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SYMBIOSIS INSTITUTE OF TECHNOLOGY, PUNE

Symbiosis International (Deemed University)

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Founder: Prof. Dr. S. B. Mujumdar, M. Sc., Ph. D. (Awarded Padma Bhushan and Padma Shri by President of India)

Assignment No. 09

Subject:

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Branch	CS
Class	**A**
Academic Year & Semester	2023-24 _ 7th semester
Date	**9th October**
Title of Lab Assignment	**CLASSIFICATION MODEL**

Theory:

Classification Models:

- *Random Forest: An ensemble learning method which constructs a multitude of decision trees during training time and outputs the mode of the classes for classification.*
- *Decision Tree: A flowchart-like structure in which the internal node represents a feature(or attribute), the branch represents a decision rule, and each leaf node represents an outcome.*
- *Logistic Regression: A statistical method for analyzing datasets where the outcome is binary. It predicts the probability of one of the two outcomes.*

- *Mean, Mode, Median: Measures of central tendency.*
- *Confusion Matrix: A table layout that visualizes the performance of an algorithm.*
- *Recall: The ratio of correctly predicted positive observations to the actual positives.*
- *Precision: The ratio of correctly predicted positive observations to the predicted positives.*
- *Entropy: Measure of randomness or unpredictability in the dataset.*
- *R2 Score: Represents the proportion of the variance for the dependent variable that's explained by independent variables in a regression model.*
- *Mean Square Error (MSE): The average of the squares of the errors or deviations, i.e., the difference between estimator and what is estimated.*
- *Mean Absolute Error (MAE): Represents the average of the absolute difference between the observed actual outturns and the forecasted values.*

Answer:

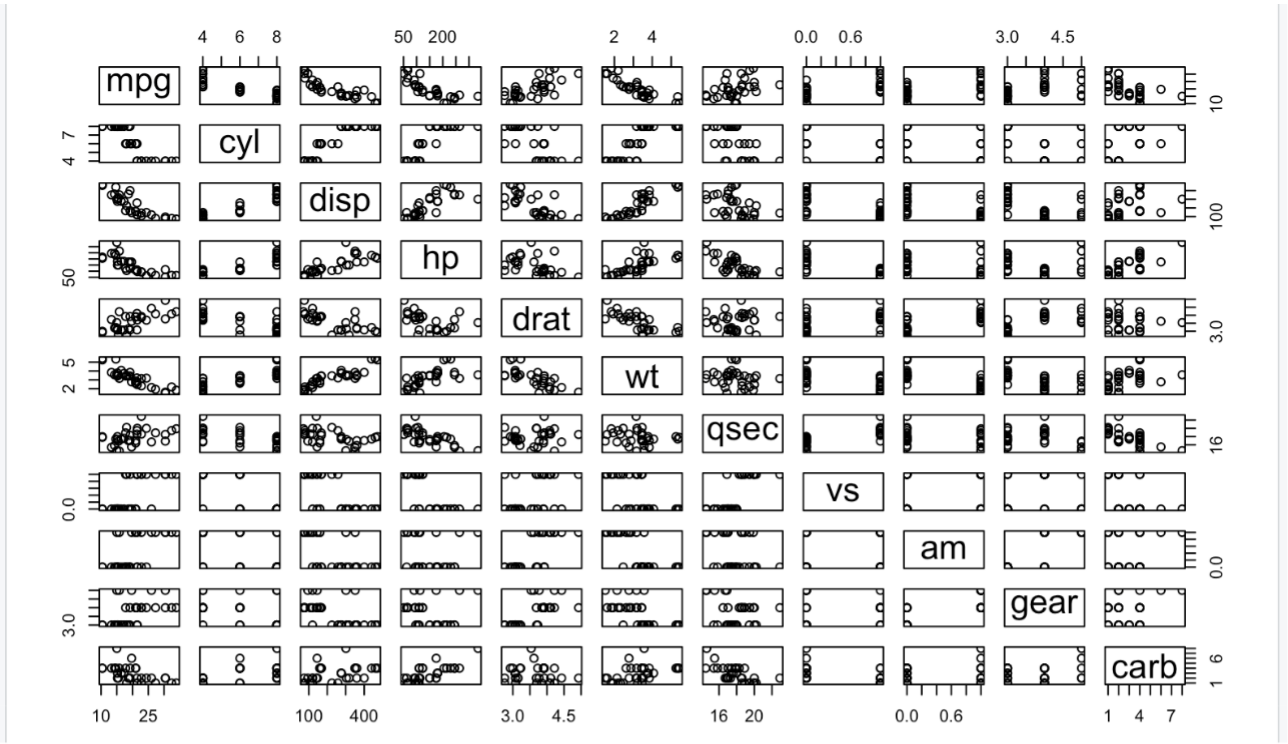
```
# Install and Load Necessary Libraries
install.packages(c("randomForest", "rpart", "caret", "e1071", "ggplot2"))

library(randomForest)
library(rpart)
library(caret)
library(e1071)
library(ggplot2)

# Load mtcars dataset
data(mtcars)

# EDA
summary(mtcars)
pairs(mtcars)
hist(mtcars$mpg)
boxplot(mtcars$mpg, main = "Boxplot of mpg")

# Let's take 'am' (automatic or manual transmission) as target variable
# Convert it to factor for classifcation
mtcars$am <- as.factor(mtcars$am)

# Splitting the dataset into training and test set
set.seed(123)
index <- sample(1:nrow(mtcars), nrow(mtcars)*0.7)
train <- mtcars[index,]
test <- mtcars[-index,]

# Classifcation using Random Forest
rf_model <- randomForest(am ~ ., data = train)
rf_pred <- predict(rf_model, test)

# Classifcation using Decision Tree
dt_model <- rpart(am ~ ., data = train, method = "class")
dt_pred <- predict(dt_model, test, type = "class")

# Classifcation using Logistic Regression
lr_model <- glm(am ~ ., data = train, family = binomial)
lr_pred_prob <- predict(lr_model, test, type = "response")
lr_pred <- ifelse(lr_pred_prob > 0.5, 1, 0)
lr_pred <- factor(lr_pred, levels = c(0,1))

# Metrics Calculation
metrics <- function(model_name, actual, predicted)
  { actual_numeric <-
  as.numeric(as.character(actual)) cat("\n",
  model_name, "\n") cat("----------------------------\n")

  # Confusion Matrix
  conf_matrix <- confusionMatrix(predicted, actual)
  print(conf_matrix$table)
```

