Airplane Dataset Analysis

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Exploratory Analysis - Correlation Heatmap

Load Training & Test data files, replace blanks with median

Kaggle Airline Passenger Dataset

```
rm(list=ls())
air_training <- read.csv("C:/Users/amitr/Downloads/airplane_train.csv") # Load dataset
air_training$Arrival.Delay.in.Minutes[is.na(air_training$Arrival.Delay.in.Minutes)]<-median(air_trainin

air_test<- read.csv("C:/Users/amitr/Downloads/airplane_test.csv") # Load dataset
air_test$Arrival.Delay.in.Minutes[is.na(air_test$Arrival.Delay.in.Minutes)]<-median(air_test$Arrival.Del
```

Pre-processing, convert categorical columns to numeric for training data

```
# Update categorical columns to numeric for training data
air_training<-air_training[,-1:-2] # Eliminate the first 2 columns for row number and identifier
air_training$Gender<-ifelse(air_training$Gender=="Male", 1, 0)
air_training$Customer.Type<-ifelse(air_training$Customer.Type=="Loyal Customer", 1, 0)
air_training$Type.of.Travel<-ifelse(air_training$Type.of.Travel=="Business travel", 1, 0)
air_training$Business<-ifelse(air_training$Class=="Business", 1, 0)
air_training$EcoPlus<-ifelse(air_training$Class=="Eco Plus", 1, 0)
air_training<-air_training[,-5] # remove Class column since created Business and EcoPlus column from th
air_training$satisfaction<-ifelse(air_training$satisfaction=="satisfied", 1, 0)
```

Pre-processing, convert categorical columns to numeric for testing data

```
air_test<-air_test[,-1:-2] # Eliminate the first 2 columns for row number and identifier
air_test$Gender<-ifelse(air_test$Gender=="Male", 1, 0)
air_test$Customer.Type<-ifelse(air_test$Customer.Type=="Loyal Customer", 1, 0)
air_test$Type.of.Travel<-ifelse(air_test$Type.of.Travel=="Business travel", 1, 0)
air_test$Business<-ifelse(air_test$Class=="Business", 1, 0)
air_test$EcoPlus<-ifelse(air_test$Class=="Eco Plus", 1, 0)
air_test<-air_test[,-5] # Eliminates class column
air_test$satisfaction<-ifelse(air_test$satisfaction=="satisfied", 1, 0)
```

Plot a Correlation Matrix with all relevant variables

```
library(ggcorrplot)
dev.off()
```

```
## null device
```

```
##               1
cor_matrix<-cor(air_training)
ggcorrplot(cor_matrix, hc.order=TRUE, type = 'lower', lab = TRUE)
```
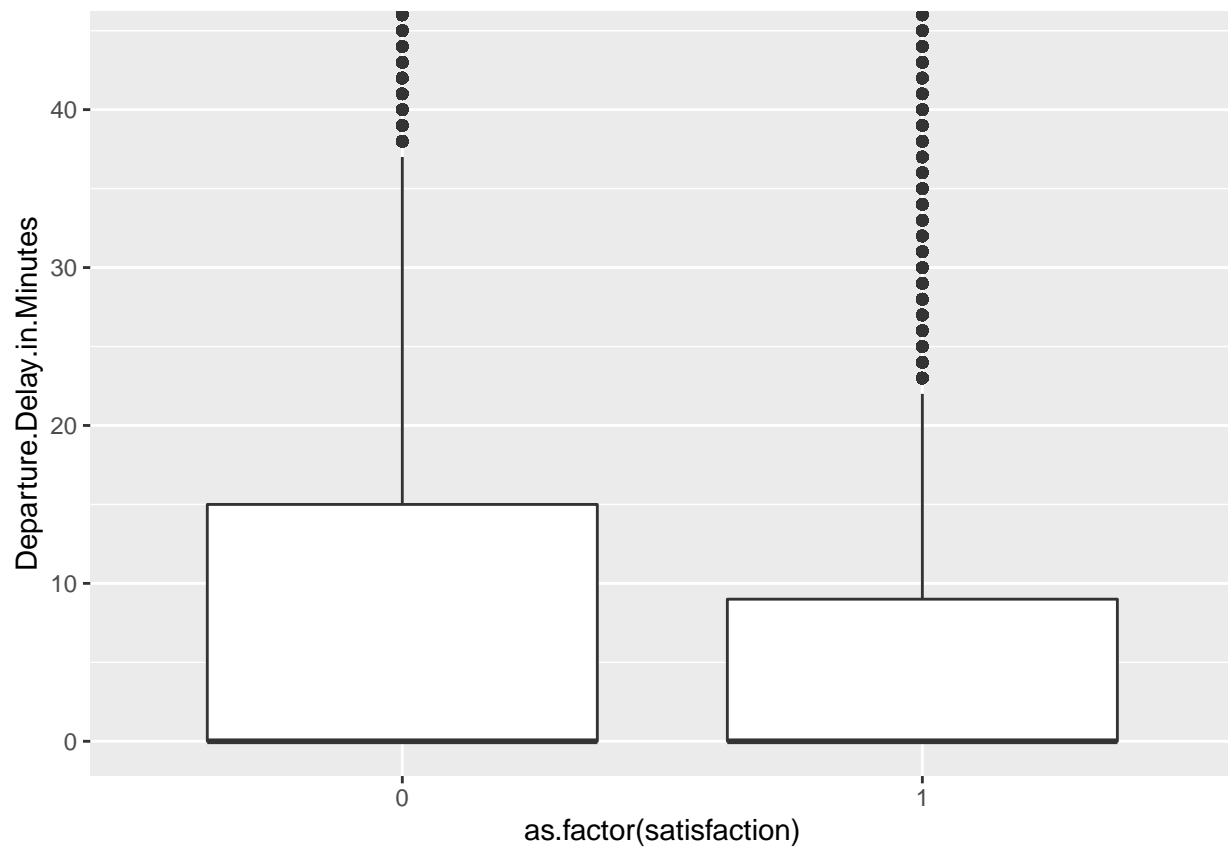

Exploratory Analysis - How Depature Delayal impact Passenger Satisfaction

```
class(air_training$Departure.Delay.in.Minutes)
```

```
## [1] "integer"
```

```
ggplot(air_training, aes(x = as.factor(satisfaction), y = Departure.Delay.in.Minutes)) +
  geom_boxplot() +
  coord_cartesian(ylim = quantile(air_training$Departure.Delay.in.Minutes, p = c(0.1, 0.9)))
```

Exploratory Analysis - How do different classes impact Satisfaction (Economy vs. Business)?

Prepare data for Satisfied vs. Neutral/Disatisfied in different Classes

```
rm(list=ls())
air_training <- read.csv("C:/Users/amitr/Downloads/airplane_train.csv") # Load dataset
air_training$Arrival.Delay.in.Minutes[is.na(air_training$Arrival.Delay.in.Minutes)]<-median(air_training
air_training<-air_training[,-2] # Eliminate the first 2 columns for row number and identifier
air_training$Gender<-ifelse(air_training$Gender=="Male", 1, 0)
air_training$Customer.Type<-ifelse(air_training$Customer.Type=="Loyal Customer", 1, 0)
air_training$Type.of.Travel<-ifelse(air_training$Type.of.Travel=="Business travel", 1, 0)
air_training$Business<-ifelse(air_training$Class=="Business", 1, 0)
air_training$EcoPlus<-ifelse(air_training$Class=="Eco Plus", 1, 0)
air_training$satisfaction<-ifelse(air_training$satisfaction=="satisfied", 1, 0)
```
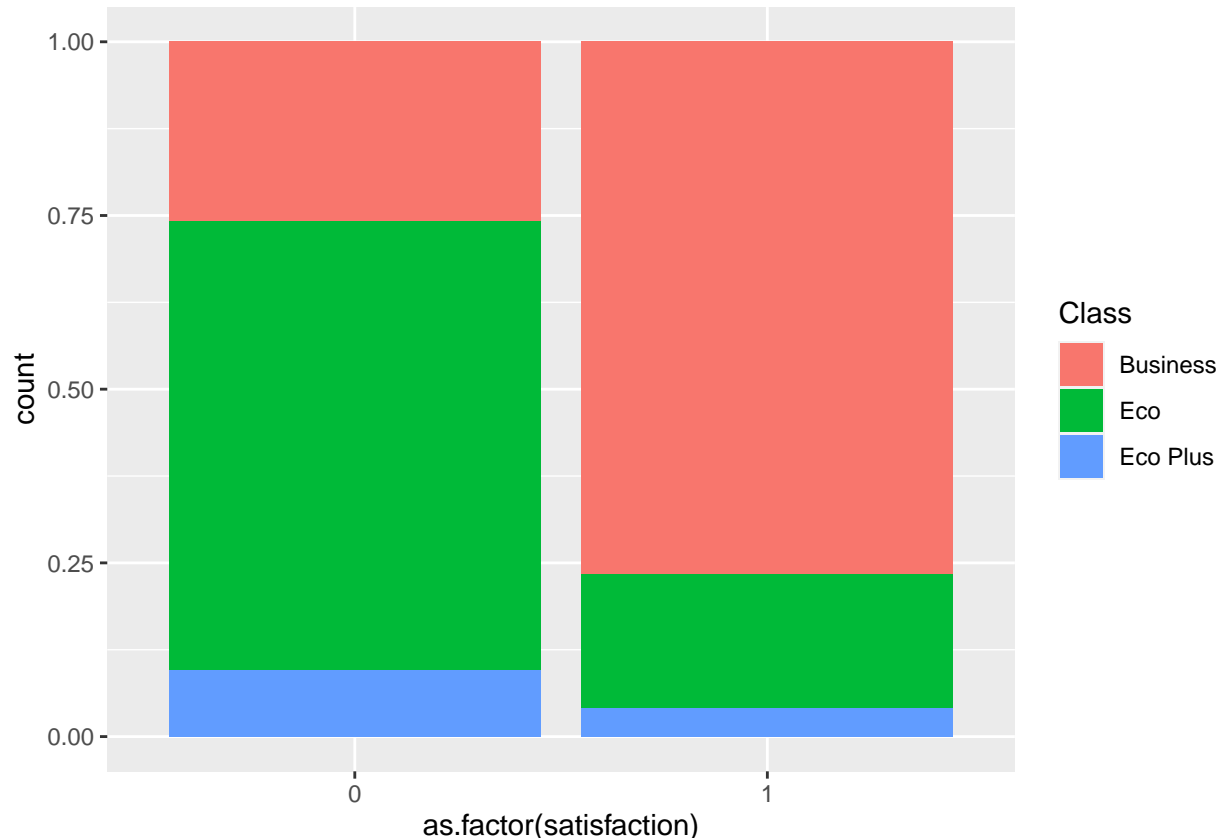
Plot passengers in Different Classes (economy, plus, business)

```
class(air_training$Class)
```

