9,10}: 4 (80.8/20.6)
##
## -----  Trial 11:  -----
##
## Decision tree:
##
## F1 in {7,9,10}: 4 (85.1/1.8)
## F1 in {1,2,3,4,5,6,8}:
## :...F2 in {5,6,7,10}: 4 (53.3/6.4)
##     F2 in {1,2,3,4,8,9}:
##     :...F8 in {4,9,10}: 4 (22.4)
##         F8 in {1,2,3,5,6,7,8}:
##         :...F6 in {1,2,6,9}: 2 (114.2)
##             F6 in {3,4,5,7,8,10}:
##             :...F5 = 9: 2 (0)
##                 F5 in {1,8,10}: 4 (24.4/0.5)
##                 F5 in {2,3,4,5,6,7}:
##                 :...F1 in {1,3,4,6}: 2 (112.9/16)
##                     F1 in {2,5,8}: 4 (65.8/25.5)
##
## -----  Trial 12:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (51.7)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F6 = 6: 2 (0)
##     F6 in {7,9,10}: 4 (103.9/23.6)
##     F6 in {1,2,3,4,5,8}:
##     :...F9 in {4,6,9}: 2 (0)
##         F9 in {2,3,10}: 4 (20.2/1.5)
##         F9 in {1,5,7,8}:
##         :...F1 in {4,6}: 4 (83.4/38.5)
##             F1 in {1,2,3,5,7,8}:
##             :...F4 in {1,2,3,6,7,9,10}: 2 (189.2/9.2)
##                 F4 in {4,5,8}: 4 (29.6/9.2)
##
```

```
## -----  Trial 13:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (179.4/53.6)
## F7 in {1,2,3}:
## :...F1 in {9,10}: 4 (15.6)
##     F1 in {1,2,3,4,5,6,7,8}:
##     :...F8 in {1,2,4,5,7}: 2 (258.4/33.3)
##         F8 in {3,6,8,9,10}: 4 (24.6/7.4)
##
## -----  Trial 14:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (43.5)
## F2 in {1,2,3,4,7,8,9}:
## :...F6 in {1,2}: 2 (160.1/11.2)
##     F6 in {3,4,5,6,7,8,9,10}:
##     :...F1 in {7,8,9,10}: 4 (31.1)
##         F1 in {1,2,3,4,5,6}:
##         :...F8 in {2,7}: 2 (44/0.3)
##             F8 in {1,3,4,5,6,8,9,10}:
##             :...F7 in {1,6}: 2 (23.4)
##                 F7 in {2,3,4,5,7,8,9,10}:
##                 :...F2 in {1,4,7}: 2 (89.2/30.4)
##                     F2 in {2,3,8,9}: 4 (86.8/18.2)
##
## -----  Trial 15:  -----
##
## Decision tree:
##
## F2 in {5,6,7,8,10}: 4 (112.8/12.7)
## F2 in {1,2,3,4,9}:
## :...F8 in {4,6,9,10}: 4 (57.4/10.6)
##     F8 in {1,2,3,5,7,8}:
##     :...F3 in {1,2,3,4,8,10}: 2 (267.2/49.9)
##         F3 in {5,6,7,9}: 4 (40.7/9.1)
##
## -----  Trial 16:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (64.5)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F4 in {1,5}: 2 (187/36.7)
##     F4 in {2,3,4,6,7,8,9,10}:
##     :...F6 in {1,2,3,4,5}: 2 (145.2/67.4)
##         F6 in {6,7,8,9,10}: 4 (81.4)
##
## -----  Trial 17:  -----
##
## Decision tree:
##
```

```
## F8 in {9,10}: 4 (68.9)
## F8 in {1,2,3,4,5,6,7,8}:
## :...F1 in {7,8,9,10}: 4 (82.9/6)
##     F1 in {1,2,3,4,5,6}:
##     :...F7 = 1: 2 (34.7)
##         F7 in {2,3,4,5,6,7,8,9,10}:
##         :...F6 in {1,2,6,8}: 2 (86.9/15.8)
##             F6 in {3,4,5,7,9,10}:
##             :...F8 in {2,7}: 2 (25.4/2.8)
##                 F8 in {1,3,4,5,6,8}:
##                 :...F1 in {1,2,4,5,6}: 4 (138.2/25.9)
##                     F1 = 3: 2 (40.8/14.4)
##
## -----  Trial 18:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (74.7)
## F2 in {1,2,3,4,7,8,9}:
## :...F5 in {2,5,7}:
##     :...F4 in {1,2,3,5}: 2 (126.9/8.9)
##     :   F4 in {4,6,7,8,9,10}: 4 (37.4/4.1)
##     F5 in {1,3,4,6,8,9,10}:
##     :...F3 in {5,6,7,9,10}: 4 (64.4)
##         F3 in {1,2,3,4,8}:
##         :...F1 in {1,4,5,6,7,8,9,10}: 4 (160.5/54.4)
##             F1 in {2,3}: 2 (14)
##
## -----  Trial 19:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (219.5/46.3)
## F7 in {1,2,3}:
## :...F2 = 9: 2 (0)
##     F2 in {5,6,10}: 4 (19.3)
##     F2 in {1,2,3,4,7,8}:
##     :...F4 in {7,8,9}: 2 (0)
##         F4 in {3,4}: 4 (55.9/22.9)
##         F4 in {1,2,5,6,10}:
##         :...F1 in {1,2,3,4,5,6,8,9}: 2 (171.8/6.8)
##             F1 in {7,10}: 4 (11.5)
##
## -----  Trial 20:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (223.2/32.2)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F4 in {6,7,8,9,10}: 4 (63.8)
##     F4 in {1,2,3,4,5}:
##     :...F8 in {1,2,3,4,5,6,7}: 2 (156.8/70)
##         F8 in {8,9,10}: 4 (34.2)
##
```

