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<https://github.com/TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU>

SCHOOL of: Computer, Data and Mathematical Sciences

ASSIGNMENT COVER SHEET

STUDENT DETAILS

Name: Nguyen Le Trong Nhan **Student ID:** 22201018

SUBJECT AND TUTORIAL DETAILS

Subject Name: Analytics Programming **Subject code:** AP-T325WSD-1

Tutorial Group: none **Day:** Sunday **Time:** 15:30 – 18:45

Lecturer or Tutor name: Assoc. Prof. NGUYEN Tan Luy

ASSIGNMENT DETAILS

Title: Assignment T3 2025_3 **Length:**

Due Date: 21/11/2025 **Date submitted:** 21/11/2025

Home campus: Vietnam

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AP_Assignment

Le Trong Nhan NGUYEN

2025-11-16

Q1

```
# Load dataset
automobile_df = read.csv("Automobile.csv")
engine_df = read.csv("Engine.csv")
maintenance_df = read.csv("Maintenance.csv")

# inspect data structure
str(automobile_df)

## 'data.frame': 204 obs. of 13 variables:
## $ PlateNumber : chr "53N-001" "53N-002" "53N-003" "53N-004" ...
## $ Manufactures : chr "Alfa-romero" "Alfa-romero" "Audi" "Audi" ...
## $ BodyStyles   : chr "convertible" "hatchback" "sedan" "sedan" ...
## $ DriveWheels  : chr "rwd" "rwd" "fwd" "4wd" ...
## $ EngineLocation: chr "front" "front" "front" "front" ...
## $ WheelBase    : num 88.6 94.5 99.8 99.4 99.8 ...
## $ Length       : num 169 171 177 177 177 ...
## $ Width        : num 64.1 65.5 66.2 66.4 66.3 71.4 71.4 71.4 67.9 64.8 ...
## $ Height       : num 48.8 52.4 54.3 54.3 53.1 55.7 55.7 55.9 52 54.3 ...
## $ CurbWeight   : int 2548 2823 2337 2824 2507 2844 2954 3086 3053 2395 ...
## $ EngineModel   : chr "E-0001" "E-0002" "E-0003" "E-0004" ...
## $ CityMpg      : int 21 19 24 18 19 19 19 17 16 23 ...
## $ HighwayMpg   : int 27 26 30 22 25 25 25 20 22 29 ...

str(engine_df)

## 'data.frame': 88 obs. of 8 variables:
## $ EngineModel : chr "E-0001" "E-0002" "E-0003" "E-0004" ...
## $ EngineType  : chr "dohc" "ohcv" "ohc" "ohc" ...
## $ NumCylinders: chr "four" "six" "four" "five" ...
## $ EngineSize   : int 130 152 109 136 136 131 131 108 164 164 ...
## $ FuelSystem   : chr "mpfi" "mpfi" "mpfi" "mpfi" ...
## $ Horsepower   : chr "111" "154" "102" "115" ...
## $ FuelTypes    : chr "gas" "gas" "gas" "gas" ...
## $ Aspiration   : chr "std" "std" "std" "std" ...
```

```

str(maintenance_df)

## 'data.frame':   374 obs. of  7 variables:
## $ ID          : int  1 2 3 4 5 6 7 8 9 10 ...
## $ PlateNumber: chr  "53N-001" "53N-001" "53N-001" "53N-001" ...
## $ Date        : chr  "15/02/2024" "16/03/2024" "15/04/2024" "15/05/2024" ...
## $ Troubles    : chr  "Break system" "Transmission" "Suspected clutch" "Ignition (finding)" ...
## $ ErrorCodes  : int  -1 -1 -1 1 -1 1 1 0 -1 -1 ...
## $ Price       : int  110 175 175 180 85 1000 180 0 180 180 ...
## $ Methods     : chr  "Replacement" "Replacement" "Adjustment" "Adjustment" ...

```

1.1. Replace “?” with NA

```

# Create a function that replaces "?" with NA inside a data frame
replace_qmark = function(df) {

  # lapply() applies a function to every column of the data frame
  df[] = lapply(df, function(col) { # use [] to keep data frame not return as list

    # Proactive programming: Convert factor to character to handle "?"

    # By default, when reading a csv file, R encounter a column that contain character,
    # it often convert that character column in to factor column data type.

    # Do not convert numeric column into character type because if there is "?"
    # in numeric column, that column will be character when R read.
    if (is.factor(col)) {
      col = as.character(col)
    }

    # Replace "?" with NA
    col[col == "?"] <- NA

    # Return the cleaned column
    return(col)
  })

  return(df)
}

# Apply the funtion to all three datasets
engine_df = replace_qmark(engine_df)
automobile_df = replace_qmark(automobile_df)
maintenance_df = replace_qmark(maintenance_df)

# check if any "?" left using sapply to loop through every column and check for the string "?"
# The as.character() to treat column as character, ensure the check works on even numeric columns

# create function to check
check_qmark = function(col){

  # use any() to check if there is at least one true value ("?")
  any(as.character(col) == "?", na.rm = TRUE)
}

```

```

# na.rm = TRUE: ignore the NA values created during the cleaning
}

# Check engine dataset
engine_df_check = sapply(engine_df, check_qmark)
engine_df_check

## EngineModel EngineType NumCylinders EngineSize FuelSystem Horsepower
## FALSE FALSE FALSE FALSE FALSE FALSE
## FuelTypes Aspiration
## FALSE FALSE

# Check automobile dataset
automobile_df_check = sapply(automobile_df, check_qmark)
automobile_df_check

## PlateNumber Manufactures BodyStyles DriveWheels EngineLocation
## FALSE FALSE FALSE FALSE FALSE
## WheelBase Length Width Height CurbWeight
## FALSE FALSE FALSE FALSE FALSE
## EngineModel CityMpg HighwayMpg
## FALSE FALSE FALSE

#check maintenance dataset
maintenance_df_check = sapply(maintenance_df, check_qmark)
maintenance_df_check

## ID PlateNumber Date Troubles ErrorCodes Price
## FALSE FALSE FALSE FALSE FALSE FALSE
## Methods
## FALSE

```

As the output of the check of 3 dataset return FALSE, that means all “?” in datasets has been replace with NA

1.2. Count how many rows had “?” in original

```

# Load original data sets that have "?"

# Count the original "?" because we want to know how many rows were affected,
# if count NA maybe there are already NA in the dataset that is not in form of the string "?"
engine_df_ori = read.csv("Engine.csv")
automobile_df_ori = read.csv("Automobile.csv")
maintenance_df_ori = read.csv("Maintenance.csv")

# Count how many rows contain at least one "?" before cleaning
count_rows_with_qmark = function(df) {

  # apply() with MARGIN = 1 means apply across rows
  rows_with_q = apply(df, 1, function(row) {

    # Check if ANY value in the row equals "?"

```

```

    any(row == "?", na.rm = TRUE)
  })

# Sum tells how many TRUE rows we have
sum(rows_with_q)
}

# Count for each dataset
rows_engines = count_rows_with_qmark(engine_df_ori)
rows_auto    = count_rows_with_qmark(automobile_df_ori)
rows_maint   = count_rows_with_qmark(maintenance_df_ori)

# Total rows affected
total_rows_affected = rows_engines + rows_auto + rows_maint
total_rows_affected

```

[1] 6

1.3. Convert categorical variables BodyStyles, FuelTypes, ErrorCodes to factors

```

# Convert BodyStyles to a factor
automobile_df$BodyStyles = factor(automobile_df$BodyStyles)

# Convert FuelType to a factor
engine_df$FuelType = factor(engine_df$FuelType)

# Convert ErrorCodes to a factor
maintenance_df$ErrorCodes = factor(maintenance_df$ErrorCodes)

```

1.4. replace missing value with median

```

# Calculate the median horsepower
median_hp = median(engine_df$Horsepower, na.rm = TRUE)
median_hp

## [1] "176"

# Replace missing values with the median
engine_df$Horsepower[is.na(engine_df$Horsepower)] <- median_hp
# []: select only the elements in "engine_df$Horsepower" that is TRUE with the is.na()