Where 1 = satisfied and 0 = Neutral or disatisfied

```
## [1] "character"
```

```
ggplot(air_training, aes(x = as.factor(satisfaction), fill = Class)) +
  geom_bar(position = 'fill')
```

**Box Plot of Simliar Passenger variables to compare ratings**

```
library(ggpubr)
Food_and_drink<-ggplot(air_training, aes(x = as.factor(satisfaction), y = Food.and.drink)) +
  geom_boxplot()

seat_comfort<-ggplot(air_training, aes(x = as.factor(satisfaction), y = Seat.comfort)) +
  geom_boxplot()


Legroom<-ggplot(air_training, aes(x = as.factor(satisfaction), y = Leg.room.service)) +
  geom_boxplot()

Inflight_enter<-ggplot(air_training, aes(x = as.factor(satisfaction), y = Inflight.entertainment)) +
  geom_boxplot()

ggarrange(Food_and_drink, seat_comfort, Legroom, Inflight_enter, ncol = 2, nrow = 2)
```
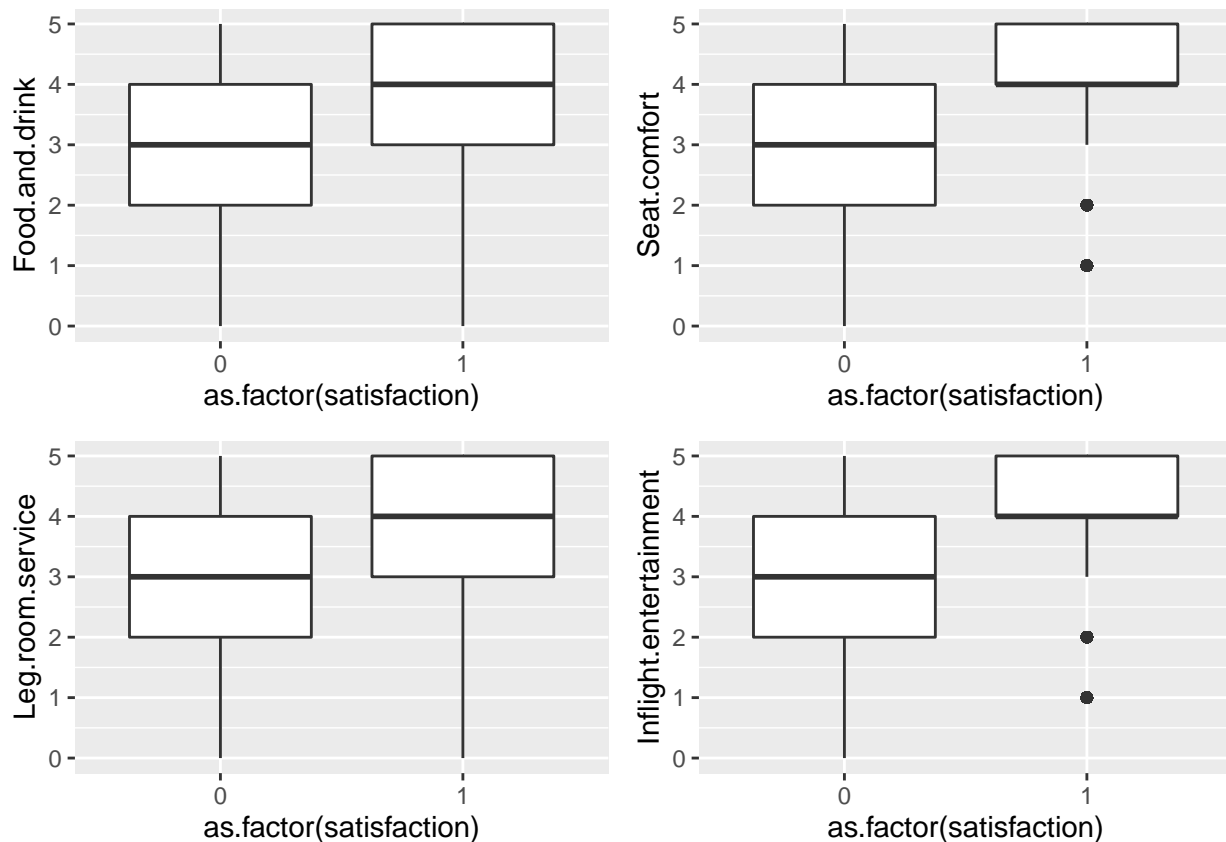

TEST 1: Naives Bayes

```r
rm(list=ls())
air_training<- read.csv('C:/Users/amitr/Downloads/airplane_train.csv') # Load Training
air_training$Arrival.Delay.in.Minutes[is.na(air_training$Arrival.Delay.in.Minutes)]<-median(air_training


air_test<- read.csv("C:/Users/amitr/Downloads/airplane_test.csv") # Load Test
air_test$Arrival.Delay.in.Minutes[is.na(air_test$Arrival.Delay.in.Minutes)]<-median(air_test$Arrival.Del
```

Clear environment - Load training, test data. Fill blanks with median

Pre-processing, convert categorical columns to numeric for training data

Eliminate columns from dataset based on correlation matrix which are Row,

```r
air_training<-air_training[,-c(1,2,3,10,12,23,24)] # eliminates columns
air_training$Customer.Type<-ifelse(air_training$Customer.Type=="Loyal Customer", 1, 0)
air_training$Type.of.Travel<-ifelse(air_training$Type.of.Travel=="Business travel", 1, 0)
air_training$Business<-ifelse(air_training$Class=="Business", 1, 0)
air_training$EcoPlus<-ifelse(air_training$Class=="Eco Plus", 1, 0)
air_training<-air_training[,-4] # Eliminates class column since added Business & EcoPlus columns
```

ID, Gender, Gate Location, Departure Arrival Time, Arrival Delay in Minutes, Departure delay in minutes

```r
air_test<-air_test[,-c(1,2,3,10,12,23,24)] # eliminates columns
air_test$Customer.Type<-ifelse(air_test$Customer.Type=="Loyal Customer", 1, 0)
air_test$Type.of.Travel<-ifelse(air_test$Type.of.Travel=="Business travel", 1, 0)
air_test$Business<-ifelse(air_test$Class=="Business", 1, 0)
air_test$EcoPlus<-ifelse(air_test$Class=="Eco Plus", 1, 0)
air_test<-air_test[,-4] # Eliminates class column
```

Pre-processing, convert categorical columns to numeric for test data

```r
air_training$satisfaction <- factor(air_training$satisfaction)
air_test$satisfaction <- factor(air_test$satisfaction)
```

Factor data

```r
set.seed(111)
library(e1071)
library(caret)
nB<-naiveBayes(satisfaction~., data = air_training) # this is the model
categorize<-predict(nB, air_test) # this is the prediction
```

Build Naive Bayes model and prediction

```r
table(nB=categorize, Class=air_test$satisfaction)
```

Return Confusion Matrix & Accuracy

```
##                            Class
## nB                         neutral or dissatisfied satisfied
##   neutral or dissatisfied                    12942      2151
##   satisfied                                   1631      9252
```

```
confusionMatrix(table(air_test$satisfaction, categorize)) # return all stats
```

```
## Confusion Matrix and Statistics
##
##                            categorize
##                            neutral or dissatisfied satisfied
##   neutral or dissatisfied                    12942      1631
##   satisfied                                   2151      9252
##
##                Accuracy : 0.8544
##                  95% CI : (0.8501, 0.8587)
##     No Information Rate : 0.581
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7029
##
##  Mcnemar's Test P-Value : < 2.2e-16
##
##             Sensitivity : 0.8575
##             Specificity : 0.8501
##          Pos Pred Value : 0.8881
##          Neg Pred Value : 0.8114
##              Prevalence : 0.5810
##          Detection Rate : 0.4982
##    Detection Prevalence : 0.5610
##       Balanced Accuracy : 0.8538
##
##        'Positive' Class : neutral or dissatisfied
##
```