```
## -----  Trial 21:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (196.5/40.3)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F1 in {1,4,6}: 2 (70.1/28.8)
##     F1 in {2,3,5,7,8,9,10}: 4 (211.3/29.7)
##
## -----  Trial 22:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (74.1)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {9,10}: 4 (48.7)
##     F1 in {1,2,3,4,5,6,7,8}:
##     :...F6 in {1,2,6}: 2 (132.5/9.6)
##         F6 in {3,4,5,7,8,9,10}:
##         :...F7 in {1,3,4}: 2 (106.2/40.4)
##             F7 in {2,5,6,7,8,9,10}: 4 (116.5/27.8)
##
## -----  Trial 23:  -----
##
## Decision tree:
##
## F2 = 1: 2 (127.1/23.1)
## F2 in {2,3,4,5,6,7,8,9,10}:
## :...F7 in {5,6,8,9,10}: 4 (70.1)
##     F7 in {1,2,3,4,7}:
##     :...F2 in {5,6,10}: 4 (38.2)
##         F2 in {2,3,4,7,8,9}:
##         :...F1 in {7,9,10}: 4 (34.7)
##             F1 in {1,2,3,4,5,6,8}:
##             :...F6 in {1,2,3,5,8}: 2 (117/36.3)
##                 F6 in {4,6,7,9,10}: 4 (90.8/16.4)
##
## -----  Trial 24:  -----
##
## Decision tree:
##
## F8 in {3,4,6,8,9,10}: 4 (205.3/25.5)
## F8 in {1,2,5,7}:
## :...F7 in {6,7,8,9,10}: 4 (52.5/3.5)
##     F7 in {1,2,3,4,5}:
##     :...F5 in {1,2,3,4,5,7,8,9}: 2 (207.6/49.8)
##         F5 in {6,10}: 4 (12.5)
##
## -----  Trial 25:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (115.9/5.2)
## F1 in {1,2,3,4,5,6}:
```

```
## :...F7 = 1: 2 (40.1)
##     F7 in {2,3,4,5,6,7,8,9,10}:
##     :...F8 in {9,10}: 4 (32.7)
##         F8 in {1,2,3,4,5,6,7,8}:
##         :...F6 in {1,2,6}: 2 (68.1/8.7)
##             F6 in {3,4,5,7,8,9,10}:
##             :...Sample <= 1018561: 2 (110.5/39.9)
##                 Sample > 1018561: 4 (110.7/17.2)
##
## -----  Trial 26:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (150.6/14)
## F6 in {1,2,3,4,5,8}:
## :...F9 in {6,9}: 2 (0)
##     F9 in {3,4,8,10}: 4 (36.6/0.1)
##     F9 in {1,2,5,7}:
##     :...F1 in {1,3}: 2 (62.6/2.1)
##         F1 in {2,4,5,6,7,8,9,10}:
##         :...F8 in {4,5,6,9,10}: 4 (63.7/4.9)
##             F8 in {1,2,3,7,8}:
##             :...F2 in {1,2,3,4,7,8,9}: 2 (148.9/40)
##                 F2 in {5,6,10}: 4 (15.5)
##
## -----  Trial 27:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (242.5/36.1)
## F7 in {1,2,3}:
## :...F2 in {1,2,3,4,7,8,9}: 2 (215.6/69.8)
##     F2 in {5,6,10}: 4 (19.9)
##
## -----  Trial 28:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (128/7.4)
## F1 in {1,2,3,4,5,6}:
## :...F8 in {2,7}: 2 (35.2/0.7)
##     F8 in {1,3,4,5,6,8,9,10}:
##     :...F2 in {1,2,4}: 2 (154/50.4)
##         F2 in {3,5,6,7,8,9,10}: 4 (160.8/36)
##
## -----  Trial 29:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (56.1)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F6 = 6: 4 (0)
##     F6 in {1,2}: 2 (122.1/24.6)
##     F6 in {3,4,5,7,8,9,10}:
```

```
##     :...F1 in {2,7,8}: 4 (45.1/0.2)
##         F1 in {1,3,4,5,6}:
##         :...F8 in {2,5,7}: 2 (44.6/5.7)
##             F8 in {1,3,4,6,8,9,10}:
##             :...F5 in {1,3,4,8,9,10}: 4 (113.9/5.2)
##                 F5 in {2,5,6,7}: 2 (96.2/36.9)
##
## -----  Trial 30:  -----
##
## Decision tree:
##
## F2 in {5,6,8,10}: 4 (108.5/2.4)
## F2 in {1,2,3,4,7,9}:
## :...F1 in {1,3}: 2 (68.5/10.5)
##     F1 in {9,10}: 4 (30.5)
##     F1 in {2,4,5,6,7,8}:
##     :...F8 in {6,9,10}: 4 (58)
##         F8 in {1,2,3,4,5,7,8}:
##         :...F6 in {1,2,6,7,8}: 2 (75/7.9)
##             F6 in {3,4,5,9,10}: 4 (137.4/44.8)
##
## -----  Trial 31:  -----
##
## Decision tree:
##
## F3 in {3,5,6,7,8,9,10}:
## :...F4 in {1,5}: 2 (85.6/39.1)
## :   F4 in {2,3,4,6,7,8,9,10}: 4 (174.3/6.7)
## F3 in {1,2,4}:
## :...F1 in {6,8,9,10}: 4 (24.6/0.5)
##     F1 in {1,2,3,4,5,7}:
##     :...F8 in {4,5,6,9,10}: 4 (26.5/6.3)
##         F8 in {1,2,3,7,8}:
##         :...F5 in {1,5,10}: 4 (32.1/10.7)
##             F5 in {2,3,4,6,7,8,9}: 2 (135)
##
## -----  Trial 32:  -----
##
## Decision tree:
##
## F3 in {3,5,6,7,8,9,10}: 4 (256.4/50.3)
## F3 in {1,2,4}:
## :...F2 in {1,2,3,4}: 2 (208.2/38.2)
##     F2 in {5,6,7,8,9,10}: 4 (13.5)
##
## -----  Trial 33:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (209.5/38.4)
## F7 in {1,2,3}:
## :...F4 in {7,9}: 2 (0)
##     F4 in {3,4,6,8}: 4 (68.8/25)
##     F4 in {1,2,5,10}:
```