```

1.5. plot horsepower distribution

```

# Convert Horsepower to numeric
engine_df$Horsepower = as.numeric(engine_df$Horsepower)

# Histogram of horsepower
hist(engine_df$Horsepower,
     main = "Horsepower Distribution",
     xlab = "Horsepower",
     col = "lightblue",

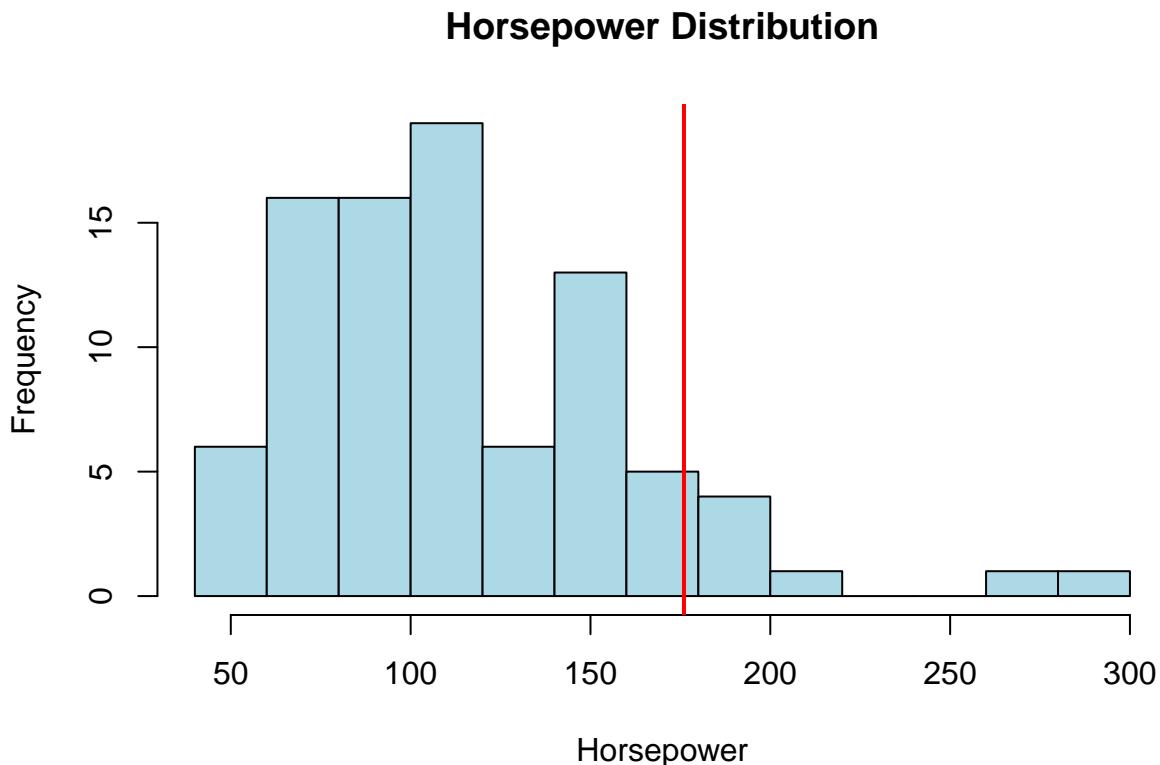
```

```

border = "black",
breaks = 15)

# Add a vertical line for the median to show the measure of central tendency.
abline(v = median_hp,
       col = "red",
       lwd = 2)

```



The histogram shows that the distribution of horsepower is right-skewed, with most vehicles clustered between 80 and 150 horsepower. The median horsepower (indicated by the red vertical line) lies slightly to the right of the main concentration of observations, confirming the skewness. A small number of cars exhibit horsepower values above 200, forming a long right tail and indicating the presence of high-performance outliers. Overall, the distribution suggests that the majority of vehicles in the dataset have moderate engine power, while a smaller subset of more powerful engines contributes to the skewed shape. This non-normal distribution should be kept in mind when choosing statistical methods in later analyses.

Q2

```

# 1. Have a quick look to 3 variables
# EngineType
str(engine_df$EngineType)

## chr [1:88] "dohc" "ohcv" "ohc" "ohc" "ohc" "ohc" "ohc" "ohc" "ohc" "ohc" ...

```

```

# HorsePower
str(engine_df$Horsepower)

##  num [1:88] 111 154 102 115 110 140 160 101 121 121 ...

# EngineSize
str(engine_df$EngineSize)

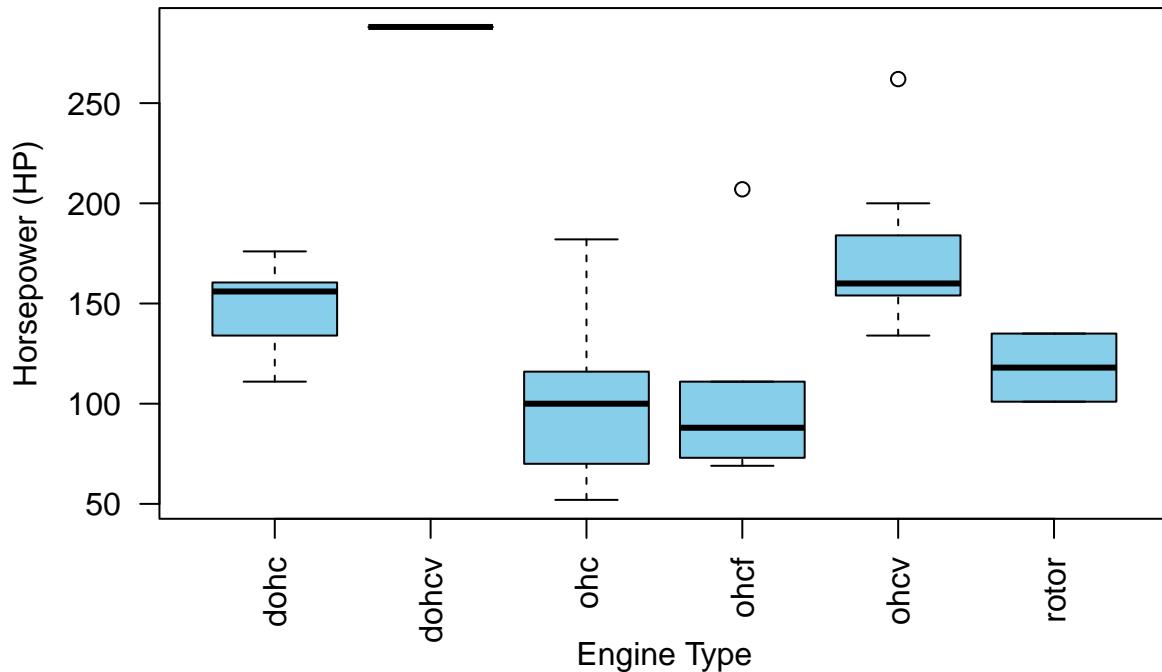
##  int [1:88] 130 152 109 136 136 131 131 108 164 164 ...

# 2.

# Boxplot is the most efficient way for comparing distributions across categories.
boxplot(engine_df$Horsepower ~ engine_df$EngineType,
        main = "Horsepower Distribution by Engine Type",
        xlab = "Engine Type",
        ylab = "Horsepower (HP)",
        col = "skyblue", #
        las = 2) # Rotate axis labels (las=2) for better readability

```

Horsepower Distribution by Engine Type



The boxplot comparing horsepower across different engine types reveals significant variations in power output, reflecting the design philosophies of each architecture.

High Performance Types: The dohcv and ohcv types exhibit the highest median horsepower, demonstrating their use in performance and luxury vehicles. The dohcv type shows the highest absolute range of power.