TEST 2: KNN Method

This model and all subsequent models use same preprocessing in test 1

```r
k_value<-c(1,3,4,5,6,7,9,12,15,20,30,50,65,80,100) # K value to test
error_Rate<-vector(length = length(k_value))  # store error rate for each model
```

create vector to store K-values, and variable for error rates

```r
library(kknn) # use library to run kknn formula
for(i in 1:length(k_value)){
  knn_model<-kknn(satisfaction~., air_training, air_test,k = k_value[i],kernel = "rectangular")
  predicted<-fitted(knn_model)
  wrong<-sum(predicted!=air_test$satisfaction) # count number of wrong where test data doesn't predicti
  error_Rate[i]<-wrong/length(predicted)
}
```

```
print(1-error_Rate) # Print Accuracies
```

run For-loop to return results (25 mins est)

```
##  [1] 0.9240453 0.9332076 0.9332076 0.9344395 0.9344395 0.9340930 0.9335925
##  [8] 0.9331691 0.9328996 0.9314752 0.9307823 0.9271250 0.9246612 0.9228519
## [15] 0.9218124
```

```
plot(k_value, 1-error_Rate, type = "b", ylab = "Accuracy") # Plot the accuracy
```
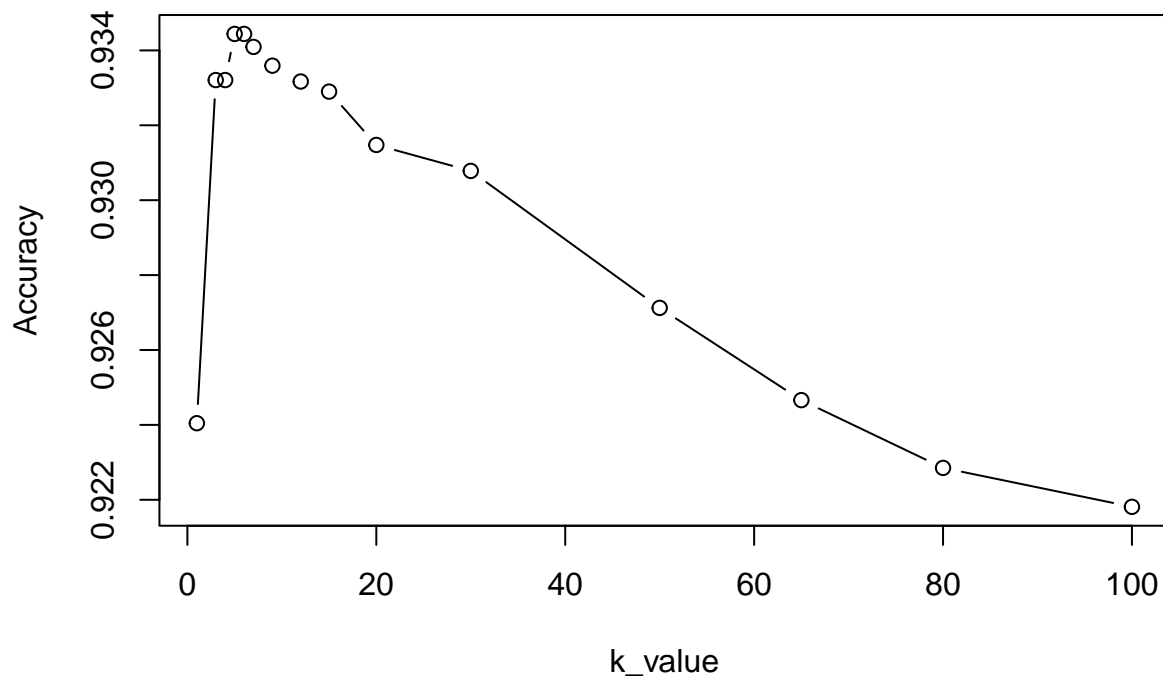

TEST 3: CART Method

```
library(rpart)
library(rpart.plot)
library(rattle)
library(RColorBrewer)
library(caret)
```

Install Packages for CART

```
set.seed(111)
CART_class<-rpart(satisfaction~.,data=air_training) # run CART algorithm on training data
```

```
CART_class
```

Grow the tree

```
## n= 103904
##
## node), split, n, loss, yval, (yprob)
##       * denotes terminal node
##
##  1) root 103904 45025 neutral or dissatisfied (0.566667308 0.433332692)
##    2) Online.boarding< 3.5 52429  7802 neutral or dissatisfied (0.851189227 0.148810773)
##      4) Inflight.wifi.service>=0.5 50661  6042 neutral or dissatisfied (0.880736661 0.119263339)
##        8) Inflight.wifi.service< 3.5 45932  2983 neutral or dissatisfied (0.935056170 0.064943830) *
##        9) Inflight.wifi.service>=3.5 4729  1670 satisfied (0.353140199 0.646859801) *
##      5) Inflight.wifi.service< 0.5 1768     8 satisfied (0.004524887 0.995475113) *
##    3) Online.boarding>=3.5 51475 14252 satisfied (0.276872268 0.723127732)
##      6) Type.of.Travel< 0.5 10492  2347 neutral or dissatisfied (0.776305757 0.223694243)
##       12) Inflight.wifi.service< 4.5 9373  1228 neutral or dissatisfied (0.868985384 0.131014616) *
##       13) Inflight.wifi.service>=4.5 1119     0 satisfied (0.000000000 1.000000000) *
##      7) Type.of.Travel>=0.5 40983  6107 satisfied (0.149013005 0.850986995) *
```

```
dev.off() # reset graphics device
```

Plot the tree

```
## null device
##           1
```
```
par(mar=c(1,1,1,1))
rpart.plot(CART_class)
```

```
CART_predict<-predict(CART_class,air_test, type="class")
table(Actual=air_test[,"satisfaction"],CART=CART_predict) # reg confusion matrix
```

Score the CART

```
##                              CART
## Actual                  neutral or dissatisfied satisfied
##   neutral or dissatisfied                   12599      1974
##   satisfied                                  1045     10358
```
```
str(CART_predict) # check data structure
```

```
##  Factor w/ 2 levels "neutral or dissatisfied",..: 2 2 1 2 1 2 2 2 2 2 ...
##  - attr(*, "names")= chr [1:25976] "1" "2" "3" "4" ...
```
```
confusionMatrix(table(actual=air_test$satisfaction,prediction=CART_predict))
```

```
## Confusion Matrix and Statistics
##
##                          prediction
## actual                  neutral or dissatisfied satisfied
##   neutral or dissatisfied                   12599      1974
##   satisfied                                  1045     10358
##
```

```
##                  Accuracy : 0.8838
##                    95% CI : (0.8798, 0.8877)
##       No Information Rate : 0.5253
##       P-Value [Acc > NIR] : < 2.2e-16
##
##                     Kappa : 0.7661
##
##   Mcnemar's Test P-Value : < 2.2e-16
##
##               Sensitivity : 0.9234
##               Specificity : 0.8399
##            Pos Pred Value : 0.8645
##            Neg Pred Value : 0.9084
##                Prevalence : 0.5253
##            Detection Rate : 0.4850
##      Detection Prevalence : 0.5610
##         Balanced Accuracy : 0.8817
##
##          'Positive' Class : neutral or dissatisfied
##
```

TEST 4: C5.0 Algorithm

```
library('C50')
C50_class<- C5.0(satisfaction~.,data=air_training)
```

Grow the tree

```
summary(C50_class) # this only uses training not test, don't rely on
```