```
##     :...F1 in {1,2,3,4,5,6,8}: 2 (185.9/12.3)
##         F1 in {7,9,10}: 4 (13.9)
##
## -----  Trial 34:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (119.1/18.1)
## F6 in {1,2,3,4,5,8}:
## :...F2 in {5,6,10}: 4 (22.7)
##     F2 in {1,2,3,4,7,8,9}:
##     :...F8 in {1,2,3,4,5,6,7,8}: 2 (319.2/65)
##         F8 in {9,10}: 4 (17.1)
##
## -----  Trial 35:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (108.7/6.7)
## F1 in {1,2,3,4,5,6}:
## :...F7 = 1: 2 (63.5)
##     F7 in {2,3,4,5,6,7,8,9,10}:
##     :...F8 in {1,2,5,7}: 2 (187.4/55.3)
##         F8 in {3,4,6,8,9,10}: 4 (118.4/29.5)
##
## -----  Trial 36:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (157/20.7)
## F7 in {1,2,3,4}:
## :...F5 = 9: 2 (0)
##     F5 in {6,8,10}: 4 (30.4)
##     F5 in {1,2,3,4,5,7}:
##     :...F6 in {1,2}: 2 (118.3)
##         F6 in {3,4,5,6,7,8,9,10}:
##         :...F8 in {1,2,4,5,6,7}: 2 (146.2/62.6)
##             F8 in {3,8,9,10}: 4 (26.2)
##
## -----  Trial 37:  -----
##
## Decision tree:
##
## F6 in {1,2}: 2 (133.4/26.2)
## F6 in {3,4,5,6,7,8,9,10}:
## :...F1 in {7,8,9,10}: 4 (86)
##     F1 in {1,2,3,4,5,6}:
##     :...Sample <= 1018561: 2 (119.8/49.7)
##         Sample > 1018561: 4 (138.9/21.6)
##
## -----  Trial 38:  -----
##
## Decision tree:
##
```

```
## F2 in {5,6,7,8,10}: 4 (137/7.4)
## F2 in {1,2,3,4,9}:
## :...F6 = 1: 2 (87.3/10.6)
##     F6 in {2,3,4,5,6,7,8,9,10}:
##     :...F8 = 2: 2 (13.2)
##         F8 in {4,8,9,10}: 4 (23.6)
##         F8 in {1,3,5,6,7}:
##         :...F1 in {7,8,9,10}: 4 (35.5)
##             F1 in {1,2,3,4,5,6}:
##             :...F5 in {1,3,5,8,9,10}: 4 (83/19.3)
##                 F5 in {2,4,6,7}: 2 (98.6/27.3)
##
## -----  Trial 39:  -----
##
## Decision tree:
##
## F2 = 1: 2 (116.4/17.9)
## F2 in {2,3,4,5,6,7,8,9,10}:
## :...F7 in {5,6,8,9,10}: 4 (73.5)
##     F7 in {1,2,3,4,7}:
##     :...F1 in {1,3,4,6}: 2 (110/39.4)
##         F1 in {2,5,7,8,9,10}:
##         :...Sample <= 255644: 2 (9.8)
##             Sample > 255644: 4 (168.4/21.1)
##
## -----  Trial 40:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (72.6)
## F2 in {1,2,3,4,7,8,9}:
## :...F7 in {4,5,6,7,8,9,10}: 4 (174.4/37.5)
##     F7 in {1,2,3}:
##     :...F6 = 9: 2 (0)
##         F6 in {5,6,7}: 4 (51.3/9)
##         F6 in {1,2,3,4,8,10}:
##         :...F5 in {1,2,3,5,7,8,9,10}: 2 (168/14.3)
##             F5 in {4,6}: 4 (11.7/0.6)
##
## -----  Trial 41:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (133.3/13.9)
## F6 in {1,2,3,4,5,8}:
## :...F7 = 1: 2 (62.9)
##     F7 in {6,8,9,10}: 4 (17.7)
##     F7 in {2,3,4,5,7}:
##     :...F1 in {7,9,10}: 4 (28.1/2)
##         F1 in {1,2,3,4,5,6,8}:
##         :...F8 = 9: 2 (0)
##             F8 in {4,5,10}: 4 (49/12.1)
##             F8 in {1,2,3,6,7,8}:
##             :...F5 in {1,3,10}: 4 (74.1/28.9)
```

```
##                 F5 in {2,4,5,6,7,8,9}: 2 (112.9)
##
## -----  Trial 42:  -----
##
## Decision tree:
##
## F3 in {1,2}:
## :...F1 in {1,2,3,4,5,7,8}: 2 (207.3/12.1)
## :   F1 in {6,9,10}: 4 (16.8/1.2)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F4 in {1,3,5}: 2 (123.2/53.8)
##     F4 in {2,4,6,7,8,9,10}: 4 (130.8/15.3)
##
## -----  Trial 43:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (188.7/27.1)
## F3 in {3,4,5,6,7,8,9,10}: 4 (289.3/77.2)
##
## -----  Trial 44:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (58.2)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {7,8,9,10}: 4 (66.5/7.1)
##     F1 in {1,2,3,4,5,6}:
##     :...F6 in {1,2,6}: 2 (149.9/4.4)
##         F6 in {3,4,5,7,8,9,10}:
##         :...F8 in {2,7}: 2 (28.8/0.7)
##             F8 in {1,3,4,5,6,8,9,10}:
##             :...F7 = 1: 2 (20.6)
##                 F7 in {2,3,4,5,6,7,8,9,10}: 4 (154/64.3)
##
## -----  Trial 45:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (46.4)
## F2 in {1,2,3,4,7,8,9}:
## :...F6 in {6,7,9,10}: 4 (90.6/26.2)
##     F6 in {1,2,3,4,5,8}:
##     :...F8 in {1,2,3,4,5,6,7,8}: 2 (320.8/51.8)
##         F8 in {9,10}: 4 (20.2)
##
## -----  Trial 46:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (58.8)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F8 in {3,4,6,7,8,9,10}: 4 (164.5/47.6)
##     F8 in {1,2,5}:
```

```
##     :...F4 in {1,2,5,6,9,10}: 2 (201.8/19.1)
##         F4 in {3,4,7,8}: 4 (52.9/20.8)
##
## -----  Trial 47:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (96.3/12.4)
## F1 in {1,2,3,4,5,6}:
## :...F2 in {1,2,3,4,7,8,9}: 2 (356/93.8)
##     F2 in {5,6,10}: 4 (25.8)
##
## -----  Trial 48:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (224.9/44.7)
## F7 in {1,2,3}:
## :...F1 in {1,2,3,4,5,6,7,8}: 2 (244/57.2)
##     F1 in {9,10}: 4 (9.1)
##
## -----  Trial 49:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (159.7/33.9)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F4 in {6,7,8,9,10}: 4 (66.6)
##     F4 in {1,2,3,4,5}:
##     :...F8 in {8,9,10}: 4 (34.7)
##         F8 in {1,2,3,4,5,6,7}:
##         :...F1 in {1,6}: 2 (27.9/1.2)
##             F1 in {2,3,4,5,7,8,9,10}:
##             :...F2 in {1,4,7}: 2 (66.9/17.1)
##                 F2 in {2,3,5,6,8,9,10}: 4 (122.3/19.6)
##
## -----  Trial 50:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (61.4)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F6 in {4,6,7,9,10}: 4 (147.8/22.5)
##     F6 in {1,2,3,5,8}:
##     :...F2 in {5,6,8,10}: 4 (27.7)
##         F2 in {1,2,3,4,7,9}:
##         :...F9 in {1,2,4,5,6,7,8,9,10}: 2 (226.4/51.9)
##             F9 = 3: 4 (14.7)
##
## -----  Trial 51:  -----
##
## Decision tree:
##
## F1 in {1,3}: 2 (92.1/12.2)
```