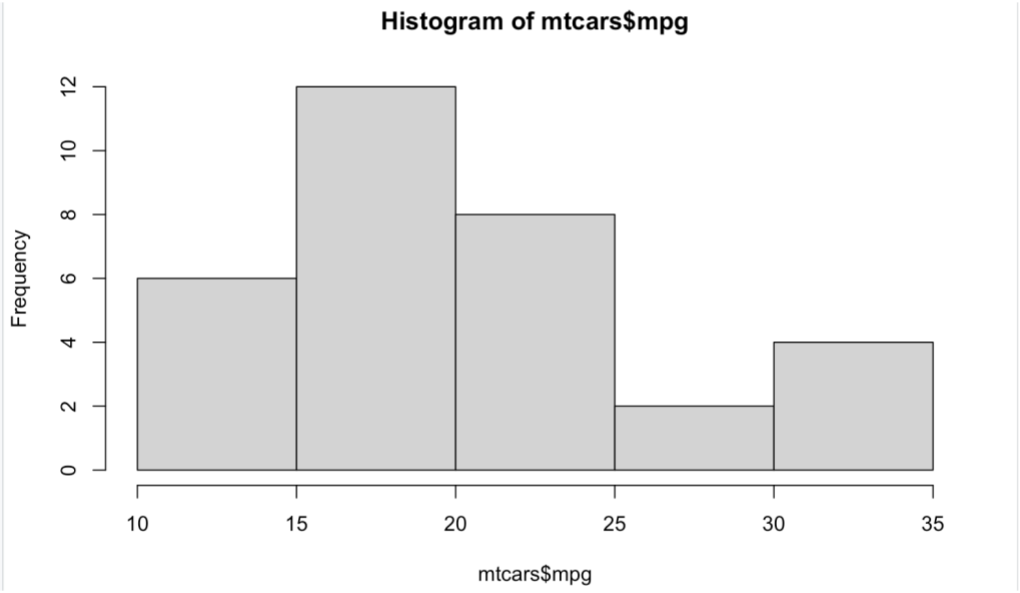
```
  # Basic Metrics
  cat("Mean:", mean(actual_numeric), "\n")
  cat("Median:", median(actual_numeric), "\n")
  cat("Mode:", as.numeric(names(which.max(table(actual)))), "\n")

  # Precision and Recall
  cat("Recall:", conf_matrix$byClass['Recall'], "\n")
  cat("Precision:", conf_matrix$byClass['Precision'], "\n")

  # Resampling Metrics
  resample_metrics <- postResample(predicted, actual)
  cat("R2 Score:", resample_metrics["Rsquared"], "\n")
  cat("Mean Absolute Error:", resample_metrics["MAE"], "\n")
  cat("Mean Square Error:", resample_metrics["RMSE"]^2, "\n")
}
metrics("Random Forest", test$am, rf_pred)
metrics("Decision Tree", test$am, dt_pred)
metrics("Logistic Regression", test$am, lr_pred)

# For entropy calculation
entropy <- function(data) {
  prob <- table(data) / length(data)
  -sum(prob * log2(prob))
}
cat("\nEntropy: ", entropy(test$am), "\n")
```