Summarize training data - only for viewing purposes

```
##
## Call:
## C5.0.formula(formula = satisfaction ~ ., data = air_training)
##
##
## C5.0 [Release 2.07 GPL Edition]      Sat Dec 04 11:04:33 2021
## -------------------------------
##
## Class specified by attribute `outcome'
##
## Read 103904 cases (19 attributes) from undefined.data
##
## Decision tree:
##
## Inflight.wifi.service > 4:
## :...Ease.of.Online.booking > 4: satisfied (8430/18)
## :   Ease.of.Online.booking <= 4:
## :   :...Online.boarding > 4: satisfied (1792/2)
## :        Online.boarding <= 4:
```

```
## :          :...Leg.room.service > 4: satisfied (638/3)
## :             Leg.room.service <= 4:
## :             :...Inflight.entertainment <= 4: satisfied (441/3)
## :                  Inflight.entertainment > 4:
## :                  :...Type.of.Travel <= 0: satisfied (22)
## :                       Type.of.Travel > 0:
## :                       :...Customer.Type <= 0: satisfied (18)
## :                            Customer.Type > 0:
## :                            :...Baggage.handling <= 1: satisfied (8)
## :                                 Baggage.handling > 1:
## :                                 :...Checkin.service > 4: satisfied (6)
## :                                      Checkin.service <= 4: [S1]
## Inflight.wifi.service <= 4:
## :...Online.boarding <= 3:
##     :...Inflight.wifi.service <= 0:
##     :   :...Food.and.drink > 0: satisfied (1735)
##     :   :   Food.and.drink <= 0:
##     :   :   :...Ease.of.Online.booking <= 0: satisfied (25)
##     :   :       Ease.of.Online.booking > 0: neutral or dissatisfied (8)
##     :   Inflight.wifi.service > 0:
##     :   :...Inflight.wifi.service > 3:
##     :       :...Type.of.Travel <= 0: neutral or dissatisfied (881/224)
##     :       :   Type.of.Travel > 0:
##     :       :   :...Baggage.handling > 4:
##     :       :       :...Customer.Type > 0: satisfied (357/12)
##     :       :       :   Customer.Type <= 0:
##     :       :       :   :...Food.and.drink > 1: satisfied (77/15)
##     :       :       :       Food.and.drink <= 1: [S2]
##     :       :       Baggage.handling <= 4:
##     :       :       :...Checkin.service > 4: satisfied (198/7)
##     :       :           Checkin.service <= 4:
##     :       :           :...Seat.comfort > 4:
##     :       :               :...Customer.Type > 0: satisfied (130)
##     :       :               :   Customer.Type <= 0:
##     :       :               :   :...Business > 0: satisfied (6/1)
##     :       :               :       Business <= 0: [S3]
##     :       :               Seat.comfort <= 4:
##     :       :               :...Cleanliness > 4: [S4]
##     :       :                   Cleanliness <= 4:
##     :       :                   :...Inflight.service > 4:
##     :       :                       :...Business > 0: satisfied (63/3)
##     :       :                       :   Business <= 0:
##     :       :                       :   :...Age <= 23: satisfied (6)
##     :       :                       :       Age > 23: [S5]
##     :       :                       Inflight.service <= 4:
##     :       :                       :...Seat.comfort <= 1:
##     :       :                           :...Customer.Type <= 0: [S6]
##     :       :                           :   Customer.Type > 0: [S7]
##     :       :                           Seat.comfort > 1:
##     :       :                           :...Online.boarding <= 2:
##     :       :                               :...Ease.of.Online.booking <= 3: [S8]
##     :       :                               :   Ease.of.Online.booking > 3: [S9]
##     :       :                               Online.boarding > 2:
##     :       :                               :...Ease.of.Online.booking <= 3: [S10]
```

```
##     :           :                                       Ease.of.Online.booking > 3: [S11]
##     :           Inflight.wifi.service <= 3:
##     :           :...Business > 0:
##     :               :...Inflight.entertainment > 3:
##     :               :   :...Customer.Type <= 0: neutral or dissatisfied (1560/61)
##     :               :   :   Customer.Type > 0:
##     :               :   :   :...Type.of.Travel <= 0: neutral or dissatisfied (379)
##     :               :   :       Type.of.Travel > 0: [S12]
##     :               :   Inflight.entertainment <= 3:
##     :               :   :...Cleanliness > 4:
##     :               :       :...Type.of.Travel <= 0: neutral or dissatisfied (20)
##     :               :       :   Type.of.Travel > 0: [S13]
##     :               :       Cleanliness <= 4:
##     :               :       :...Seat.comfort > 4: [S14]
##     :               :           Seat.comfort <= 4:
##     :               :           :...Checkin.service > 4: [S15]
##     :               :               Checkin.service <= 4:
##     :               :               :...Baggage.handling > 4: [S16]
##     :               :                   Baggage.handling <= 4:
##     :               :                   :...On.board.service > 4: [S17]
##     :               :                       On.board.service <= 4:
##     :               :                       :...Inflight.service > 4: [S18]
##     :               :                           Inflight.service <= 4: [S19]
##     :               Business <= 0:
##     :               :...Type.of.Travel <= 0: neutral or dissatisfied (19183)
##     :                   Type.of.Travel > 0:
##     :                   :...Customer.Type <= 0: neutral or dissatisfied (8256/45)
##     :                       Customer.Type > 0:
##     :                       :...Checkin.service > 4: satisfied (112/1)
##     :                           Checkin.service <= 4:
##     :                           :...Baggage.handling > 4: satisfied (65/2)
##     :                               Baggage.handling <= 4:
##     :                               :...Inflight.service > 4: satisfied (38/1)
##     :                                   Inflight.service <= 4:
##     :                                   :...Cleanliness > 4: [S20]
##     :                                       Cleanliness <= 4:
##     :                                       :...On.board.service > 4: [S21]
##     :                                           On.board.service <= 4: [S22]
##     Online.boarding > 3:
##     :...Type.of.Travel <= 0:
##         :...Inflight.wifi.service <= 3:
##         :   :...Inflight.wifi.service <= 0: satisfied (125)
##         :   :   Inflight.wifi.service > 0: neutral or dissatisfied (5014)
##         :   Inflight.wifi.service > 3:
##         :...Business <= 0: neutral or dissatisfied (3946/1013)
##         :       Business > 0:
##         :       :...Inflight.service > 4: neutral or dissatisfied (62/9)
##         :           Inflight.service <= 4:
##         :           :...Online.boarding > 4:
##         :               :...Flight.Distance <= 1275: neutral or dissatisfied (47/10)
##         :               :   Flight.Distance > 1275: satisfied (7/2)
##         :               Online.boarding <= 4:
##         :               :...Checkin.service <= 2: neutral or dissatisfied (41/7)
##         :                   Checkin.service > 2:
```

```
##          :                           :...Seat.comfort > 3: [S23]
##          :                               Seat.comfort <= 3: [S24]
##          Type.of.Travel > 0:
##          :...Cleanliness <= 2:
##              :...Online.boarding > 4:
##              :   :...Customer.Type > 0: satisfied (347/2)
##              :   :   Customer.Type <= 0:
##              :   :   :...Checkin.service <= 2: [S25]
##              :   :       Checkin.service > 2:
##              :   :       :...Age <= 23: satisfied (20)
##              :   :           Age > 23: [S26]
##              :   Online.boarding <= 4:
##              :   :...Inflight.entertainment > 4:
##              :       :...Leg.room.service > 4: satisfied (127)
##              :       :   Leg.room.service <= 4: [S27]
##              :       Inflight.entertainment <= 4:
##              :       :...Inflight.service <= 3:
##              :           :...Checkin.service > 4:
##              :           :   :...Customer.Type > 0: satisfied (23)
##              :           :   :   Customer.Type <= 0: [S28]
##              :           :   Checkin.service <= 4:
##              :           :   :...On.board.service > 4: [S29]
##              :           :       On.board.service <= 4:
##              :           :       :...Seat.comfort > 2: [S30]
##              :           :           Seat.comfort <= 2:
##              :           :           :...Food.and.drink > 3: satisfied (16/1)
##              :           :               Food.and.drink <= 3: [S31]
##              :           Inflight.service > 3:
##              :           :...On.board.service <= 2:
##              :               :...Baggage.handling <= 2: [S32]
##              :               :   Baggage.handling > 2: [S33]
##              :               On.board.service > 2:
##              :               :...Seat.comfort > 4:
##              :                   :...Customer.Type > 0: satisfied (47)
##              :                   :   Customer.Type <= 0:
##              :                   :   :...Business > 0: satisfied (18/5)
##              :                   :       Business <= 0: [S34]
##              :                   Seat.comfort <= 4:
##              :                   :...Seat.comfort <= 2: [S35]
##              :                       Seat.comfort > 2:
##              :                       :...Baggage.handling > 4: satisfied (26/3)
##              :                           Baggage.handling <= 4: [S36]
##          Cleanliness > 2:
##          :...Customer.Type <= 0:
##              :...Inflight.wifi.service <= 3: [S37]
##              :   Inflight.wifi.service > 3:
##              :   :...Business > 0:
##              :       :...Checkin.service <= 2:
##              :       :   :...Baggage.handling > 4: [S38]
##              :       :   :   Baggage.handling <= 4: [S39]
##              :       :   Checkin.service > 2:
##              :       :   :...Age <= 24:
##              :       :       :...On.board.service > 2: satisfied (243/5)
##              :       :       :   On.board.service <= 2:
```

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```
##                       :        :           :     :...Checkin.service > 4: satisfied (2)
##                       :        :           :          Checkin.service <= 4: [S40]
##                       :        :        Age > 24:
##                       :        :        :...Flight.Distance > 1616:
##                       :        :        :   :...Age <= 41: neutral or dissatisfied (39/6)
##                       :        :        :   :   Age > 41: satisfied (19/5)
##                       :        :        :   Flight.Distance <= 1616:
##                       :        :        :   :...Age <= 30: satisfied (259/69)
##                       :        :        :       Age > 30: [S41]
##                       :     Business <= 0:
##                       :     :...Age > 24: [S42]
##                       :        Age <= 24:
##                       :        :...Age <= 13: [S43]
##                       :            Age > 13:
##                       :            :...On.board.service <= 2:
##                       :                :...Baggage.handling > 4: satisfied (15/3)
##                       :                :   Baggage.handling <= 4: [S44]
##                       :                On.board.service > 2:
##                       :                :...Baggage.handling > 3: satisfied (315/122)
##                       :                    Baggage.handling <= 3: [S45]
##               Customer.Type > 0:
##               :...Food.and.drink <= 1:
##                   :...Leg.room.service > 3:
##                   :   :...Online.boarding > 4: satisfied (101)
##                   :   :   Online.boarding <= 4: [S46]
##                   :   Leg.room.service <= 3:
##                   :   :...Online.boarding > 4: satisfied (15/1)
##                   :       Online.boarding <= 4:
##                   :       :...Inflight.wifi.service <= 0: satisfied (6)
##                   :           Inflight.wifi.service > 0:
##                   :           :...Seat.comfort > 4: satisfied (7)
##                   :               Seat.comfort <= 4: [S47]
##                   Food.and.drink > 1:
##                   :...Checkin.service <= 2:
##                       :...Online.boarding > 4: satisfied (521)
##                       :   Online.boarding <= 4:
##                       :   :...Inflight.entertainment <= 2:
##                       :       :...Seat.comfort <= 2: satisfied (6)
##                       :       :   Seat.comfort > 2: [S48]
##                       :       Inflight.entertainment > 2:
##                       :       :...On.board.service > 4: satisfied (270/3)
##                       :           On.board.service <= 4:
##                       :           :...Baggage.handling > 4: satisfied (156)
##                       :               Baggage.handling <= 4: [S49]
##                       Checkin.service > 2:
##                       :...Business <= 0:
##                           :...Checkin.service > 4: satisfied (463)
##                           :   Checkin.service <= 4:
##                           :   :...Baggage.handling > 4: satisfied (176/1)
##                           :       Baggage.handling <= 4:
##                           :       :...Inflight.service > 4: satisfied (141)
##                           :           Inflight.service <= 4: [S50]
##                           Business > 0:
##                           :...Seat.comfort <= 3:
```

```
##                                          :...Baggage.handling > 3: [S51]
##                                          :    Baggage.handling <= 3:
##                                          :    :...Online.boarding > 4: satisfied (31)
##                                          :        Online.boarding <= 4: [S52]
##                                     Seat.comfort > 3:
##                                     :...Inflight.service > 3:
##                                         :...On.board.service > 2: [S53]
##                                         :    On.board.service <= 2: [S54]
##                                         Inflight.service <= 3:
##                                         :...Ease.of.Online.booking > 4: [S55]
##                                             Ease.of.Online.booking <= 4: [S56]
##
## SubTree [S1]
##
## Business > 0: neutral or dissatisfied (66/9)
## Business <= 0:
## :...Baggage.handling <= 4: neutral or dissatisfied (38/15)
##     Baggage.handling > 4: satisfied (10)
##
## SubTree [S2]
##
## Flight.Distance <= 873: neutral or dissatisfied (6)
## Flight.Distance > 873: satisfied (2)
##
## SubTree [S3]
##
## Inflight.service <= 4: neutral or dissatisfied (17/3)
## Inflight.service > 4: satisfied (2)
##
## SubTree [S4]
##
## Inflight.entertainment <= 4: satisfied (86)
## Inflight.entertainment > 4:
## :...Customer.Type <= 0: neutral or dissatisfied (4)
##     Customer.Type > 0: satisfied (3)
##
## SubTree [S5]
##
## Customer.Type <= 0: neutral or dissatisfied (9/2)
## Customer.Type > 0: satisfied (2)
##
## SubTree [S6]
##
## Inflight.service <= 3: neutral or dissatisfied (15/1)
## Inflight.service > 3:
## :...Leg.room.service <= 1: neutral or dissatisfied (2)
##     Leg.room.service > 1: satisfied (6)
##
## SubTree [S7]
##
## Ease.of.Online.booking > 2: satisfied (84/9)
## Ease.of.Online.booking <= 2:
## :...Business <= 0: satisfied (22/6)
##     Business > 0: neutral or dissatisfied (8/2)
```