```
## F1 in {2,4,5,6,7,8,9,10}:
## :...F7 in {5,6,8,9,10}: 4 (77.2)
##     F7 in {1,2,3,4,7}:
##     :...F3 in {5,6,9,10}: 4 (61.7/3.6)
##         F3 in {1,2,3,4,7,8}:
##         :...F6 = 1: 2 (47.3/3)
##             F6 in {2,3,4,5,6,7,8,9,10}:
##             :...Sample <= 1018561: 2 (86.4/29.3)
##                 Sample > 1018561: 4 (113.3/17.7)
##
## -----  Trial 52:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (175/18.4)
## F7 in {1,2,3,4}:
## :...F8 in {3,4,8,9,10}: 4 (85.4/15.8)
##     F8 in {1,2,5,6,7}:
##     :...F5 = 9: 2 (0)
##         F5 in {1,6,8,10}: 4 (34.4/7.7)
##         F5 in {2,3,4,5,7}:
##         :...F4 in {1,2,3,5,6,7,9,10}: 2 (162.5/14.3)
##             F4 in {4,8}: 4 (20.7/5.8)
##
## -----  Trial 53:  -----
##
## Decision tree:
##
## F3 = 1: 2 (135.8/16.3)
## F3 in {2,3,4,5,6,7,8,9,10}:
## :...F1 in {9,10}: 4 (52.3)
##     F1 in {1,2,3,4,5,6,7,8}:
##     :...F8 in {4,6,8,9,10}: 4 (105.3/10.7)
##         F8 in {1,2,3,5,7}:
##         :...F2 in {1,2,3,4,8,9}: 2 (165/56.9)
##             F2 in {5,6,7,10}: 4 (19.6)
##
## -----  Trial 54:  -----
##
## Decision tree:
##
## F6 in {1,2}: 2 (143.7/28.4)
## F6 in {3,4,5,6,7,8,9,10}:
## :...F1 in {7,8,9,10}: 4 (77.8)
##     F1 in {1,2,3,4,5,6}:
##     :...F7 = 1: 2 (18.9)
##         F7 in {2,3,4,5,6,7,8,9,10}:
##         :...F2 in {1,4,7,9}: 2 (90.8/36.7)
##             F2 in {2,3,5,6,8,10}: 4 (146.8/16.9)
##
## -----  Trial 55:  -----
##
## Decision tree:
##
```

```
## F7 in {4,5,6,7,8,9,10}: 4 (249.9/37.4)
## F7 in {1,2,3}:
## :...F2 = 9: 2 (0)
##     F2 in {5,6,10}: 4 (21.1)
##     F2 in {1,2,3,4,7,8}:
##     :...F6 in {1,2,4,8,9}: 2 (115/6.8)
##         F6 in {3,5,6,7,10}: 4 (92/36.1)
##
## -----  Trial 56:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (95.5/5.4)
## F1 in {1,2,3,4,5,6}:
## :...F6 = 6: 2 (0)
##     F6 in {7,9,10}: 4 (96.8/22.8)
##     F6 in {1,2,3,4,5,8}:
##     :...F1 in {1,3}: 2 (103/2.9)
##         F1 in {2,4,5,6}:
##         :...F8 in {1,2,3,4,7,8}: 2 (153.5/50.5)
##             F8 in {5,6,9,10}: 4 (29.2)
##
## -----  Trial 57:  -----
##
## Decision tree:
##
## F2 in {5,6,7,8,10}: 4 (124.3/8.8)
## F2 in {1,2,3,4,9}:
## :...F8 in {1,2,5,8}: 2 (235.4/62.3)
##     F8 in {3,4,6,7,9,10}: 4 (118.4/32.3)
##
## -----  Trial 58:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (54.2)
## F1 in {1,2,3,4,5,6,7,8}:
## :...F2 in {5,6,10}: 4 (44.1)
##     F2 in {1,2,3,4,7,8,9}:
##     :...F7 in {1,3}: 2 (155.2/32)
##         F7 in {6,8,9,10}: 4 (20.4)
##         F7 in {2,4,5,7}:
##         :...F6 in {1,2,3,5,8}: 2 (151/62.2)
##             F6 in {4,6,7,9,10}: 4 (53.1)
##
## -----  Trial 59:  -----
##
## Decision tree:
##
## F1 in {1,3}: 2 (97.2/25.1)
## F1 in {2,4,5,6,7,8,9,10}:
## :...F8 = 2: 2 (17.8/1.3)
##     F8 in {6,9,10}: 4 (62.6)
##     F8 in {1,3,4,5,7,8}:
```

```
##     :...F1 in {7,8,9,10}: 4 (83.1/4.1)
##         F1 in {2,4,5,6}:
##         :...F4 in {1,2,5,10}: 2 (96.2/37.6)
##             F4 in {3,4,6,7,8,9}: 4 (121.2/20.7)
##
## -----  Trial 60:  -----
##
## Decision tree:
##
## F3 in {3,5,6,7,8,9,10}: 4 (254.4/39.6)
## F3 in {1,2,4}:
## :...F2 in {5,6,7,8,9,10}: 4 (25.1)
##     F2 in {1,2,3,4}:
##     :...F6 in {1,2,3,7,8,9}: 2 (87.3)
##         F6 in {4,5,6,10}: 4 (111.3/49.7)
##
## -----  Trial 61:  -----
##
## Decision tree:
##
## F5 in {2,7}:
## :...F8 in {1,2,3,7}: 2 (140.9/5.6)
## :   F8 in {4,5,6,8,9,10}: 4 (43.6/10.2)
## F5 in {1,3,4,5,6,8,9,10}:
## :...F1 in {7,8,9,10}: 4 (63.1)
##     F1 in {1,2,3,4,5,6}:
##     :...F8 in {1,3,4,6,8,9,10}: 4 (190.4/54.5)
##         F8 in {2,5,7}: 2 (40.1/5.4)
##
## -----  Trial 62:  -----
##
## Decision tree:
##
## F2 = 1: 2 (167.2/19.1)
## F2 in {2,3,4,5,6,7,8,9,10}:
## :...F4 in {7,8,9,10}: 4 (54.7)
##     F4 in {1,2,3,4,5,6}:
##     :...F1 in {7,9,10}: 4 (34.5)
##         F1 in {1,2,3,4,5,6,8}:
##         :...F7 in {5,6,8,9,10}: 4 (17.8)
##             F7 in {1,2,3,4,7}:
##             :...F6 in {1,2,5,6,8}: 2 (97/19.3)
##                 F6 in {3,4,7,9,10}: 4 (106.7/38.4)
##
## -----  Trial 63:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (136.1/19.1)
## F7 in {1,2,3,4}:
## :...F5 = 9: 2 (0)
##     F5 in {6,8,10}: 4 (18.3)
##     F5 in {1,2,3,4,5,7}:
##     :...F6 in {1,2}: 2 (113.7)
```