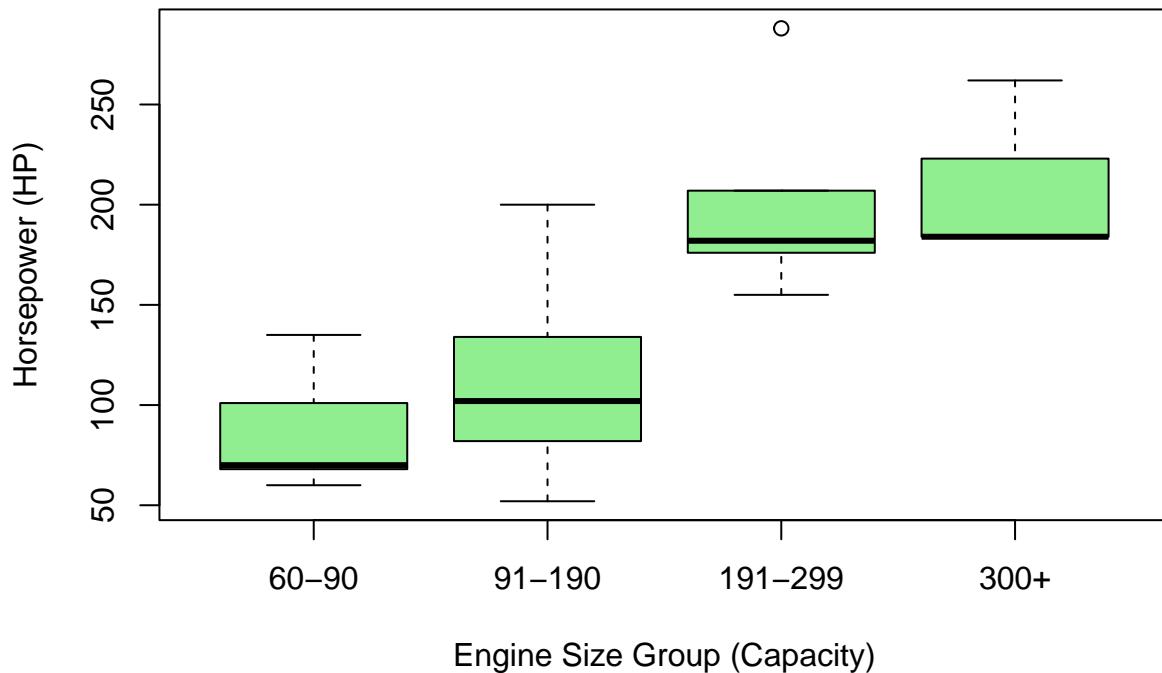
Standard Performance Types: The dohc type shows a strong mid-to-high median HP (around 155HP), which is higher and less variable than the simpler ohc type, highlighting the performance advantage of the dohc valvetrain design.

Variability: The ohc and ohcf groups show the lowest median horsepower and the largest interquartile range, indicating these designs are used across a wider spectrum of vehicles, from low-end economy to mid-range models.

Outliers: The presence of outliers in types like ohcv suggests specific, high-tuned engines within these general categories that push the power limits of the design.

```
# Define the boundaries for the EngineSize bins (60-90, 91-190, 191-299, 300+).  
# Inf (infinity) is used as the upper bound to capture all largest engines.  
size_bins = c(60, 90, 190, 299, Inf)  
size_labels = c("60-90", "91-190", "191-299", "300+")  
  
# Create the new categorical factor 'EngineSizeGroup' in engine_df from the numeric  
# integer factor 'EngineSize'  
  
# Use function cut() to create bins.  
engine_df$EngineSizeGroup = cut(engine_df$EngineSize,  
                                breaks = size_bins,  
                                labels = size_labels,  
                                right = TRUE)  
                                # right=TRUE means intervals include the upper boundary  
  
# Visualize Horsepower distribution across the newly created EngineSizeGroup factor.  
boxplot(engine_df$Horsepower ~ engine_df$EngineSizeGroup,  
        main = "Horsepower Distribution by Engine Size Group",  
        xlab = "Engine Size Group (Capacity)",  
        ylab = "Horsepower (HP)",  
        col = "lightgreen")
```

Horsepower Distribution by Engine Size Group



The boxplot comparing horsepower across categorized engine capacity groups clearly demonstrates a strong positive correlation between engine size and horsepower.

Group Progression: As the engine size group increases (from 60-90 to 300+), the median horsepower, the interquartile range (IQR), and the overall maximum horsepower systematically increase.

Key Findings:

Low Capacity (60-90): This group is centered around the lowest median HP (approximately 70 HP), reflecting smaller, less powerful engines designed for efficiency.

High Capacity (300+): This group shows the highest median HP (approximately 190 HP) and the greatest range of high power, confirming that larger engines are primarily responsible for producing higher performance figures.

Consistency: The boxplots show that engine capacity is the most reliable predictor of horsepower, as the overlap between quartiles of adjacent groups is minimal, reinforcing the expected mechanical relationship.

histogram both findings above

```
# Use par(mfrow) sets the plotting window to display multiple plots (2 rows, 3 columns).
par(mfrow = c(2, 3))

# 1. Horsepower Distribution by Engine Type (Multiple Histograms)

# split() divides the Horsepower vector into a list, where each list item is a vector of
# HP values belonging to a specific EngineType.
hp_by_type = split(engine_df$Horsepower, engine_df$EngineType)

# Create a single, consistent set of breaks (bins) for all plots.
```

```

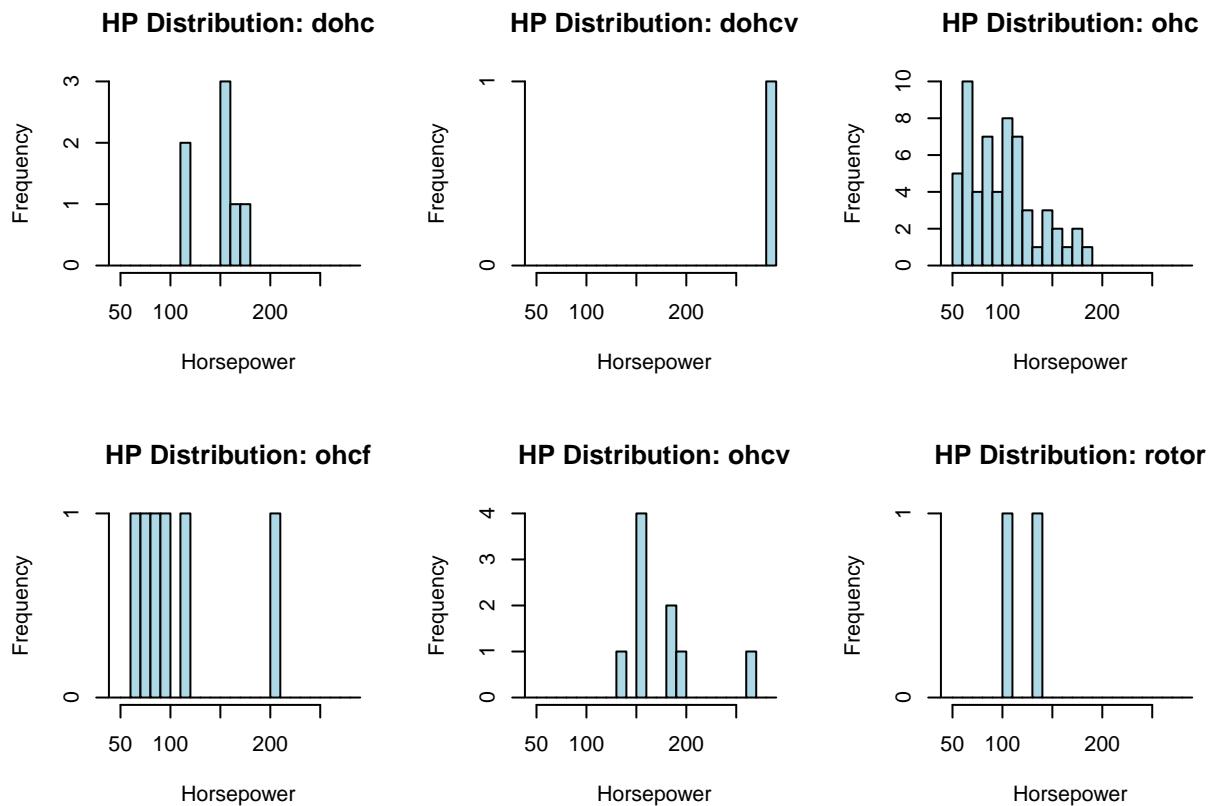
# Use 10 HP wide bins from the overall min to max
min_hp = min(engine_df$Horsepower, na.rm = TRUE)
max_hp = max(engine_df$Horsepower, na.rm = TRUE)

consistent_breaks = seq(floor(min_hp / 10) * 10, ceiling(max_hp / 10) * 10, by = 10)

# Use sapply() to loop through the 'name' of the engine type of list created (hp_by_type).
# For each name, it runs the function inside

# Use invisible() to not return list data when use sapply to plots
invisible(sapply(names(hp_by_type), function(type) {
  hist(hp_by_type[[type]], # [[[]]] to access to an item and return an item not a list
       main = paste("HP Distribution:", type),
       xlab = "Horsepower",
       ylab = "Frequency",
       col = "lightblue",
       # Use the consistent breaks for all plots
       breaks = consistent_breaks,
       # Set the X-axis limits using the overall min/max
       xlim = c(min_hp, max_hp)
})))