```
##
## SubTree [S8]
##
## Business > 0: neutral or dissatisfied (102/8)
## Business <= 0:
## :...Flight.Distance > 1523: neutral or dissatisfied (7)
##     Flight.Distance <= 1523:
##     :...Online.boarding <= 1: satisfied (33/1)
##         Online.boarding > 1:
##         :...Inflight.entertainment <= 3: neutral or dissatisfied (5)
##             Inflight.entertainment > 3:
##             :...Seat.comfort <= 3: neutral or dissatisfied (32/14)
##                 Seat.comfort > 3: satisfied (13)
##
## SubTree [S9]
##
## Ease.of.Online.booking > 4:
## :...Business > 0:
## :   :...Inflight.service <= 3: satisfied (4/1)
## :   :   Inflight.service > 3: neutral or dissatisfied (28/2)
## :   Business <= 0:
## :   :...EcoPlus > 0: neutral or dissatisfied (3)
## :       EcoPlus <= 0:
## :       :...Flight.Distance <= 932: satisfied (20/2)
## :           Flight.Distance > 932: neutral or dissatisfied (6/1)
## Ease.of.Online.booking <= 4:
## :...Age > 63:
##     :...Baggage.handling <= 3: satisfied (2)
##     :   Baggage.handling > 3: neutral or dissatisfied (7)
##     Age <= 63:
##     :...Customer.Type > 0: satisfied (134/28)
##         Customer.Type <= 0:
##         :...Online.boarding <= 1: neutral or dissatisfied (6/1)
##             Online.boarding > 1:
##             :...Inflight.entertainment > 3: satisfied (4)
##                 Inflight.entertainment <= 3:
##                 :...Inflight.entertainment <= 2: satisfied (2)
##                     Inflight.entertainment > 2: neutral or dissatisfied (7/2)
##
## SubTree [S10]
##
## Business > 0: neutral or dissatisfied (301/19)
## Business <= 0:
## :...Inflight.service > 1: neutral or dissatisfied (165/30)
##     Inflight.service <= 1:
##     :...Food.and.drink <= 3: satisfied (4)
##         Food.and.drink > 3:
##         :...Flight.Distance <= 329: satisfied (2)
##             Flight.Distance > 329: neutral or dissatisfied (4)
##
## SubTree [S11]
##
## Ease.of.Online.booking > 4: neutral or dissatisfied (146/16)
## Ease.of.Online.booking <= 4:
```

```
## :...Leg.room.service > 4: satisfied (15/1)
##     Leg.room.service <= 4:
##     :...Inflight.entertainment > 3: neutral or dissatisfied (150/49)
##         Inflight.entertainment <= 3:
##         :...Business <= 0: neutral or dissatisfied (10/2)
##             Business > 0:
##             :...Baggage.handling <= 3: satisfied (20)
##                 Baggage.handling > 3:
##                 :...Checkin.service <= 2: neutral or dissatisfied (5)
##                     Checkin.service > 2:
##                     :...Cleanliness <= 2: neutral or dissatisfied (6/1)
##                         Cleanliness > 2: satisfied (9)
##
## SubTree [S12]
##
## Ease.of.Online.booking <= 0: neutral or dissatisfied (45)
## Ease.of.Online.booking > 0:
## :...Inflight.service <= 3:
##     :...Baggage.handling > 4: satisfied (15)
##     :   Baggage.handling <= 4:
##     :   :...Inflight.entertainment > 4: satisfied (8)
##     :       Inflight.entertainment <= 4:
##     :       :...Leg.room.service <= 4: neutral or dissatisfied (85/3)
##     :           Leg.room.service > 4: satisfied (4/1)
##     Inflight.service > 3:
##     :...Baggage.handling > 3: satisfied (1617/5)
##         Baggage.handling <= 3:
##         :...Leg.room.service > 4: satisfied (39)
##             Leg.room.service <= 4:
##             :...Seat.comfort > 4: satisfied (10)
##                 Seat.comfort <= 4:
##                 :...Baggage.handling <= 2: neutral or dissatisfied (49/2)
##                     Baggage.handling > 2:
##                     :...Checkin.service > 4: satisfied (4)
##                         Checkin.service <= 4:
##                         :...Flight.Distance <= 201: satisfied (10/1)
##                             Flight.Distance > 201: neutral or dissatisfied (33/6)
##
## SubTree [S13]
##
## Customer.Type <= 0: neutral or dissatisfied (4)
## Customer.Type > 0: satisfied (52/2)
##
## SubTree [S14]
##
## Type.of.Travel <= 0: neutral or dissatisfied (39)
## Type.of.Travel > 0:
## :...Customer.Type <= 0: neutral or dissatisfied (94/5)
##     Customer.Type > 0: satisfied (55/2)
##
## SubTree [S15]
##
## Customer.Type <= 0: neutral or dissatisfied (544/11)
## Customer.Type > 0:
```

```
## :...Type.of.Travel <= 0: neutral or dissatisfied (78)
##      Type.of.Travel > 0: satisfied (123)
##
## SubTree [S16]
##
## Customer.Type <= 0: neutral or dissatisfied (552/16)
## Customer.Type > 0:
## :...Type.of.Travel <= 0: neutral or dissatisfied (93)
##      Type.of.Travel > 0: satisfied (113/2)
##
## SubTree [S17]
##
## Customer.Type <= 0: neutral or dissatisfied (192/7)
## Customer.Type > 0:
## :...Type.of.Travel <= 0: neutral or dissatisfied (39)
##      Type.of.Travel > 0:
##      :...Online.boarding <= 1: neutral or dissatisfied (14)
##          Online.boarding > 1:
##          :...Age <= 35:
##              :...Inflight.service <= 2: neutral or dissatisfied (12/4)
##              :   Inflight.service > 2: satisfied (49/4)
##              Age > 35:
##              :...Inflight.wifi.service <= 1: satisfied (3)
##                  Inflight.wifi.service > 1: neutral or dissatisfied (27/2)
##
## SubTree [S18]
##
## Customer.Type <= 0: neutral or dissatisfied (197/4)
## Customer.Type > 0:
## :...Type.of.Travel <= 0: neutral or dissatisfied (26)
##      Type.of.Travel > 0: satisfied (38)
##
## SubTree [S19]
##
## Inflight.entertainment <= 1: neutral or dissatisfied (1669/9)
## Inflight.entertainment > 1:
## :...Inflight.wifi.service > 1: neutral or dissatisfied (4611/115)
##      Inflight.wifi.service <= 1:
##      :...Customer.Type <= 0: neutral or dissatisfied (98)
##          Customer.Type > 0:
##          :...Baggage.handling <= 1:
##              :...Age > 33: neutral or dissatisfied (104)
##              :   Age <= 33:
##              :   :...Online.boarding <= 1: neutral or dissatisfied (4)
##              :       Online.boarding > 1: satisfied (5/1)
##              Baggage.handling > 1:
##              :...Type.of.Travel <= 0: neutral or dissatisfied (43)
##                  Type.of.Travel > 0:
##                  :...Seat.comfort <= 1:
##                      :...Cleanliness <= 3: neutral or dissatisfied (54/3)
##                      :   Cleanliness > 3: satisfied (3)
##                      Seat.comfort > 1: [S57]
##
## SubTree [S20]
```

```
##
## Inflight.wifi.service <= 1: neutral or dissatisfied (14)
## Inflight.wifi.service > 1: satisfied (18)
##
## SubTree [S21]
##
## Leg.room.service > 4: satisfied (8)
## Leg.room.service <= 4:
## :...Inflight.wifi.service <= 1: neutral or dissatisfied (18)
##     Inflight.wifi.service > 1:
##     :...Checkin.service > 3: satisfied (4)
##         Checkin.service <= 3:
##         :...Flight.Distance > 1599: neutral or dissatisfied (15)
##             Flight.Distance <= 1599:
##             :...Online.boarding <= 2:
##                 :...Inflight.entertainment <= 2: satisfied (20/3)
##                 :   Inflight.entertainment > 2: neutral or dissatisfied (11/1)
##                 Online.boarding > 2:
##                 :...Checkin.service <= 2: satisfied (5/1)
##                     Checkin.service > 2:
##                     :...Food.and.drink <= 3: neutral or dissatisfied (19/2)
##                         Food.and.drink > 3: satisfied (2)
##
## SubTree [S22]
##
## Age <= 33: neutral or dissatisfied (1320)
## Age > 33:
## :...Inflight.wifi.service <= 1: neutral or dissatisfied (824/1)
##     Inflight.wifi.service > 1:
##     :...Online.boarding <= 1:
##         :...Seat.comfort <= 2: neutral or dissatisfied (64/7)
##         :   Seat.comfort > 2:
##         :   :...Flight.Distance <= 1283: satisfied (19/1)
##         :       Flight.Distance > 1283: neutral or dissatisfied (4)
##         Online.boarding > 1:
##         :...Baggage.handling <= 1:
##             :...Inflight.service <= 2: neutral or dissatisfied (102/19)
##             :   Inflight.service > 2:
##             :   :...Flight.Distance <= 1485: satisfied (20/3)
##             :       Flight.Distance > 1485: neutral or dissatisfied (13/1)
##             Baggage.handling > 1:
##             :...Inflight.service > 2:
##                 :...Baggage.handling > 2: neutral or dissatisfied (2010/58)
##                 :   Baggage.handling <= 2:
##                 :   :...Inflight.service <= 3: neutral or dissatisfied (117/6)
##                 :       Inflight.service > 3:
##                 :       :...Flight.Distance <= 1312: satisfied (12/1)
##                 :           Flight.Distance > 1312: neutral or dissatisfied (21/1)
##                 Inflight.service <= 2:
##                 :...Baggage.handling <= 3:
##                     :...Online.boarding > 2: neutral or dissatisfied (435/35)
##                     :   Online.boarding <= 2:
##                     :   :...Seat.comfort <= 3: neutral or dissatisfied (234/32)
##                     :       Seat.comfort > 3: [S58]
```