```
##         F6 in {3,4,5,6,7,8,9,10}:
##         :...F8 in {3,8,9,10}: 4 (22.6)
##             F8 in {1,2,4,5,6,7}:
##             :...Sample <= 1018561: 2 (80.9/1.4)
##                 Sample > 1018561: 4 (106.5/46.9)
##
## -----  Trial 64:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (70.6/5.6)
## F1 in {1,2,3,4,5,6}:
## :...F8 in {4,8,9,10}: 4 (45.4/7)
##     F8 in {1,2,3,5,6,7}:
##     :...F2 in {1,2,3,4,8,9}: 2 (342/60.7)
##         F2 in {5,6,7,10}: 4 (20)
##
## -----  Trial 65:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (128.2/17.5)
## F6 in {1,2,3,4,5,8}:
## :...F1 in {1,3}: 2 (113.8/3.8)
##     F1 in {2,4,5,6,7,8,9,10}:
##     :...F8 in {5,6,9,10}: 4 (38.9)
##         F8 in {1,2,3,4,7,8}:
##         :...F9 in {4,6,9}: 2 (0)
##             F9 in {3,7,8,10}: 4 (15.9)
##             F9 in {1,2,5}:
##             :...F3 in {1,2,3,4,6,7,8}: 2 (170.3/45.6)
##                 F3 in {5,9,10}: 4 (11)
##
## -----  Trial 66:  -----
##
## Decision tree:
##
## F2 in {5,6,8,10}: 4 (93.3/4.6)
## F2 in {1,2,3,4,7,9}:
## :...F1 in {1,3}: 2 (110.4/16.2)
##     F1 in {9,10}: 4 (25.2)
##     F1 in {2,4,5,6,7,8}:
##     :...F8 in {6,9,10}: 4 (29.1)
##         F8 in {1,2,3,4,5,7,8}:
##         :...F6 in {1,2,6,7,8}: 2 (66.6/7)
##             F6 in {3,4,5,9,10}: 4 (153.4/57.5)
##
## -----  Trial 67:  -----
##
## Decision tree:
##
## F7 in {1,2,3}:
## :...F8 in {1,2,5,7}: 2 (218.6/38)
## :   F8 in {3,4,6,8,9,10}: 4 (45/11.6)
```

```
## F7 in {4,5,6,7,8,9,10}:
## :...F3 in {1,4}: 2 (44.7/10.4)
##     F3 in {2,3,5,6,7,8,9,10}:
##     :...F5 in {1,7}: 2 (9.1/0.4)
##         F5 in {2,3,4,5,6,8,9,10}: 4 (160.6/3.5)
##
## -----  Trial 68:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (60.1)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {7,9,10}: 4 (62.5/3.2)
##     F1 in {1,2,3,4,5,6,8}:
##     :...F7 in {1,3,6}: 2 (146.4/20.4)
##         F7 in {2,4,5,7,8,9,10}:
##         :...F6 in {1,2,3,5,8}: 2 (143.2/58.6)
##             F6 in {4,6,7,9,10}: 4 (65.8)
##
## -----  Trial 69:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (143.9/42)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F8 = 2: 2 (22/4.9)
##     F8 in {8,9,10}: 4 (74.7)
##     F8 in {1,3,4,5,6,7}:
##     :...F1 in {1,2,3,4,5,7,8,9,10}: 4 (218.4/39.3)
##         F1 = 6: 2 (19.1/1.6)
##
## -----  Trial 70:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (160.3/16.3)
## F7 in {1,2,3,4}:
## :...F4 = 7: 2 (0)
##     F4 in {3,4,6,8,9,10}: 4 (140.1/39.5)
##     F4 in {1,2,5}:
##     :...F1 in {1,2,3,4,5,6,8}: 2 (164.6/21.9)
##         F1 in {7,9,10}: 4 (13)
##
## -----  Trial 71:  -----
##
## Decision tree:
##
## F2 in {3,5,6,7,8,9,10}: 4 (221.8/51)
## F2 in {1,2,4}:
## :...F8 in {1,2,3}: 2 (209.6/33.4)
##     F8 in {4,5,6,7,8,9,10}: 4 (46.7/7.2)
##
## -----  Trial 72:  -----
##
```

```
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (99.9/10)
## F1 in {1,2,3,4,5,6}:
## :...F8 in {9,10}: 4 (22.6)
##     F8 in {1,2,3,4,5,6,7,8}:
##     :...F2 in {5,6,10}: 4 (18.9)
##         F2 in {1,2,3,4,7,8,9}:
##         :...F6 in {1,2,6}: 2 (119.9)
##             F6 in {3,4,5,7,8,9,10}:
##             :...F5 in {1,8,10}: 4 (26.4/1)
##                 F5 in {2,3,4,5,6,7,9}: 2 (190.4/71.4)
##
## -----  Trial 73:  -----
##
## Decision tree:
##
## F6 in {1,2}: 2 (133.7/20.6)
## F6 in {3,4,5,6,7,8,9,10}:
## :...F1 in {7,8,9,10}: 4 (61.3)
##     F1 in {1,2,3,4,5,6}:
##     :...F7 = 1: 2 (17.8)
##         F7 in {2,3,4,5,6,7,8,9,10}:
##         :...F8 in {1,3,4,5,6,8,9,10}: 4 (242.2/59.9)
##             F8 in {2,7}: 2 (23/0.9)
##
## -----  Trial 74:  -----
##
## Decision tree:
##
## F7 in {1,2,3}:
## :...F1 in {1,2,3,4,5,6,7,8}: 2 (236.9/64.9)
## :   F1 in {9,10}: 4 (14.7)
## F7 in {4,5,6,7,8,9,10}:
## :...F6 in {1,2,4,6,7,8,9,10}: 4 (164.9/9.7)
##     F6 in {3,5}: 2 (61.5/24.9)
##
## -----  Trial 75:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (144.7/37.6)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F7 in {5,6,8,9,10}: 4 (80.1)
##     F7 in {1,2,3,4,7}:
##     :...F1 in {1,4,6}: 2 (54.7/13.1)
##         F1 in {2,3,5,7,8,9,10}: 4 (198.5/39.5)
##
## -----  Trial 76:  -----
##
## Decision tree:
##
## F2 in {5,6,8,10}: 4 (106.5/2.6)
## F2 in {1,2,3,4,7,9}:
```