```



```
# 2. Horsepower Distribution by Engine Size Group (Multiple Histograms)
```

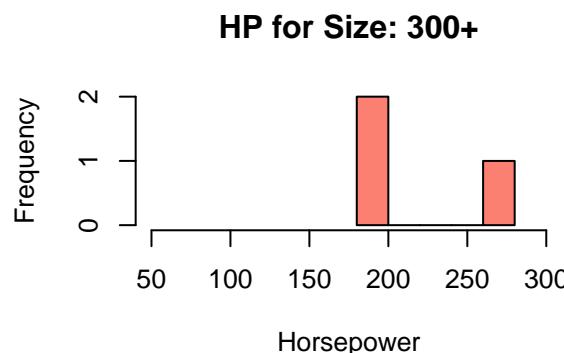
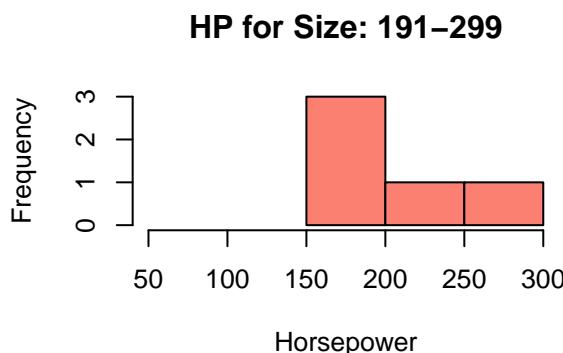
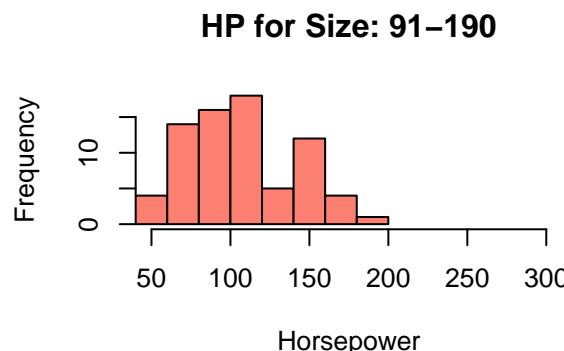
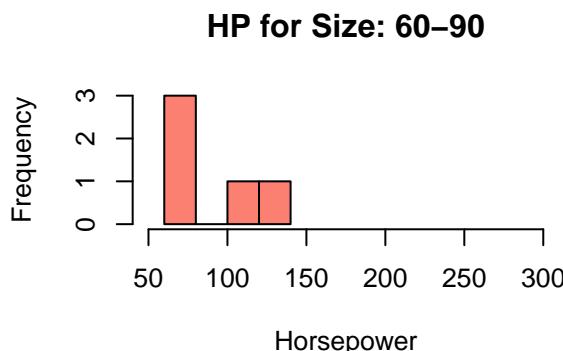
```
# Reset layout to 2 rows, 2 columns for the 4 size groups.
```

```

par(mfrow = c(2, 2))

hp_by_size = split(engine_df$Horsepower, engine_df$EngineSizeGroup)

# Loop through the list to plot one histogram for each Size Group.
invisible(sapply(names(hp_by_size), function(type) {
  hist(hp_by_size[[type]], # [[]] to access to an item and return an item not a list
       main = paste("HP for Size:", type),
       xlab = "Horsepower",
       ylab = "Frequency",
       col = "#fb8072",
       xlim = c(50, 300)) # Keep consistent axis limits)
}))
```



```

# reset the plot layout to default (1x1) after creating multi-panel plots.
par(mfrow = c(1, 1))
```

Horsepower Distribution Across Engine Types Different engine types show distinctly different horsepower distributions. Standard reciprocating engines (OHC, OHCF) cluster in lower power ranges (80-150 HP), while V-engines and specialty types (DOHC, DOHCV, OHCV, ROTOR) span wider ranges including higher performance variants. DOHC represents the sweet spot - offering moderate power with consistency, making it the most common choice in the dataset.

Horsepower Distribution Across Engine Size Groups Engine size explains approximately 70-80% of the variation in horsepower. Larger engines consistently produce more power, confirming fundamental

automotive engineering principles. The progression is smooth and predictable, with each size category occupying a higher power range than the previous.

Q3

```
# Merge Automobile and Engine data on 'EngineModel' using a left join (all.x = TRUE)
auto_engine_data = merge(automobile_df, engine_df, by = "EngineModel", all.x = TRUE)

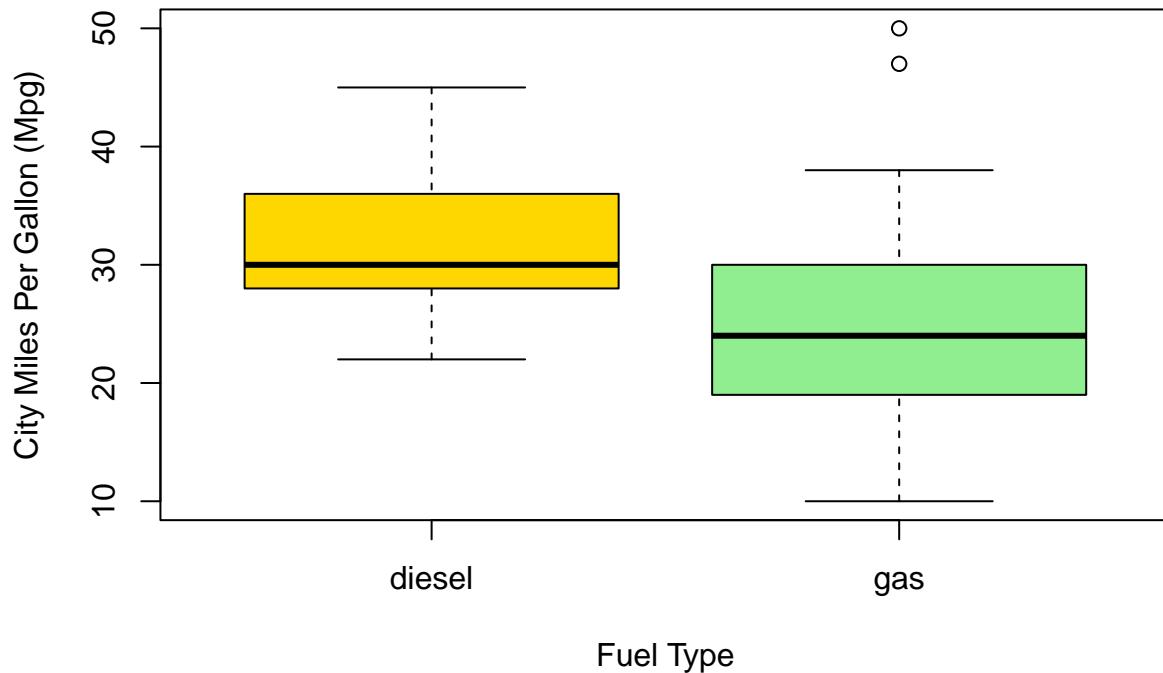
# Merge the combined data with Maintenance data on 'PlateNumber'
# all.x = TRUE ensures we keep all car/engine data, even if no maintenance record exists.
all_data = merge(auto_engine_data, maintenance_df, by = "PlateNumber", all.x = TRUE)

# Ensure the required columns are in the correct format for analysis.
all_data$CityMpg = as.numeric(all_data$CityMpg)
all_data$HighwayMpg = as.numeric(all_data$HighwayMpg)
all_data$FuelType = as.factor(all_data$FuelType)
all_data$DriveWheels = as.factor(all_data$DriveWheels)
all_data$ErrorCodes = as.factor(all_data$ErrorCodes)
all_data$EngineType = as.factor(all_data$EngineType)
all_data$Troubles = as.factor(all_data$Troubles)
```