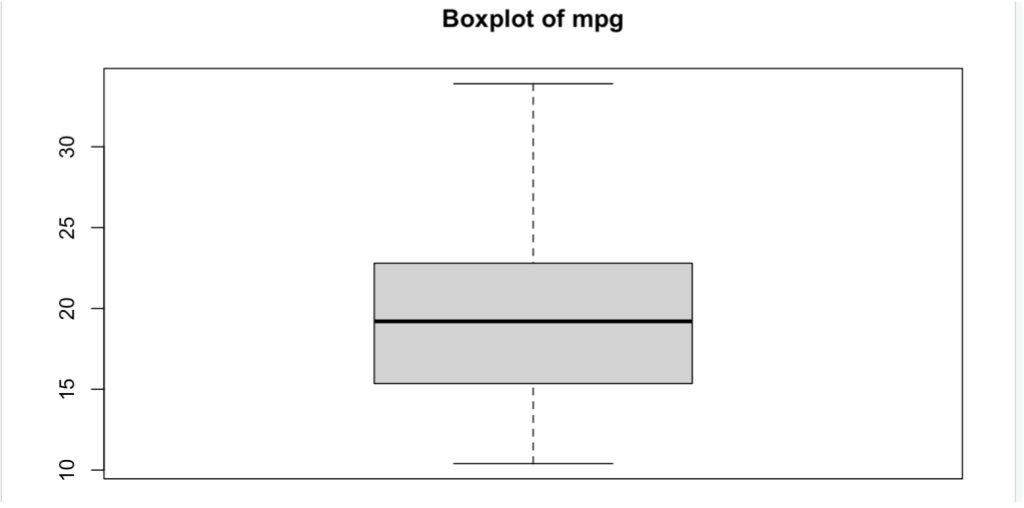
Output:

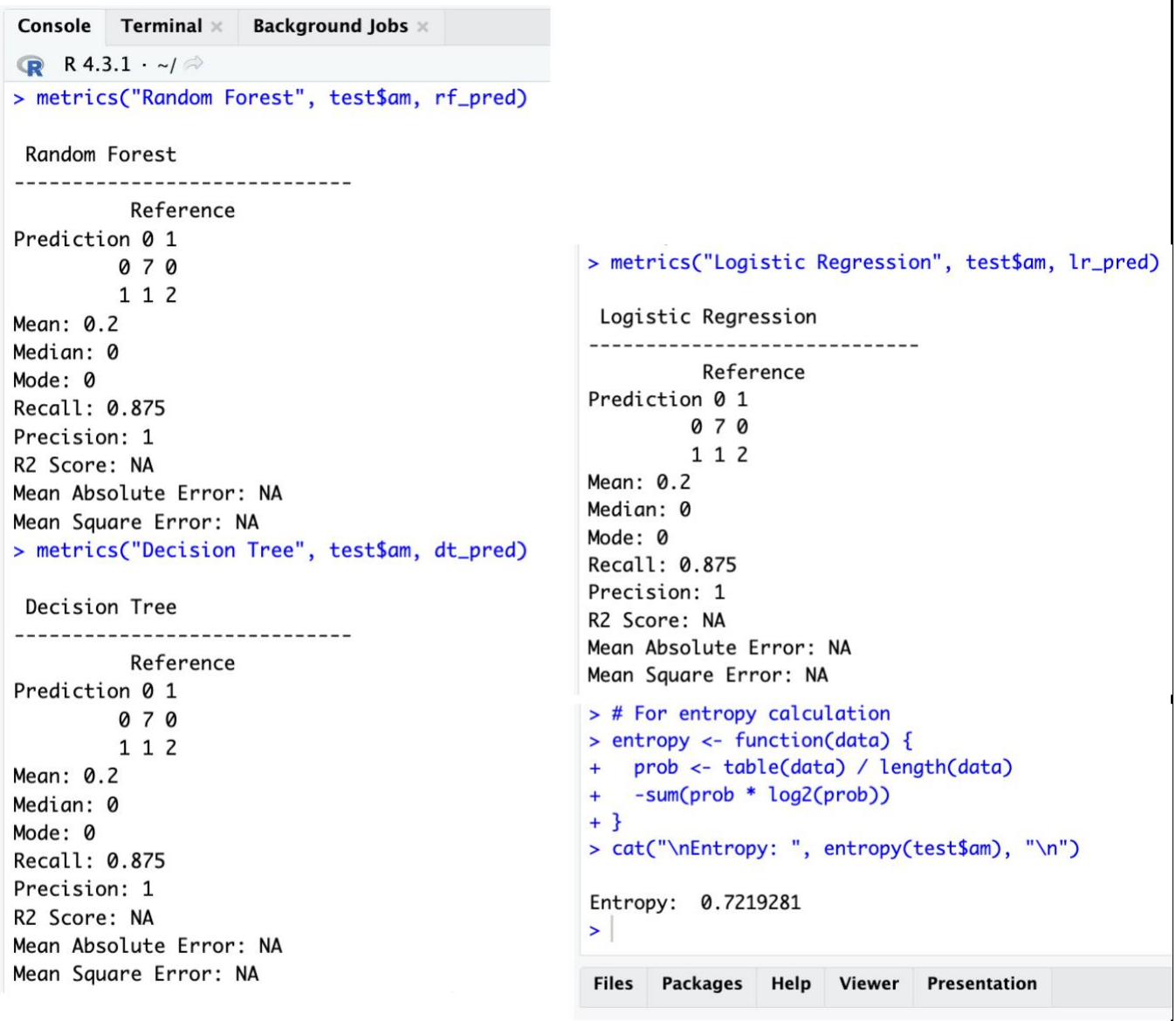
Answer:

```
> # EDA
> summary(mtcars)
      mpg             cyl             disp             hp             drat
 Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0   Min.   :2.760
 1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5   1st Qu.:3.080
 Median :19.20   Median :6.000   Median :196.3   Median :123.0   Median :3.695
 Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7   Mean   :3.597
 3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0   3rd Qu.:3.920
 Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0   Max.   :4.930
       wt             qsec             vs              am              gear
 Min.   :1.513   Min.   :14.50   Min.   :0.0000   Min.   :0.0000   Min.   :3.000
 1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:3.000
 Median :3.325   Median :17.71   Median :0.0000   Median :0.0000   Median :4.000
 Mean   :3.217   Mean   :17.85   Mean   :0.4375   Mean   :0.4062   Mean   :3.688
 3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000   3rd Qu.:1.0000   3rd Qu.:4.000
 Max.   :5.424   Max.   :22.90   Max.   :1.0000   Max.   :1.0000   Max.   :5.000
      carb
 Min.   :1.000
 1st Qu.:2.000
 Median :2.000
 Mean   :2.812
 3rd Qu.:4.000
 Max.   :8.000
> pairs(mtcars)
> hist(mtcars$mpg)
> boxplot(mtcars$mpg, main = "Boxplot of mpg")
```


mpg
cyl
disp
hp
drat
wt
qsec
vs
am
gear
carb


Histogram of mtcars$mpg
Frequency
mtcars$mpg


Boxplot of mpg



Conclusion: *In this lab assignment, students explored the mtcars dataset and practiced fundamental classification techniques. Through EDA, they understood the data's distributions and relationships. They then applied Random Forest, Decision Tree, and Logistic Regression models to classify whether a car had an automatic or manual transmission. Performance metrics were calculated for each model to evaluate and compare their effectiveness.*