```
## :...F1 in {9,10}: 4 (30.2)
##     F1 in {1,2,3,4,5,6,7,8}:
##     :...F6 = 6: 2 (0)
##         F6 in {4,7,9,10}: 4 (93.4/21.8)
##         F6 in {1,2,3,5,8}:
##         :...F1 in {1,3}: 2 (59.1)
##             F1 in {2,4,5,6,7,8}:
##             :...F8 in {1,2,3,4,7,8,9}: 2 (157.5/44.1)
##                 F8 in {5,6,10}: 4 (31.3)
##
## -----  Trial 77:  -----
##
## Decision tree:
##
## F1 in {1,3}: 2 (96.1/13.1)
## F1 in {2,4,5,6,7,8,9,10}:
## :...F7 in {4,5,6,7,8,9,10}: 4 (179.5/20)
##     F7 in {1,2,3}:
##     :...F5 in {1,6,8,10}: 4 (42/1)
##         F5 in {2,3,4,5,7,9}: 2 (160.5/52.4)
##
## -----  Trial 78:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (71.9)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {7,8,9,10}: 4 (84.5/8)
##     F1 in {1,2,3,4,5,6}:
##     :...F7 in {1,6}: 2 (53)
##         F7 in {2,3,4,5,7,8,9,10}:
##         :...F6 in {1,2,6}: 2 (52.8/4.3)
##             F6 in {3,4,5,7,8,9,10}:
##             :...F8 in {2,7}: 2 (30.7/1.4)
##                 F8 in {1,3,4,5,6,8,9,10}:
##                 :...F1 in {1,3,6}: 2 (63.7/27.5)
##                     F1 in {2,4,5}: 4 (121.6/22.9)
##
## -----  Trial 79:  -----
##
## Decision tree:
##
## F7 in {4,5,6,7,8,9,10}: 4 (219.8/40.4)
## F7 in {1,2,3}:
## :...F8 in {3,4,5,6,8,9,10}: 4 (92.3/25.1)
##     F8 in {1,2,7}:
##     :...F5 in {1,6,10}: 4 (36.5/13.7)
##         F5 in {2,3,4,5,7,8,9}: 2 (129.5/7.3)
##
## -----  Trial 80:  -----
##
## Decision tree:
##
## F5 in {1,2,5,7}:
```

```
## :...F6 in {1,2,3,4,8}: 2 (181/15.6)
## :   F6 in {5,6,7,9,10}: 4 (70.8/22.5)
## F5 in {3,4,6,8,9,10}:
## :...F7 in {1,2}: 2 (18.9/0.7)
##     F7 in {3,4,5,6,7,8,9,10}: 4 (207.4/44.6)
##
## -----  Trial 81:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (59.4)
## F2 in {1,2,3,4,7,8,9}:
## :...F8 in {4,6,8,9,10}: 4 (98.2/25.7)
##     F8 in {1,2,3,5,7}:
##     :...F1 in {9,10}: 4 (17.9)
##         F1 in {1,2,3,4,5,6,7,8}:
##         :...F3 in {5,6,7,9,10}: 4 (35.2/6)
##             F3 in {1,2,3,4,8}:
##             :...F6 in {1,2,6,7,8,9}: 2 (94.9)
##                 F6 in {3,4,5,10}:
##                 :...F5 in {1,5,10}: 4 (18/2.2)
##                     F5 in {2,3,4,6,7,8,9}: 2 (154.5/22.8)
##
## -----  Trial 82:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (46.5)
## F2 in {1,2,3,4,7,8,9}:
## :...F6 in {4,6,7,9,10}: 4 (124.6/38.9)
##     F6 in {1,2,3,5,8}:
##     :...F9 in {6,9}: 2 (0)
##         F9 in {3,4,10}: 4 (23.5/0.2)
##         F9 in {1,2,5,7,8}:
##         :...F8 in {1,2,3,4,5,6,7,8}: 2 (269.3/43.7)
##             F8 in {9,10}: 4 (14.1)
##
## -----  Trial 83:  -----
##
## Decision tree:
##
## F1 in {2,7,8,9,10}: 4 (108.7/14.9)
## F1 in {1,3,4,5,6}:
## :...F7 in {5,6,7,8,9,10}: 4 (79.7/19.5)
##     F7 in {1,2,3,4}:
##     :...F6 in {1,2,6,8}: 2 (101.1/0.9)
##         F6 in {3,4,5,7,9,10}:
##         :...F8 in {1,2,5,6,7}: 2 (153/34.8)
##             F8 in {3,4,8,9,10}: 4 (35.5)
##
## -----  Trial 84:  -----
##
## Decision tree:
##
```