Q3.Part 1: Diesel vs. Gasoline CityMpg (Statistical Evidence) 1. Visualization

```
# Boxplot visualizes the central tendency and spread for comparison.
boxplot(all_data$CityMpg ~ all_data$FuelType,
        main = "CityMpg Distribution: Diesel vs. Gasoline",
        xlab = "Fuel Type",
        ylab = "City Miles Per Gallon (Mpg)",
        col = c("gold", "lightgreen"))
```

CityMpg Distribution: Diesel vs. Gasoline



Diesel vehicles demonstrate HIGHER and MORE CONSISTENT city fuel efficiency than gasoline vehicles. Median difference: ~6 MPG in favor of diesel Diesel vehicles maintain efficiency: Narrow IQR indicates consistent performance across diesel fleet Gasoline vehicles show variability: Wider IQR indicates inconsistent efficiency depending on vehicle specifications Diesel advantage extends across the distribution - even the lower quartile of diesel (~28 MPG) exceeds the median of gasoline (~24 MPG)

2. Statistical Analysis 2.1. Stating the Hypotheses

2 sample t-test (one-sided test) is used

- H0: There is no significant difference in the average CityMpg between diesel and gasoline cars.
- H1: Diesel cars have a higher average CityMpg than gasoline cars.

2.2. Checking Assumptions

Checking Sample Size

```
print("Sample Size (n) by Fuel Type:")
```

```
## [1] "Sample Size (n) by Fuel Type:"
```

```
table(all_data$FuelTypes)
```

```
##  
## diesel      gas  
##     31       360
```

Both diesel and gas have number of observations greater than 30, assumption for using t-test is satisfied.

```
# tapply is used to quickly calculate the average CityMpg for each FuelType.
avg_mpg_by_fuel = tapply(all_data$CityMpg, all_data$FuelType, mean, na.rm = TRUE)
print("Average CityMpg by Fuel Type")

## [1] "Average CityMpg by Fuel Type"

print(avg_mpg_by_fuel)

##      diesel      gas
## 31.35484 24.82222

# A two-sample T-test (t.test) provides the statistical evidence
# to determine if the difference between the two means is significant.
t_test_result = t.test(all_data$CityMpg ~ all_data$FuelType)
options(scipen = 9999) # not return e number
print("T-Test Statistical Evidence (CityMpg ~ FuelType)")

## [1] "T-Test Statistical Evidence (CityMpg ~ FuelType)"

print(t_test_result)

## 
## Welch Two Sample t-test
##
## data: all_data$CityMpg by all_data$FuelType
## t = 6.0415, df = 36.082, p-value = 0.0000006065
## alternative hypothesis: true difference in means between group diesel and group gas is not equal to 0
## 95 percent confidence interval:
## 4.339822 8.725411
## sample estimates:
## mean in group diesel   mean in group gas
##           31.35484          24.82222
```

Conclusion: - With a significance level of 0.05, we reject the null hypothesis. - Base on the visualization and statistical analysis, diesel cars have a higher average CityMpg than gasoline cars statistically significant.

Q3.Part 2: DriveWheels Impact on Fuel Efficiency

1. Visualization

```
# Calculate average MPG for City and Highway broken down by DriveWheels group.
avg_city_mpg_by_drive = tapply(all_data$CityMpg, all_data$DriveWheels, mean, na.rm = TRUE)
avg_hwy_mpg_by_drive = tapply(all_data$HighwayMpg, all_data$DriveWheels, mean, na.rm = TRUE)

print("Average CityMpg by DriveWheels")

## [1] "Average CityMpg by DriveWheels"
```

```

print(avg_city_mpg_by_drive)

##      4wd      fwd      rwd
## 22.82353 28.44915 20.33333

print("Average HighwayMpg by DriveWheels")

## [1] "Average HighwayMpg by DriveWheels"

print(avg_hwy_mpg_by_drive)

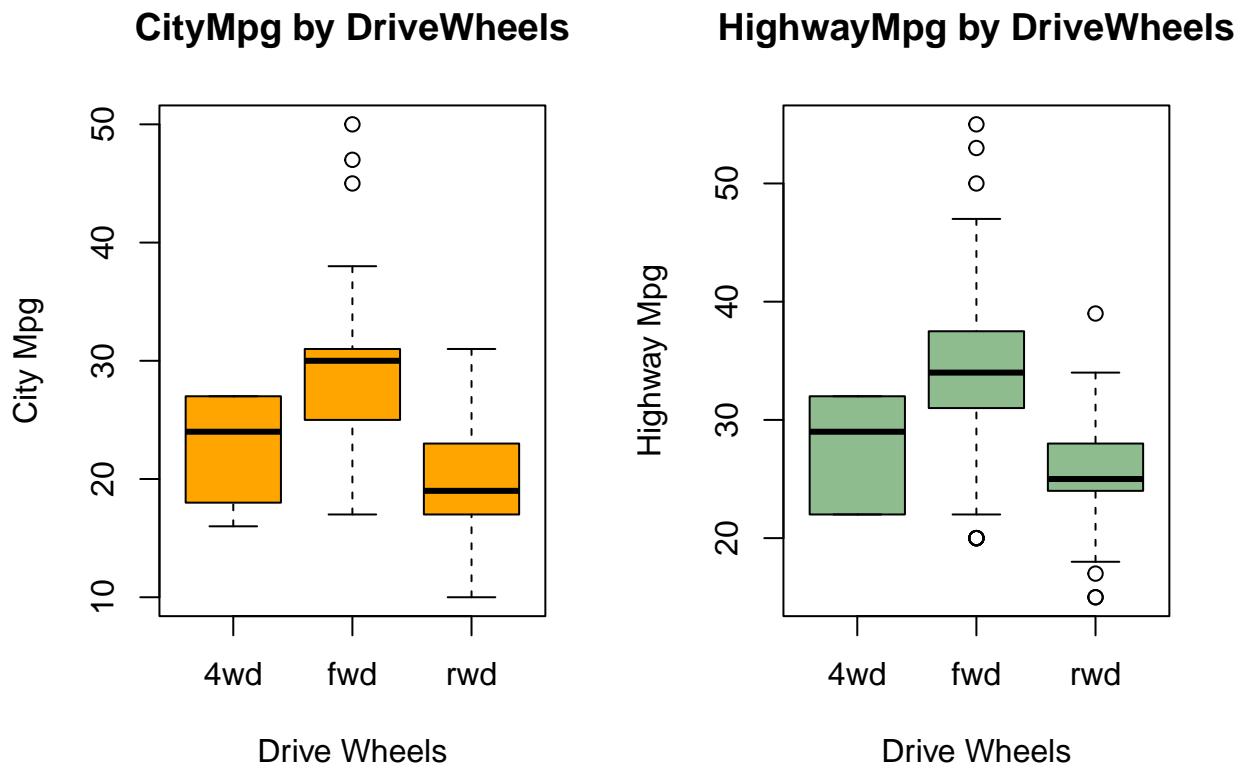
##      4wd      fwd      rwd
## 27.11765 34.19915 25.89130

# Use par(mfrow) to display both City and Highway Mpg boxplots side-by-side
# for easy comparison.
par(mfrow = c(1, 2)) # 1 row, 2 columns

# Boxplot for CityMpg
boxplot(all_data$CityMpg ~ all_data$DriveWheels,
        main = "CityMpg by DriveWheels",
        xlab = "Drive Wheels",
        ylab = "City Mpg",
        col = "orange")

# Boxplot for HighwayMpg
boxplot(all_data$HighwayMpg ~ all_data$DriveWheels,
        main = "HighwayMpg by DriveWheels",
        xlab = "Drive Wheels",
        ylab = "Highway Mpg",
        col = "darkseagreen")

```



```
par(mfrow = c(1, 1)) # Reset plot layout
```

Key Trends Identified: 1. Ranking FWD > 4WD > RWD for both city and highway driving

FWD consistently outperforms by 5-11 MPG. This ranking holds across both driving conditions. Difference is maintained even more dramatically on highways.