```
##                          Baggage.handling > 3:
##                          :...EcoPlus > 0: satisfied (7/1)
##                              EcoPlus <= 0:
##                              :...Checkin.service <= 1: satisfied (9)
##                                  Checkin.service > 1:
##                                  :...Age <= 45: satisfied (14/6)
##                                      Age > 45: neutral or dissatisfied (12/2)
##
## SubTree [S23]
##
## Food.and.drink > 2: neutral or dissatisfied (66/30)
## Food.and.drink <= 2:
## :...Ease.of.Online.booking <= 4: satisfied (18/3)
##     Ease.of.Online.booking > 4: neutral or dissatisfied (2)
##
## SubTree [S24]
##
## On.board.service > 3: neutral or dissatisfied (22/3)
## On.board.service <= 3:
## :...On.board.service <= 1: neutral or dissatisfied (8/1)
##     On.board.service > 1:
##     :...Seat.comfort <= 2: satisfied (12/2)
##         Seat.comfort > 2: neutral or dissatisfied (3)
##
## SubTree [S25]
##
## Inflight.entertainment <= 4: neutral or dissatisfied (22/1)
## Inflight.entertainment > 4: satisfied (3)
##
## SubTree [S26]
##
## Inflight.wifi.service <= 2: satisfied (3)
## Inflight.wifi.service > 2: neutral or dissatisfied (34/15)
##
## SubTree [S27]
##
## Leg.room.service <= 2: neutral or dissatisfied (4)
## Leg.room.service > 2:
## :...Customer.Type <= 0: neutral or dissatisfied (2)
##     Customer.Type > 0:
##     :...Baggage.handling <= 3: neutral or dissatisfied (2)
##         Baggage.handling > 3: satisfied (14/2)
##
## SubTree [S28]
##
## Inflight.wifi.service <= 3: neutral or dissatisfied (4)
## Inflight.wifi.service > 3: satisfied (40/19)
##
## SubTree [S29]
##
## Business <= 0: neutral or dissatisfied (31/10)
## Business > 0: satisfied (7/1)
##
## SubTree [S30]
```

```
##
## Leg.room.service <= 3: neutral or dissatisfied (1187/29)
## Leg.room.service > 3:
## :...Inflight.wifi.service <= 2: satisfied (6)
##     Inflight.wifi.service > 2: neutral or dissatisfied (32/6)
##
## SubTree [S31]
##
## Customer.Type <= 0: neutral or dissatisfied (265/43)
## Customer.Type > 0:
## :...Checkin.service > 2: satisfied (10)
##     Checkin.service <= 2:
##     :...Seat.comfort > 1: neutral or dissatisfied (6)
##         Seat.comfort <= 1:
##         :...Ease.of.Online.booking <= 4: satisfied (6/1)
##             Ease.of.Online.booking > 4: neutral or dissatisfied (3)
##
## SubTree [S32]
##
## Baggage.handling <= 1: neutral or dissatisfied (8/2)
## Baggage.handling > 1: satisfied (12/3)
##
## SubTree [S33]
##
## Checkin.service <= 4: neutral or dissatisfied (101/8)
## Checkin.service > 4:
## :...On.board.service <= 1: neutral or dissatisfied (7/2)
##     On.board.service > 1: satisfied (5/1)
##
## SubTree [S34]
##
## Checkin.service <= 1: satisfied (2)
## Checkin.service > 1: neutral or dissatisfied (5)
##
## SubTree [S35]
##
## Inflight.entertainment > 3: satisfied (80/1)
## Inflight.entertainment <= 3:
## :...Inflight.wifi.service <= 3: neutral or dissatisfied (44/3)
##     Inflight.wifi.service > 3:
##     :...Age > 27:
##         :...Business <= 0: neutral or dissatisfied (57/8)
##         :   Business > 0:
##         :   :...Age <= 36:
##         :       :...Age <= 30: satisfied (37/13)
##         :       :   Age > 30: neutral or dissatisfied (43)
##         :       Age > 36:
##         :       :...Checkin.service > 4: satisfied (46/10)
##         :           Checkin.service <= 4:
##         :           :...On.board.service <= 4: satisfied (87/29)
##         :               On.board.service > 4: neutral or dissatisfied (35/14)
##         Age <= 27:
##         :...Business > 0: satisfied (226/31)
##             Business <= 0:
```

```
##               :...Baggage.handling > 4: satisfied (68/20)
##                  Baggage.handling <= 4:
##                  :...Baggage.handling <= 1: satisfied (8)
##                     Baggage.handling > 1:
##                     :...Checkin.service > 4: satisfied (25/8)
##                        Checkin.service <= 4: [S59]
##
## SubTree [S36]
##
## Checkin.service > 4: satisfied (18/3)
## Checkin.service <= 4:
## :...Inflight.wifi.service <= 3:
##     :...Baggage.handling <= 3: neutral or dissatisfied (18)
##     :   Baggage.handling > 3:
##     :   :...Leg.room.service <= 3: neutral or dissatisfied (12)
##     :       Leg.room.service > 3: satisfied (29)
##     Inflight.wifi.service > 3:
##     :...Customer.Type <= 0:
##         :...Business <= 0:
##         :   :...Checkin.service <= 1: satisfied (2)
##         :   :   Checkin.service > 1: neutral or dissatisfied (9/1)
##         :   Business > 0:
##         :   :...Flight.Distance <= 508: neutral or dissatisfied (6/2)
##         :       Flight.Distance > 508: satisfied (8)
##         Customer.Type > 0:
##         :...Business > 0: neutral or dissatisfied (128/11)
##             Business <= 0:
##             :...Seat.comfort > 3: neutral or dissatisfied (33/8)
##                 Seat.comfort <= 3:
##                 :...Cleanliness <= 1: neutral or dissatisfied (17/5)
##                     Cleanliness > 1:
##                     :...Food.and.drink > 3: satisfied (8/1)
##                         Food.and.drink <= 3:
##                         :...Age <= 50: neutral or dissatisfied (3)
##                             Age > 50: satisfied (7/2)
##
## SubTree [S37]
##
## Inflight.wifi.service > 1: neutral or dissatisfied (317/7)
## Inflight.wifi.service <= 1:
## :...Inflight.wifi.service <= 0: satisfied (12)
##     Inflight.wifi.service > 0: neutral or dissatisfied (51)
##
## SubTree [S38]
##
## On.board.service <= 2: neutral or dissatisfied (2)
## On.board.service > 2: satisfied (4)
##
## SubTree [S39]
##
## Ease.of.Online.booking > 4: satisfied (3/1)
## Ease.of.Online.booking <= 4:
## :...Inflight.service <= 1: satisfied (4/1)
##     Inflight.service > 1: neutral or dissatisfied (43/3)
```

```
##
## SubTree [S40]
##
## Inflight.service <= 4: neutral or dissatisfied (11/1)
## Inflight.service > 4: satisfied (2)
##
## SubTree [S41]
##
## Age <= 36: neutral or dissatisfied (68)
## Age > 36: satisfied (309/98)
##
## SubTree [S42]
##
## Inflight.service <= 4: neutral or dissatisfied (493/68)
## Inflight.service > 4:
## :...EcoPlus <= 0: satisfied (54/25)
##     EcoPlus > 0: neutral or dissatisfied (6/1)
##
## SubTree [S43]
##
## Baggage.handling <= 4: neutral or dissatisfied (31/1)
## Baggage.handling > 4: satisfied (5)
##
## SubTree [S44]
##
## Baggage.handling <= 2: satisfied (34/16)
## Baggage.handling > 2: neutral or dissatisfied (104/19)
##
## SubTree [S45]
##
## Baggage.handling <= 2: satisfied (52/20)
## Baggage.handling > 2:
## :...Inflight.service <= 4: neutral or dissatisfied (64/10)
##     Inflight.service > 4: satisfied (14/6)
##
## SubTree [S46]
##
## Ease.of.Online.booking <= 4: satisfied (128/22)
## Ease.of.Online.booking > 4: neutral or dissatisfied (9/1)
##
## SubTree [S47]
##
## Seat.comfort <= 2: satisfied (2)
## Seat.comfort > 2: neutral or dissatisfied (243/2)
##
## SubTree [S48]
##
## Inflight.wifi.service > 1: neutral or dissatisfied (211/3)
## Inflight.wifi.service <= 1:
## :...Baggage.handling <= 1: neutral or dissatisfied (96)
##     Baggage.handling > 1: satisfied (4)
##
## SubTree [S49]
##
```