```
## F2 = 1: 2 (160.1/16.6)
## F2 in {5,6,10}: 4 (35.5)
## F2 in {2,3,4,7,8,9}:
## :...F1 in {7,9,10}: 4 (37.5)
##     F1 in {1,2,3,4,5,6,8}:
##     :...F7 = 6: 2 (0)
##         F7 in {5,8,9,10}: 4 (22.6)
##         F7 in {1,2,3,4,7}:
##         :...F6 in {1,2,6,8}: 2 (75.3/6.6)
##             F6 in {3,4,5,7,9,10}: 4 (147/67.1)
##
## -----  Trial 85:  -----
##
## Decision tree:
##
## F1 in {9,10}: 4 (38.5)
## F1 in {1,2,3}:
## :...F4 in {1,2,3,5,6,9}: 2 (152.6/5.4)
## :   F4 in {4,7,8,10}: 4 (18.3)
## F1 in {4,5,6,7,8}:
## :...F8 in {6,9,10}: 4 (39.1)
##     F8 in {1,2,3,4,5,7,8}:
##     :...F4 in {1,2,4,5,9}: 2 (160.2/38.6)
##         F4 in {3,6,7,8,10}: 4 (69.4/19.4)
##
## -----  Trial 86:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (137.6/24.8)
## F7 in {1,2,3,4}:
## :...F5 = 9: 2 (0)
##     F5 in {6,8,10}: 4 (20.6)
##     F5 in {1,2,3,4,5,7}:
##     :...F6 in {1,2}: 2 (114.8)
##         F6 in {3,4,5,6,7,8,9,10}:
##         :...F8 in {1,2,4,5,6,7}: 2 (180.9/55.7)
##             F8 in {3,8,9,10}: 4 (24.2)
##
## -----  Trial 87:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (99.4/7.9)
## F1 in {1,2,3,4,5,6}:
## :...F2 in {1,4,9}: 2 (175.7/24)
##     F2 in {2,3,5,6,7,8,10}:
##     :...F8 in {2,7}: 2 (19.6/1)
##         F8 in {1,3,4,5,6,8,9,10}:
##         :...F3 in {1,2,7}: 2 (64.4/23.1)
##             F3 in {3,4,5,6,8,9,10}: 4 (118.8/13.9)
##
## -----  Trial 88:  -----
##
```

```
## Decision tree:
##
## F3 = 1: 2 (84.9/2.5)
## F3 in {2,3,4,5,6,7,8,9,10}:
## :...F2 in {5,6,10}: 4 (69.9)
##     F2 in {1,2,3,4,7,8,9}:
##     :...F8 in {8,9,10}: 4 (39.1)
##         F8 in {1,2,3,4,5,6,7}:
##         :...F6 in {1,2}: 2 (64.7/5.6)
##             F6 in {3,4,5,6,7,8,9,10}:
##             :...F1 in {1,2,7,8,9,10}: 4 (47.2)
##                 F1 in {3,4,5,6}:
##                 :...F8 in {1,3,4,6,7}: 4 (144.9/59.2)
##                     F8 in {2,5}: 2 (26.3/0.1)
##
## -----  Trial 89:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (55.3)
## F2 in {1,2,3,4,7,8,9}:
## :...F7 in {4,5,6,7,8,9,10}:
##     :...F3 in {1,4,5}: 2 (81.5/24.5)
##     :   F3 in {2,3,6,7,8,9,10}: 4 (110.3/6.7)
##     F7 in {1,2,3}:
##     :...F4 in {7,8,9}: 2 (0)
##         F4 in {4,10}: 4 (43.8/17.3)
##         F4 in {1,2,3,5,6}:
##         :...F5 in {1,2,3,5,7,8,9}: 2 (178.6/9)
##             F5 in {4,6,10}: 4 (7.5/1.7)
##
## -----  Trial 90:  -----
##
## Decision tree:
##
## F6 in {6,7,9,10}: 4 (148.9/13.7)
## F6 in {1,2,3,4,5,8}:
## :...F8 in {3,4,5,8,9,10}: 4 (106.3/29.9)
##     F8 in {1,2,6,7}:
##     :...F1 in {1,2,3,4,5,6,7,8}: 2 (206.4/19.7)
##         F1 in {9,10}: 4 (15.4)
##
## -----  Trial 91:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (98.6/7.6)
## F1 in {1,2,3,4,5,6}:
## :...F7 in {1,2,3}:
##     :...F2 in {1,2,3,4,7,8,9}: 2 (200.7/18.6)
##     :   F2 in {5,6,10}: 4 (11)
##     F7 in {4,5,6,7,8,9,10}:
##     :...F6 in {1,2,3,5,8}: 2 (99.9/38.9)
##         F6 in {4,6,7,9,10}: 4 (66.8)
```

```
##
## -----  Trial 92:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (68)
## F2 in {1,2,3,4,7,8,9}:
## :...F7 in {1,2,3}: 2 (212.5/53.3)
##     F7 in {4,5,6,7,8,9,10}:
##     :...F1 in {1,2,3,4}: 2 (67.2/28.9)
##         F1 in {5,6,7,8,9,10}: 4 (129.3/9.8)
##
## -----  Trial 93:  -----
##
## Decision tree:
##
## F3 in {1,2}: 2 (123.3/30.5)
## F3 in {3,4,5,6,7,8,9,10}:
## :...F8 = 2: 2 (19.7/2)
##     F8 in {8,9,10}: 4 (73.9)
##     F8 in {1,3,4,5,6,7}:
##     :...F1 in {2,7,8,9,10}: 4 (65.6/0.3)
##         F1 = 6: 2 (15.2/1.7)
##         F1 in {1,3,4,5}:
##         :...F3 in {3,5,6,8,9,10}: 4 (135.2/18.9)
##             F3 in {4,7}: 2 (44.3/12)
##
## -----  Trial 94:  -----
##
## Decision tree:
##
## F7 in {5,6,7,8,9,10}: 4 (176.1/16.2)
## F7 in {1,2,3,4}:
## :...F2 in {1,9}: 2 (77.1)
##     F2 in {2,3,4,5,6,7,8,10}:
##     :...F1 in {2,7,9,10}: 4 (54.4/0.8)
##         F1 in {1,3,4,5,6,8}:
##         :...F6 in {1,2,5,6,8}: 2 (59/2.7)
##             F6 in {3,4,7,9,10}: 4 (110.6/36.8)
##
## -----  Trial 95:  -----
##
## Decision tree:
##
## F2 in {5,6,10}: 4 (64.6)
## F2 in {1,2,3,4,7,8,9}:
## :...F1 in {9,10}: 4 (35.3)
##     F1 in {1,2,3,4,5,6,7,8}:
##     :...F8 in {1,2,3,5,7}: 2 (283.1/62.5)
##         F8 in {4,6,8,9,10}: 4 (94/19.5)
##
## -----  Trial 96:  -----
##
## Decision tree:
```