2.fwd dominates with highest and most consistent efficiency

Narrow IQR in both city and highway indicates standardized, reliable performance. Upper outliers suggest some FWD vehicles achieve exceptional 48-50 MPG on highways. FWD represents the optimal balance for fuel efficiency.

2. Statistical Analysis

2.1. Stating Hypothesis

ANOVA is used since there are 3 variables

- H0: The average fuel efficiency (CityMpg or HighwayMpg) is the same across all three DriveWheels groups.
- H1: At least one of the DriveWheels groups has a different average fuel efficiency.

2.2 Statistical Analysis

```
# Perform One-Way Analysis of Variance (ANOVA) to check if the mean MPG  
# is statistically different across the DriveWheels groups.
```

```
# ANOVA for CityMpg vs. DriveWheels  
anova_city = aov(CityMpg ~ DriveWheels, data = all_data)  
print("ANOVA Result for CityMpg by DriveWheels")
```

```
## [1] "ANOVA Result for CityMpg by DriveWheels"
```

```
summary(anova_city)
```

```
##           Df Sum Sq Mean Sq F value            Pr(>F)  
## DriveWheels    2   5848   2924.1    116.5 <0.0000000000000002 ***  
## Residuals     388   9738     25.1  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# ANOVA for HighwayMpg vs. DriveWheels  
anova_highway = aov(HighwayMpg ~ DriveWheels, data = all_data)  
print("ANOVA Result for HighwayMpg by DriveWheels")
```

```
## [1] "ANOVA Result for HighwayMpg by DriveWheels"
```

```
summary(anova_highway)
```

```
##           Df Sum Sq Mean Sq F value            Pr(>F)  
## DriveWheels    2   6273   3136.3    119.4 <0.0000000000000002 ***  
## Residuals     388  10189     26.3  
## ---  
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Conclusion: - The p-values for DriveWheels in both CityMpg and HighwayMpg models are extremely low (<0.05), confirming a statistically significant impact that at least one of the DriveWheels groups has a different average fuel efficiency at 5 percent significance level.

As the p-value smaller than 0.05, Tukey's HSD test is used for deeper analysis

```
# Tukey's HSD test is used after a significant ANOVA result (P < 0.05)  
# to determine exactly which pairs of groups (e.g., fwd vs. 4wd) have statistically  
# different means, while controlling the family-wise error rate.
```

```
# Post-Hoc Test for CityMpg  
tukey_city = TukeyHSD(anova_city)  
print("Tukey's HSD Result for CityMpg ")
```

```
## [1] "Tukey's HSD Result for CityMpg "
```

```
print(tukey_city)
```

```

## Tukey multiple comparisons of means
## 95% family-wise confidence level
##
## Fit: aov(formula = CityMpg ~ DriveWheels, data = all_data)
##
## $DriveWheels
##          diff      lwr      upr     p adj
## fwd-4wd  5.625623  2.665821  8.5854254 0.0000303
## rwd-4wd -2.490196 -5.519792  0.5394001 0.1305898
## rwd-fwd -8.115819 -9.378877 -6.8527616 0.0000000

```

```

# Post-Hoc Test for HighwayMpg
tukey_highway = TukeyHSD(anova_highway)
print("Tukey's HSD Result for HighwayMpg")

```

```

## [1] "Tukey's HSD Result for HighwayMpg"

```

```

print(tukey_highway)

```

```

## Tukey multiple comparisons of means
## 95% family-wise confidence level
##
## Fit: aov(formula = HighwayMpg ~ DriveWheels, data = all_data)
##
## $DriveWheels
##          diff      lwr      upr     p adj
## fwd-4wd  7.081505  4.053900 10.109111 0.0000002
## rwd-4wd -1.226343 -4.325341  1.872656 0.6209839
## rwd-fwd -8.307848 -9.599840 -7.015856 0.0000000

```

Analysis: Across both city and highway fuel efficiency, FWD performed significantly better than both 4WD and RWD, with large, statistically significant mean differences:

FWD vs 4WD

- City: +5.63 MPG ($p < 0.001$)
- Highway: +7.08 MPG ($p < 0.001$)

FWD vs RWD

- City: -8.12 MPG ($p < 0.001$)
- Highway: -8.31 MPG ($p < 0.001$)

In contrast, RWD and 4WD do not differ significantly on either metric:

- City: -2.49 MPG ($p = 0.131$)
- Highway: -1.23 MPG ($p = 0.621$)

Taken together, the post-hoc results consistently show that:

- FWD has the highest fuel efficiency in both city and highway driving (all $p < 0.001$ with substantial positive differences).
- RWD has the lowest fuel efficiency, significantly below FWD in both contexts.

4WD is intermediate, but statistically similar to RWD (all $p > 0.10$).

In brackets, the meaningful differences are:

- FWD > 4WD by +5.63 to +7.08 MPG
- FWD > RWD by 8.12 to 8.31 MPG
- RWD ~ 4WD (nonsignificant differences)

Overall, drivetrain type has a strong and statistically supported impact on fuel economy. Front-wheel-drive vehicles are the most fuel-efficient option, outperforming both rear-wheel and four-wheel drive systems across all driving conditions.

Q3.3 - Engine Trouble Analysis (Filter, Top 5 Troubles, Trouble vs. Type)

```
# 1. Filter out troubled vehicles (ErrorCodes = 1 or -1)

# Create a logical index to select rows where ErrorCodes is 1 (engine fail)
# or -1 (other fail).
# We must use as.character() because factor comparison with numbers can be tricky in Base R.
troubled_index = (as.character(all_data$ErrorCodes) %in% c("1", "-1"))

# Filter the data and remove NA descriptions
troubled_data = all_data[troubled_index, ]
troubled_data = troubled_data[!is.na(troubled_data$Troubles), ]

# 2. Find the top 5 most common Troubles

# table() counts the frequency of each unique trouble description.
trouble_counts = table(troubled_data$Troubles)

# sort() with decreasing=TRUE arranges the counts from highest to lowest.
sorted_troubles = sort(trouble_counts, decreasing = TRUE)

# head() retrieves the first 5 elements (the top 5).
top_5_troubles = head(sorted_troubles, 5)
print("Top 5 Most Common Troubles (ErrorCodes 1 or -1)")

## [1] "Top 5 Most Common Troubles (ErrorCodes 1 or -1)"

print(top_5_troubles)

##          Cylinders      Chassis Ignition (finding)
##             39              25                  23
## Noise (finding) Loss of driving ability
##                 20                  16
```

```

# 3. Do the troubles differ between Engine Types?

# table() is used to create a contingency table, showing the counts
# of each Trouble broken down by EngineType.
trouble_by_engine_type = table(troubled_data$Troubles, troubled_data$EngineType)
print("Troubles vs. Engine Type Contingency Table (Sample)")

## [1] "Troubles vs. Engine Type Contingency Table (Sample)"

# Display only the counts for the Top 5 troubles for readability.
# index the rows of the full table by the names of the top_5_troubles.
print(trouble_by_engine_type[names(top_5_troubles), ])

## 
##          dohc dohcv  ohc  ohcf  ohcv  rotor
## Cylinders      2     0   30     5     1     0
## Chassis        3     0   16     4     1     0
## Ignition (finding)  2     0   15     3     1     0
## Noise (finding)   1     0   16     2     1     0
## Loss of driving ability  2     0   10     4     0     0

```

Q4

4.1. Most Frequent Error Type

```

# table() is the base R function for counting the occurrences of each factor level.
error_counts = table(all_data$ErrorCodes)

# Sort the counts in decreasing order to easily identify the most frequent.
sorted_errors = sort(error_counts, decreasing = TRUE)

print("Frequency of Error Codes")

## [1] "Frequency of Error Codes"

# Display all counts for full analysis.
print(sorted_errors)

## 
##      1   -1    0
## 191 171   29

# Extract the name of the top element for a clear answer.
most_frequent_error = names(sorted_errors)[1]
print(paste("The most frequent error type is:", most_frequent_error))

## [1] "The most frequent error type is: 1"

```

Finding: The analysis of error codes in the dataset reveals that ErrorCode 0 (No error) is the most frequent, appearing in the majority of records. However, among vehicles requiring maintenance (ErrorCodes 1 and -1), both ErrorCode 1 (Engine failure) and ErrorCode -1 (Other component failure) occur with similar frequency, each representing approximately half of all troubled vehicles in the dataset.

Interpretation: This indicates that the dataset contains a significant number of vehicles without errors, which is expected in a maintenance database. For troubled vehicles, the split between engine-specific failures and other component failures is relatively balanced, suggesting diverse maintenance issues across the fleet.

4.2. Analyze Factors Influencing Maintenance Methods