```
## Inflight.service > 4: satisfied (134/1)
## Inflight.service <= 4:
## :...Inflight.service <= 2:
##     :...Baggage.handling > 3: satisfied (68)
##     :   Baggage.handling <= 3:
##     :   :...Inflight.service <= 1: satisfied (90/5)
##     :       Inflight.service > 1:
##     :       :...Baggage.handling <= 1: satisfied (36/3)
##     :           Baggage.handling > 1:
##     :           :...Inflight.wifi.service <= 3: satisfied (23/3)
##     :               Inflight.wifi.service > 3:
##     :               :...Flight.Distance > 484: neutral or dissatisfied (63/20)
##     :                   Flight.Distance <= 484: [S60]
##     Inflight.service > 2:
##     :...Baggage.handling <= 2:
##         :...Flight.Distance <= 1589: satisfied (125/18)
##         :   Flight.Distance > 1589:
##         :   :...Age > 33: neutral or dissatisfied (13)
##         :       Age <= 33:
##         :       :...Inflight.wifi.service <= 3: satisfied (22/2)
##         :           Inflight.wifi.service > 3: neutral or dissatisfied (16/3)
##         Baggage.handling > 2:
##         :...Inflight.wifi.service <= 2:
##             :...Leg.room.service > 2: satisfied (44/1)
##             :   Leg.room.service <= 2:
##             :   :...Business <= 0: neutral or dissatisfied (3)
##             :       Business > 0:
##             :       :...Seat.comfort <= 2: neutral or dissatisfied (3)
##             :           Seat.comfort > 2: satisfied (14/1)
##             Inflight.wifi.service > 2:
##             :...Cleanliness > 4:
##                 :...Inflight.entertainment <= 4: satisfied (16)
##                 :   Inflight.entertainment > 4:
##                 :   :...Age <= 43: satisfied (4)
##                 :       Age > 43: neutral or dissatisfied (5)
##                 Cleanliness <= 4:
##                 :...Inflight.entertainment <= 3: neutral or dissatisfied (168/11)
##                     Inflight.entertainment > 3:
##                     :...Inflight.wifi.service > 3:
##                         :...Food.and.drink > 3: neutral or dissatisfied (498/108)
##                         :   Food.and.drink <= 3: [S61]
##                         Inflight.wifi.service <= 3:
##                         :...Business <= 0: neutral or dissatisfied (2)
##                             Business > 0:
##                             :...Baggage.handling > 3: satisfied (14)
##                                 Baggage.handling <= 3: [S62]
##
## SubTree [S50]
##
## Online.boarding > 4: satisfied (69)
## Online.boarding <= 4:
## :...On.board.service > 4:
##     :...Inflight.entertainment > 3: satisfied (107/2)
##     :   Inflight.entertainment <= 3:
```

```
##     :    :...Seat.comfort <= 3: satisfied (5)
##     :         Seat.comfort > 3:
##     :         :...Baggage.handling <= 1: satisfied (4)
##     :              Baggage.handling > 1: neutral or dissatisfied (8/1)
##     On.board.service <= 4:
##     :...Inflight.wifi.service <= 3:
##         :...Age > 40: neutral or dissatisfied (116/10)
##         :   Age <= 40:
##         :   :...Inflight.service <= 2: satisfied (10/1)
##         :        Inflight.service > 2:
##         :        :...Seat.comfort <= 3: neutral or dissatisfied (12)
##         :             Seat.comfort > 3: satisfied (4)
##         Inflight.wifi.service > 3:
##         :...Baggage.handling <= 2:
##             :...Flight.Distance <= 1568: satisfied (209/37)
##             :   Flight.Distance > 1568:
##             :   :...Flight.Distance <= 2213: neutral or dissatisfied (7)
##             :        Flight.Distance > 2213: satisfied (7/1)
##             Baggage.handling > 2:
##             :...Inflight.service > 2: neutral or dissatisfied (381/126)
##                  Inflight.service <= 2:
##                  :...Inflight.entertainment > 3: satisfied (111/16)
##                       Inflight.entertainment <= 3:
##                       :...Seat.comfort <= 3: satisfied (2)
##                            Seat.comfort > 3: neutral or dissatisfied (18/2)
##
## SubTree [S51]
##
## Inflight.wifi.service <= 3: satisfied (266/2)
## Inflight.wifi.service > 3:
## :...Seat.comfort <= 2: satisfied (55)
##     Seat.comfort > 2:
##     :...Baggage.handling > 4: satisfied (22)
##         Baggage.handling <= 4:
##         :...Online.boarding > 4: satisfied (7)
##             Online.boarding <= 4:
##             :...Age <= 32: satisfied (10)
##                  Age > 32: neutral or dissatisfied (42/4)
##
## SubTree [S52]
##
## Checkin.service > 4: satisfied (14)
## Checkin.service <= 4:
## :...Inflight.wifi.service > 3: satisfied (13/1)
##     Inflight.wifi.service <= 3:
##     :...Age <= 33:
##         :...Baggage.handling <= 1: satisfied (4)
##         :   Baggage.handling > 1: neutral or dissatisfied (26/9)
##         Age > 33:
##         :...Inflight.wifi.service > 1: neutral or dissatisfied (139/1)
##             Inflight.wifi.service <= 1:
##             :...Baggage.handling > 1: satisfied (5)
##                  Baggage.handling <= 1:
##                  :...Inflight.wifi.service <= 0: satisfied (2)
```

```
##                                Inflight.wifi.service > 0: neutral or dissatisfied (47)
##
## SubTree [S53]
##
## Baggage.handling > 3: satisfied (15970/39)
## Baggage.handling <= 3:
## :...Inflight.wifi.service <= 3: satisfied (251/3)
##     Inflight.wifi.service > 3:
##     :...Ease.of.Online.booking > 4: neutral or dissatisfied (9/2)
##         Ease.of.Online.booking <= 4:
##         :...Ease.of.Online.booking > 3: satisfied (48/5)
##             Ease.of.Online.booking <= 3:
##             :...Age <= 22: satisfied (4/1)
##                 Age > 22: neutral or dissatisfied (5)
##
## SubTree [S54]
##
## Inflight.wifi.service <= 3: satisfied (214)
## Inflight.wifi.service > 3:
## :...Cleanliness > 4: satisfied (35)
##     Cleanliness <= 4:
##     :...Inflight.service > 4: satisfied (16)
##         Inflight.service <= 4:
##         :...Baggage.handling > 4: satisfied (5)
##             Baggage.handling <= 4:
##             :...Leg.room.service <= 4: neutral or dissatisfied (42/5)
##                 Leg.room.service > 4:
##                 :...Checkin.service <= 3: neutral or dissatisfied (3)
##                     Checkin.service > 3: satisfied (4)
##
## SubTree [S55]
##
## Online.boarding > 4: satisfied (48)
## Online.boarding <= 4:
## :...Seat.comfort > 4: satisfied (20)
##     Seat.comfort <= 4:
##     :...Cleanliness > 4: satisfied (8)
##         Cleanliness <= 4:
##         :...Checkin.service > 4: satisfied (5)
##             Checkin.service <= 4:
##             :...Baggage.handling > 4: satisfied (4)
##                 Baggage.handling <= 4:
##                 :...Inflight.wifi.service > 3: neutral or dissatisfied (35/1)
##                     Inflight.wifi.service <= 3:
##                     :...Leg.room.service > 3: satisfied (5)
##                         Leg.room.service <= 3: [S63]
##
## SubTree [S56]
##
## Online.boarding > 4: satisfied (1549)
## Online.boarding <= 4:
## :...Seat.comfort > 4: satisfied (615)
##     Seat.comfort <= 4:
##     :...Age > 60:
```

```
##          :...Inflight.wifi.service <= 0: satisfied (4)
##          :   Inflight.wifi.service > 0:
##          :   :...Leg.room.service <= 3: neutral or dissatisfied (27/3)
##          :       Leg.room.service > 3: satisfied (2)
##          Age <= 60:
##          :...Checkin.service > 4: satisfied (302)
##             Checkin.service <= 4:
##             :...Cleanliness > 4: satisfied (124)
##                 Cleanliness <= 4:
##                 :...Baggage.handling > 4: satisfied (107)
##                     Baggage.handling <= 4:
##                     :...Inflight.wifi.service <= 0: satisfied (62)
##                         Inflight.wifi.service > 0:
##                         :...Inflight.entertainment <= 1: [S64]
##                             Inflight.entertainment > 1:
##                             :...Inflight.wifi.service <= 1: [S65]
##                                 Inflight.wifi.service > 1: [S66]
##
## SubTree [S57]
##
## Ease.of.Online.booking <= 0: neutral or dissatisfied (26)
## Ease.of.Online.booking > 0: satisfied (57/1)
##
## SubTree [S58]
##
## Flight.Distance <= 1094: satisfied (6)
## Flight.Distance > 1094: neutral or dissatisfied (5)
##
## SubTree [S59]
##
## Inflight.service <= 4: neutral or dissatisfied (58/10)
## Inflight.service > 4:
## :...Age <= 21: satisfied (8/1)
##     Age > 21: neutral or dissatisfied (11/3)
##
## SubTree [S60]
##
## On.board.service <= 3: satisfied (25/1)
## On.board.service > 3: neutral or dissatisfied (4/1)
##
## SubTree [S61]
##
## Seat.comfort <= 2: satisfied (11)
## Seat.comfort > 2: neutral or dissatisfied (41/5)
##
## SubTree [S62]
##
## Seat.comfort <= 3: neutral or dissatisfied (5)
## Seat.comfort > 3: satisfied (4)
##
## SubTree [S63]
##
## Inflight.entertainment <= 3: neutral or dissatisfied (31/7)
## Inflight.entertainment > 3: satisfied (3)
```

```
##
## SubTree [S64]
##
## Leg.room.service <= 1: neutral or dissatisfied (31)
## Leg.room.service > 1:
## :...Inflight.wifi.service <= 3: satisfied (11/1)
##     Inflight.wifi.service > 3: neutral or dissatisfied (11/1)
##
## SubTree [S65]
##
## Ease.of.Online.booking <= 2: satisfied (87/1)
## Ease.of.Online.booking > 2:
## :...Baggage.handling <= 1: neutral or dissatisfied (4)
##     Baggage.handling > 1: satisfied (6)
##
## SubTree [S66]
##
## Ease.of.Online.booking <= 1: neutral or dissatisfied (50/5)
## Ease.of.Online.booking > 1:
## :...Leg.room.service > 3:
##     :...Inflight.wifi.service <= 3: satisfied (89/1)
##     :   Inflight.wifi.service > 3:
##     :   :...On.board.service <= 1: neutral or dissatisfied (8/1)
##     :       On.board.service > 1:
##     :       :...Ease.of.Online.booking <= 3: neutral or dissatisfied (10/3)
##     :           Ease.of.Online.booking > 3: satisfied (58/8)
##     Leg.room.service <= 3:
##     :...Baggage.handling <= 2:
##         :...Inflight.wifi.service > 2: satisfied (62/6)
##         :   Inflight.wifi.service <= 2:
##         :   :...Ease.of.Online.booking <= 2: satisfied (44/6)
##         :       Ease.of.Online.booking > 2:
##         :       :...Inflight.entertainment <= 3: neutral or dissatisfied (22/1)
##         :           Inflight.entertainment > 3: satisfied (2)
##         Baggage.handling > 2:
##         :...Inflight.wifi.service <= 2: satisfied (31)
##             Inflight.wifi.service > 2:
##             :...Ease.of.Online.booking > 2: satisfied (104/39)
##                 Ease.of.Online.booking <= 2:
##                 :...Inflight.service <= 1: satisfied (2)
##                     Inflight.service > 1: neutral or dissatisfied (25/2)
##
##
## Evaluation on training data (103904 cases):
##
##       Decision Tree
##     ----------------
##    Size      Errors
##
##     384 3485( 3.4%)   <<
##
##
##    (a)   (b)    <-classified as
##    ----  ----
```

27