```
##
## F6 in {6,7,9,10}: 4 (154.7/17.9)
## F6 in {1,2,3,4,5,8}:
## :...F9 in {6,9}: 2 (0)
##     F9 in {2,3,4,7,10}: 4 (46.4/2.4)
##     F9 in {1,5,8}:
##     :...F2 in {5,6,10}: 4 (20.7)
##         F2 in {1,2,3,4,7,8,9}:
##         :...F4 = 7: 2 (0)
##             F4 in {4,5,8,9,10}: 4 (71/26.6)
##             F4 in {1,2,3,6}:
##             :...F1 in {1,2,3,4,5,7,8,9}: 2 (158.2/3)
##                 F1 in {6,10}: 4 (25.9/7.3)
##
## -----  Trial 97:  -----
##
## Decision tree:
##
## F1 in {7,8,9,10}: 4 (76.2/4.9)
## F1 in {1,2,3,4,5,6}:
## :...F2 in {1,2,4,9}:
##     :...F8 in {1,2,3,4,5,7,8,9}: 2 (165.4/3.2)
##     :   F8 in {6,10}: 4 (30/11.5)
##     F2 in {3,5,6,7,8,10}:
##     :...F7 in {1,2,3,4}: 2 (134.6/57.5)
##         F7 in {5,6,7,8,9,10}: 4 (70.8)
##
## -----  Trial 98:  -----
##
## Decision tree:
##
## F2 in {1,2,4}:
## :...F3 in {8,9}: 2 (0)
## :   F3 in {6,7,10}: 4 (14.4)
## :   F3 in {1,2,3,4,5}:
## :   :...F1 in {1,2,3,4,5,6,7,8}: 2 (161.2/14.9)
## :       F1 in {9,10}: 4 (10.8)
## F2 in {3,5,6,7,8,9,10}:
## :...F5 in {1,4,6,7,8,9,10}: 4 (118.2/2.8)
##     F5 in {2,3,5}:
##     :...F6 in {1,2,8}: 2 (50/4.8)
##         F6 in {3,4,5,6,7,9,10}: 4 (122.5/25.4)
##
## -----  Trial 99:  -----
##
## Decision tree:
##
## F8 in {3,4,6,8,9,10}: 4 (222.4/35.9)
## F8 in {1,2,5,7}:
## :...F3 in {5,9,10}: 4 (31.5)
##     F3 in {1,2,3,4,6,7,8}:
##     :...F5 = 9: 2 (0)
##         F5 in {6,8,10}: 4 (15.6)
##         F5 in {1,2,3,4,5,7}:
```

```
##         :...F7 in {1,2,3,4,5,7}: 2 (199.8/32.1)
##             F7 in {6,8,9,10}: 4 (7.8)
##
##
## Evaluation on training data (478 cases):
##
## Trial        Decision Tree
## -----      ----------------
##    Size      Errors
##
##    0      4   18( 3.8%)
##    1      4   26( 5.4%)
##    2      3   36( 7.5%)
##    3      4   36( 7.5%)
##    4      4   25( 5.2%)
##    5      5   47( 9.8%)
##    6      3   29( 6.1%)
##    7      4   41( 8.6%)
##    8      3   47( 9.8%)
##    9      6   12( 2.5%)
##   10      3   33( 6.9%)
##   11      7   14( 2.9%)
##   12      6   75(15.7%)
##   13      4   25( 5.2%)
##   14      7   23( 4.8%)
##   15      4   22( 4.6%)
##   16      4   41( 8.6%)
##   17      7   24( 5.0%)
##   18      6   47( 9.8%)
##   19      5   37( 7.7%)
##   20      4   59(12.3%)
##   21      3   38( 7.9%)
##   22      5   25( 5.2%)
##   23      6   14( 2.9%)
##   24      4   28( 5.9%)
##   25      6   27( 5.6%)
##   26      6   18( 3.8%)
##   27      3   26( 5.4%)
##   28      4   27( 5.6%)
##   29      6   36( 7.5%)
##   30      6   16( 3.3%)
##   31      6   63(13.2%)
##   32      3   41( 8.6%)
##   33      4   44( 9.2%)
##   34      4   24( 5.0%)
##   35      4   29( 6.1%)
##   36      5   24( 5.0%)
##   37      4   52(10.9%)
##   38      7   17( 3.6%)
##   39      5   35( 7.3%)
##   40      5   22( 4.6%)
##   41      7   39( 8.2%)
##   42      4   62(13.0%)
##   43      2   41( 8.6%)
```

```
##   44      6   20( 4.2%)
##   45      4   24( 5.0%)
##   46      4   49(10.3%)
##   47      3   35( 7.3%)
##   48      3   28( 5.9%)
##   49      6   25( 5.2%)
##   50      5   20( 4.2%)
##   51      6   36( 7.5%)
##   52      5   49(10.3%)
##   53      5   20( 4.2%)
##   54      5   34( 7.1%)
##   55      4   29( 6.1%)
##   56      5   17( 3.6%)
##   57      3   28( 5.9%)
##   58      6   20( 4.2%)
##   59      6   41( 8.6%)
##   60      4   42( 8.8%)
##   61      5   65(13.6%)
##   62      6   18( 3.8%)
##   63      6   24( 5.0%)
##   64      4   21( 4.4%)
##   65      6   20( 4.2%)
##   66      6   16( 3.3%)
##   67      5   39( 8.2%)
##   68      5   21( 4.4%)
##   69      5   40( 8.4%)
##   70      4   45( 9.4%)
##   71      3   33( 6.9%)
##   72      6   23( 4.8%)
##   73      5   33( 6.9%)
##   74      4   42( 8.8%)
##   75      4   28( 5.9%)
##   76      6   15( 3.1%)
##   77      4   40( 8.4%)
##   78      7   18( 3.8%)
##   79      4   47( 9.8%)
##   80      4   27( 5.6%)
##   81      7   12( 2.5%)
##   82      5   24( 5.0%)
##   83      5   47( 9.8%)
##   84      6   18( 3.8%)
##   85      6   42( 8.8%)
##   86      5   24( 5.0%)
##   87      5   26( 5.4%)
##   88      7   18( 3.8%)
##   89      6   28( 5.9%)
##   90      4   20( 4.2%)
##   91      5   23( 4.8%)
##   92      4   27( 5.6%)
##   93      7   38( 7.9%)
##   94      5   21( 4.4%)
##   95      4   25( 5.2%)
##   96      6   26( 5.4%)
##   97      5   21( 4.4%)
```

```
##   98      6   19( 4.0%)
##   99      5   27( 5.6%)
## boost              1( 0.2%)   <<
##
##
##     (a)   (b)    <-classified as
##    ----  ----
##     311          (a): class 2
##       1   166    (b): class 4
##
##
##  Attribute usage:
##
##  100.00% F1
##  100.00% F2
##  100.00% F3
##  100.00% F5
##  100.00% F6
##  100.00% F7
##  100.00% F8
##   99.79% F4
##   77.82% F9
##   35.15% Sample
##
##
## Time: 0.1 secs
```