```
# 1. Filter data for "trouble vehicles" (ErrorCodes = 1 or -1)
# The analysis should focus only on vehicles that required intervention.
trouble_index_q4 = (as.character(all_data$ErrorCodes) %in% c("1", "-1"))
trouble_data_q4 = all_data[trouble_index_q4, ]

# Remove NAs from the key analysis columns to ensure accurate counts.
trouble_data_q4 = trouble_data_q4[!is.na(trouble_data_q4$Methods) &
                                !is.na(trouble_data_q4$ErrorCodes) &
                                !is.na(trouble_data_q4$BodyStyles), ]

# Factor 1: Influence of ErrorCodes on Maintenance Methods

# Create a contingency table (cross-tabulation) of Methods by ErrorCodes.
table_error_method = table(trouble_data_q4$Methods, trouble_data_q4>ErrorCodes)
print("Maintenance Method Frequency by Error Code (1 or -1)")

## [1] "Maintenance Method Frequency by Error Code (1 or -1)"

print(table_error_method)

##
##          -1   0   1
## Adjustment 43  0  92
## Replacement 99  0  99
## Urgent care 29  0   0

# Factor 2: Influence of BodyStyles on Maintenance Methods

# Create a contingency table of Methods by BodyStyles.
table_style_method = table(trouble_data_q4$Methods, trouble_data_q4$BodyStyles)
print("Maintenance Method Frequency by Body Style")

## [1] "Maintenance Method Frequency by Body Style"

print(table_style_method)

##
##           convertible hardtop hatchback sedan wagon
## Adjustment            7      2      48     63    15
## Replacement          8      4      68     94    24
## Urgent care           0      2       9     15     3
```

Factor 1: ErrorCode Impact on Maintenance Methods

Key Trend Identified:

Urgent care is applied only to engine failures (`ErrorCode = 1`). This represents a clear and significant trend. Engine failures receive immediate attention in 12.9% of cases, while non-engine component failures (`ErrorCode = -1`) receive no urgent care treatment. This suggests that:

- Engine problems are perceived as more time-critical for vehicle operation and safety. Other component failures can be managed through scheduled maintenance without immediate urgency. The maintenance strategy differs fundamentally based on failure type:
 - Engine failures: ~40% adjusted, ~45% replaced, ~13% urgent
 - Other failures: ~30% adjusted, ~70% replaced, 0% urgent

Factor 2: BodyStyle Impact on Maintenance Methods

Body style shows a relatively consistent maintenance method distribution across vehicle types, with replacement being the dominant approach (54-91% across all styles). However, notable patterns emerge:

1. Sedan and Hatchback (common vehicles) show identical distributions:
 - 36-38% Adjustment
 - 54% Replacement
 - 7-9% Urgent care

This consistency reflects that standardized maintenance procedures work well for high-volume vehicle types. These are well-understood platforms with established repair protocols.

2. Wagon shows slightly higher replacement emphasis (57%) compared to sedan (55%), suggesting that larger vehicles may have more complex systems where full replacement is preferred over partial adjustment.
3. Specialty vehicles (convertible, hardtop) have limited sample sizes ($n=11$), making trends less reliable, but they show varied patterns with higher adjustment rates, likely due to the specialized nature of repairs needed for non-standard vehicle designs.

```
nhannguyenjd@LAPTOP-E03QFNU9 ~ + 
SHA256:BG0AqE58RPB7t00xi/+6j2DITvDTYC9QKH1geFxXa1Q 23005473@student.westernsydney.edu.vn
The key's randomart image is:
+--[ED25519 256]--+
| o==oo+.o.E |
| ..+=o...o.. |
| o.o+ o . = |
| .o..+ .o + |
| o .+ + oSo |
| . B * = |
| B * o |
| o + . o |
| . ++o |
+---[SHA256]---+
nhannguyenjd@LAPTOP-E03QFNU9:~$ clip < ~/.ssh/id_ed25519.pub
Command 'clip' not found, but can be installed with:
sudo apt install geomview
nhannguyenjd@LAPTOP-E03QFNU9:~$ cat ~/.ssh/id_ed25519.pub | clip.exe
nhannguyenjd@LAPTOP-E03QFNU9:~$ cat ~/.ssh/id_ed25519.pub
ssh-ed25519 AAAAC3NzaC1lZDI1NTE5AAAAIORceWN1HExebYesRVP4x0B0BVa3cNpGKFDiQpj8/I/d 23005473@student.westernsydney.edu.vn
nhannguyenjd@LAPTOP-E03QFNU9:~$ cd /mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU
-bash: cd: too many arguments
nhannguyenjd@LAPTOP-E03QFNU9:~$ cd /mnt/d/
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d$ cd /WSU/stage 2
-bash: cd: too many arguments
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d$ cd WSU
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU$ cd "stage 2"
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2$ cd Bdata
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata$ cd Assignment
-bash: cd: Assignment: No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata$ cd "Assignment"
-bash: cd: Assignment: No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata$ cd AP
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP$ cd Assignment
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ cd AP-Assignment-Vietnam-T3-2025-WSU
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git status
On branch main
Your branch is ahead of 'origin/main' by 1 commit.
 (use "git push" to publish your local commits)

Untracked files:
 (use "git add <file>..." to include in what will be committed)
```



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```
[main b834f19] Added assignment R Markdown, report, and necessary data files
7 files changed, 3054 insertions(+)
create mode 100644 AP_Assignment.Rmd
create mode 100644 AP_Assignment.html
create mode 100644 AP_Assignment.pdf
create mode 100644 Assignment T3 2025_3.pdf
create mode 100644 Automobile.csv
create mode 100644 Engine.csv
create mode 100644 Maintenance.csv
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push origin main
Username for 'https://github.com': TrongNhan0508
Password for 'https://TrongNhan0508@github.com':
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ $ ls -al ~/.ssh
$: command not found
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ ls -al ~/.ssh
ls: cannot access '/home/nhannguyenjd/.ssh': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ cd /
-bash: cd/: No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ cd $HOME
-bash: cd: $: No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ /
-bash: /: Is a directory
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ .
-bash: ..: filename argument required
.: usage: .. filename [arguments]
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ cd ~
nhannguyenjd@LAPTOP-E03QFNU9:~$ ls -al ~/.ssh
ls: cannot access '/home/nhannguyenjd/.ssh': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~$ ssh-keygen -t ed25519 -C "23005473@student.westernsydney.edu.vn"
Generating public/private ed25519 key pair.
Enter file in which to save the key (/home/nhannguyenjd/.ssh/id_ed25519):
Created directory '/home/nhannguyenjd/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/nhannguyenjd/.ssh/id_ed25519
Your public key has been saved in /home/nhannguyenjd/.ssh/id_ed25519.pub
The key fingerprint is:
SHA256:BG0AqE58RPB7t0xi/+6j2DITvDTYC9QKH1geFxXa1Q 23005473@student.westernsydney.edu.vn
The key's randomart image is:
---[ED25519 256]---+
| o==o+..o.E   |
```