```
##    57961    918    (a): class neutral or dissatisfied
##     2567 42458    (b): class satisfied
##
##
##  Attribute usage:
##
##  100.00% Inflight.wifi.service
##   91.89% Online.boarding
##   78.24% Type.of.Travel
##   74.27% Business
##   49.19% Customer.Type
##   46.30% Cleanliness
##   43.79% Checkin.service
##   41.03% Inflight.service
##   38.72% Baggage.handling
##   34.67% On.board.service
##   34.27% Seat.comfort
##   27.20% Food.and.drink
##   19.44% Inflight.entertainment
##   18.06% Ease.of.Online.booking
##    9.93% Age
##    4.26% Leg.room.service
##    1.54% Flight.Distance
##    0.13% EcoPlus
##
##
## Time: 1.1 secs
```

```r
C50_predict<-predict(C50_class, air_test, type="class")
table(actual=air_test[,17],C50=C50_predict)
```

Score the C5.0 Model

```
##                                C50
## actual                    neutral or dissatisfied satisfied
##   neutral or dissatisfied                    14250       323
##   satisfied                                    711     10692
```

```r
confusionMatrix(table(actual=air_test[,17],C50=C50_predict))
```

```
## Confusion Matrix and Statistics
##
##                                C50
## actual                    neutral or dissatisfied satisfied
##   neutral or dissatisfied                    14250       323
##   satisfied                                    711     10692
##
##               Accuracy : 0.9602
##                 95% CI : (0.9577, 0.9625)
##     No Information Rate : 0.576
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                  Kappa : 0.9189
##
```

```
##   Mcnemar's Test P-Value : < 2.2e-16
##
##               Sensitivity : 0.9525
##               Specificity : 0.9707
##            Pos Pred Value : 0.9778
##            Neg Pred Value : 0.9376
##                Prevalence : 0.5760
##            Detection Rate : 0.5486
##      Detection Prevalence : 0.5610
##         Balanced Accuracy : 0.9616
##
##          'Positive' Class : neutral or dissatisfied
##
```

TEST 5: Random Forest Algorithm

```r
set.seed(111)
library(randomForest)
```

Set seed, load Random Forest Library

```r
fit <- randomForest(satisfaction~., data=air_training, importance=TRUE, ntree=200)
importance(fit)
```

Create the Random Forest fit model, plot

```
##                       neutral or dissatisfied  satisfied MeanDecreaseAccuracy
## Customer.Type                       40.961298  68.119717            62.853934
## Age                                 39.455065  37.745932            51.307940
## Type.of.Travel                      43.127633 102.292455            69.122008
## Flight.Distance                     26.848592  29.042922            35.245370
## Inflight.wifi.service              106.320788  76.563683           114.274128
## Ease.of.Online.booking              25.703234  36.950507            34.734731
## Food.and.drink                      15.438617  21.994124            23.630514
## Online.boarding                     64.288241  49.564065            72.530357
## Seat.comfort                        61.077388  39.240628            78.223071
## Inflight.entertainment              33.410530  29.385578            40.829896
## On.board.service                    45.819305  22.174000            38.534257
## Leg.room.service                    35.479509  24.981382            34.206340
## Baggage.handling                    60.592617  28.266953            66.958854
## Checkin.service                     76.769001  37.383132            83.915757
## Inflight.service                    52.370050  15.971886            46.295757
## Cleanliness                         39.336927  29.851275            48.939913
## Business                            27.967650  30.176683            33.081388
## EcoPlus                             -5.086521   4.460288             3.303115
##                       MeanDecreaseGini
## Customer.Type              1891.06141
## Age                        1828.34371
## Type.of.Travel             4970.39125
## Flight.Distance            2048.78357
## Inflight.wifi.service      7835.22580
```

```
## Ease.of.Online.booking      2019.49248
## Food.and.drink               607.97110
## Online.boarding             9526.78696
## Seat.comfort                2357.51889
## Inflight.entertainment      2984.09289
## On.board.service            1624.79902
## Leg.room.service            1849.46507
## Baggage.handling            1235.01976
## Checkin.service             1309.48272
## Inflight.service            1246.78608
## Cleanliness                 1169.21021
## Business                    5523.66543
## EcoPlus                       99.70197
```

```
varImpPlot(fit)
```

fit
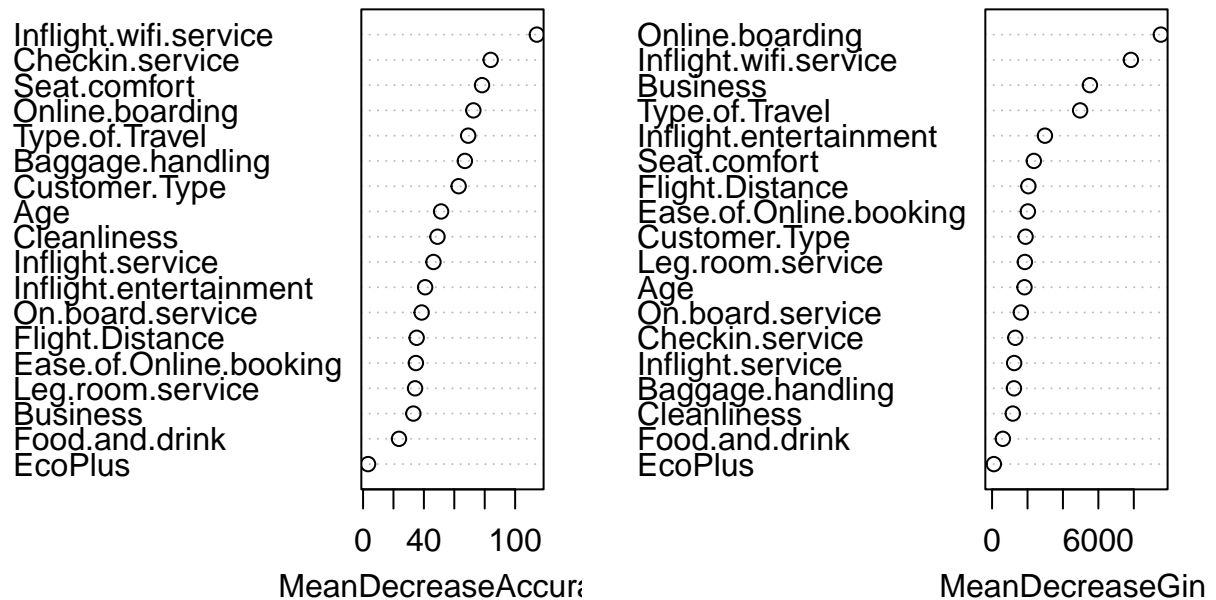

```
Prediction <- predict(fit, air_test)
```

```
confusionMatrix(table(actual=air_test[,17],Prediction)) #Accuracy results
```

Score the Random Forest

```
## Confusion Matrix and Statistics
##
##                               Prediction
## actual                        neutral or dissatisfied satisfied
```

```
##    neutral or dissatisfied                            14273        300
##    satisfied                                            672      10731
##
##                Accuracy : 0.9626
##                  95% CI : (0.9602, 0.9649)
##     No Information Rate : 0.5753
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.9238
##
##  Mcnemar's Test P-Value : < 2.2e-16
##
##             Sensitivity : 0.9550
##             Specificity : 0.9728
##          Pos Pred Value : 0.9794
##          Neg Pred Value : 0.9411
##              Prevalence : 0.5753
##          Detection Rate : 0.5495
##    Detection Prevalence : 0.5610
##       Balanced Accuracy : 0.9639
##
##        'Positive' Class : neutral or dissatisfied
##
```

TEST 6: SVM - Support Vector Machine

```
library(e1071)
svm.model <- svm( satisfaction~ ., data = air_training  )
svm.pred <- predict(svm.model,  air_test )
```

Load SVM package and grow tree

```
table(actual=air_test[,17],svm.pred )
```

Establish confusion matrix, accuracy

```
##                           svm.pred
## actual                 neutral or dissatisfied satisfied
##    neutral or dissatisfied                14127       446
##    satisfied                                723     10680
```
```
confusionMatrix(table(actual=air_test[,17],svm.pred))
```

```
## Confusion Matrix and Statistics
##
##                           svm.pred
## actual                 neutral or dissatisfied satisfied
##    neutral or dissatisfied                14127       446
##    satisfied                                723     10680
##
##                Accuracy : 0.955
##                  95% CI : (0.9524, 0.9575)
```

```
##      No Information Rate : 0.5717
##      P-Value [Acc > NIR] : < 2.2e-16
##
##                    Kappa : 0.9084
##
##  Mcnemar's Test P-Value : 6.894e-16
##
##              Sensitivity : 0.9513
##              Specificity : 0.9599
##           Pos Pred Value : 0.9694
##           Neg Pred Value : 0.9366
##               Prevalence : 0.5717
##           Detection Rate : 0.5438
##     Detection Prevalence : 0.5610
##         Balanced Accuracy : 0.9556
##
##          'Positive' Class : neutral or dissatisfied
##
```

```
SVM_wrong<- (air_test$satisfaction!=svm.pred)
rate<-sum(SVM_wrong)/length(SVM_wrong)
accuracy = 1-rate
accuracy
```

```
## [1] 0.9549969
```

```
print(svm.model)
```

Print

```
##
## Call:
## svm(formula = satisfaction ~ ., data = air_training)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##
## Number of Support Vectors:  15266
```