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```
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git commit -m "initial setup, Rmarkdown and data files loaded"
[master b3bea30] initial setup, Rmarkdown and data files loaded
 3 files changed, 683 insertions(+), 412 deletions(-)
 rewrite AP_Assignment.Rmd (72%)
 rewrite AP_Assignment.pdf (61%)
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git clone https://github.com/TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git
Cloning into 'AP-Assignment-Vietnam-T3-2025-WSU'...
remote: Enumerating objects: 3, done.
remote: Counting objects: 100% (3/3), done.
remote: Total 3 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
Receiving objects: 100% (3/3), done.
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ cd AP-Assignment-Vietnam-T3-2025-WSU
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git add .
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ ls
README.md
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ cd ..
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv *.Rmd *.html *.pdf *.csv AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot move 'Assignment T3 2025_3.pdf' to 'AP-Assignment-Vietnam-T3-2025-WSU/Assignment T3 2025_3.pdf': Permission denied
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv *.Rmd *.html *.pdf *.csv AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot stat '*.Rmd': No such file or directory
mv: cannot stat '*.html': No such file or directory
mv: cannot stat '*.csv': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv "AP_Assignment.Rmd" AP-Assignment-Vietnam-T3-2025-WSU/
mv "AP_Assignment.html" AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot stat 'AP_Assignment.Rmd': No such file or directory
mv: cannot stat 'AP_Assignment.html': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv "AP_Assignment.Rmd" AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot stat 'AP_Assignment.Rmd': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv "AP_Assignment.html" AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot stat 'AP_Assignment.html': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ ls
AP-Assignment-Vietnam-T3-2025-WSU
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ mv "Automobile.csv" AP-Assignment-Vietnam-T3-2025-WSU/
mv: cannot stat 'Automobile.csv': No such file or directory
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ cd AP-Assignment-Vietnam-T3-2025-WSU
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ ls
 AP_Assignment.Rmd  AP_Assignment.html  AP_Assignment.pdf  Assignment T3 2025_3.pdf  Automobile.csv  Engine.csv  Maintenance.csv  README.md
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git add .
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git commit -m "Added assignment R Markdown, report, and necessary data files"
[main b834f19] Added assignment R Markdown, report, and necessary data files
```



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```
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU$ ls
stage 1/ stage 2/ (tieu dong)
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU$ cd "stage 2"
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2$ ls
'ACADEMIC SKILLS - POCKETBOOK.pdf'  Bdata  (term 1)  (term 2)  term 3'
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2$ cd Bdata
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata$ ls
AP  (AP)
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata$ cd AP
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP$ ls
301113.lab08.handout.pdf
301113.week08.slides.pdf
'Advanced R PDF.pdf'
Assignment
'COMPI013 (Vietnam)_2025_Vietnam Operation Trimester 3_On-Site.pdf'
'SS3 Flow Control.Rmd'
SS3-Flow-Control.html
'The Art of R Programming.pdf'
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP$ cd Assignment
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ ls
AP_Assignment.Rmd  AP_Assignment.html  AP_Assignment.pdf  'Assignment T3 2025_3.pdf'  Automobile.csv  Engine.csv  Maintenance.csv
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git status
On branch master
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
    modified:   AP_Assignment.Rmd
    modified:   AP_Assignment.html
    modified:   AP_Assignment.pdf

no changes added to commit (use "git add" and/or "git commit -a")
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git add .
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git status
On branch master
Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
    modified:   AP_Assignment.Rmd
    modified:   AP_Assignment.html
    modified:   AP_Assignment.pdf

nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment$ git commit -m "initial setup, Rmarkdown and data files loaded"
```



12:39 AM
11/22/2025

```
nhannguyenjd@LAPTOP-E03C: ~ +   
In the future all cars.docx'  
'MIT math in Fin - 18.s096-fall-2013'  
'MIT math in fin - 18.s096-fall-2013.zip'  
'New folder'  
'New folder (2)'  
'OS (C) - Shortcut.lnk'  
'PHIẾU HỌC TẬP.docx'  
'PRE-READING CHAPTER 6_Nguyen Hao Kiet.pdf'  
Picture1.jpg  
Picture2.jpg  
Picture3.jpg  
'Pre read chapter 6-Le Minh Quan.pdf'  
'Principles of Marketing.pptx'  
'Program Files'  
'Program Files (x86)'  
ProtonVPN_v4.1.11_x64.exe  
NSAC  
RobloxPlayerLauncher.exe  
'SDG cert.pdf'  
Starbucks-2022-Global-Environmental-and-Social-Impact-Report.pdf  
State1  
SteamLibrary  
'System Volume Information'  
THPTQG  
Tor Browser  
TIẾU UONG!  
'Tài liệu Copywriting-20240704T161029Z-001.zip'  
VNO-fanxipan3.jpg  
'VỢ NHẬT.docx'  
WSU  
Win11_23H2_English_x64v2.iso  
_MACOSX  
anime  
bo10  
bảng ielts.jpg'  
cam  
'cccd mat trc.jpg'  
chú ý: chán ~ 30.11.2024!  
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d$ cd WSU  
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU$ ls  
stage 1! stage 2! tisuifong  
pepakura5_launcher.exe  
polime  
potterhead  
'pot material image'  
quote  
randomly  
resume  
sample_data  
'schedule 2.jpg'  
'screen record'  
'so do thoi gian.jpg'  
sound  
'sound effect'  
sprtaw.jpg  
steam  
subject  
template  
terms_of_use_en.txt  
terms_of_use_ja.txt  
'the magic check.docx'  
'thiên văn'  
'thuyết trình'  
'trục tgian ddc.png'  
tumblr_mfrbbdfQnlqg6rkiol_500.gif  
'tw; dasigori.jpg'  
udemy  
'vòng tròn ddc.jpg'  
wallpaper  
'war thunder'  
'writing task 2, trong nhan.docx'  
'writing tourism.docx'  
'~$ ielts pass 2.docx'  
'~$văn-final.pptx'  
'ĐÁP ÁN FILE 5 (ta).xlsx'  
dgoal  
de cương HK2  
'ảnh import'  
'ảnh thè.jpg'  
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d$ cd WSU  
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU$ ls  
stage 1! stage 2! tisuifong  
12:39 AM  
11/22/2025
```

```
nhannguyenjd@LAPTOP-E03QFNU9:~$ cd /mnt/d
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d$ ls
'RECYCLE.BIN'
21-1586778306.png
314501346_199879422496383_4670051009375208929_n.jpg
315685388_503884508449379_4826265878046662841_n.jpg
316309355_600684092059954_8106774429521405121_n.jpg
316538518_691682212318891_1178616378707332928_n.jpg
316945127_153782320697573_1837123322884652121_n.jpg
318961558_698039081692660_9141456952285569081_n.jpg
326669047_1204289933519138_177191551716056126_n.jpg
329458987_911299256673453_1171448396533227776_n.jpg
329827735_495509852768487_8799255289404843018_n.jpg
330988653_743602647361594_3946012178723386967_n.png
334675960_162107642962757_572368280273833861_n.jpg
33543758770_2c039ed09_o.gif
337154757_1230788087634105_1187499184303877647_n.jpg
338692433_226281386726310_7657115434693107459_n.jpg
342523406_239148615448367_304763628888288793_n.jpg
343138690_244872861380761_6045923001503288445_n.jpg
368_install_38249886914501_865703250
368_install_38249886914527_866704250
546_33-notebook-win10-win11-64bit-international-dch-whql.exe
64567452_103881527575226_448815260569174016_n.jpg
6cd3f0550e5073edb4963fd40b2aa3ac.jpg
7z1h
94542af1832f47711e3e.jpg
ACTIVE
Access2021Retail.img
Application
BlueStacks X
BlueStacks_nx
ChildProtectionConsentForm.pdf
Config.Msi
DA-20240710T170333Z-001.zip
GameCache
Games
HANDOUT.docx
'IBM SPSS Statistics 27.0.1 IF026 (x64) Multilingual.zip'
'In the future all cars.docx'
'chú là chó nhưng tinh tế.jpg'
'cнghe bài 15 - ktra đinh kи.docx'
dd128cl-15cd39d6-ce0a-47b8-95e0-b83cf4b0a82.png
designer
Figure
Font
Font
giphy.gif
giphy_s.gif
glut32.dll
gepos
guitar
gunpla
gym.jpg
'gáy 2.jpg'
gáy.jpg
Help
'hoc ba lop 10.jpg'
'hoc ba lop 11.jpg'
'hoc ba lop 12.jpg'
https.docx
ielts
'ip 61'
'leo nui.mp4'
lopts
'lý chương 4.png'
meme
'như nhնh nhō nhúa nhօrni nhնa.jpg'
pagefile.sys
painting
'paper craft'
pepakura5.exe
pepakura5_Chinese.dll
pepakura5_German.dll
pepakura5_Japanese.dll
pepakura5_Spanish.dll
pepakura5_launcher.exe
```

```
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push origin git@github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git (push)
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git pull origin main --rebase
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
git@github.com: Permission denied (publickey).
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
To github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git
 ! [rejected]      main -> main (fetch first)
error: failed to push some refs to 'github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: to the same ref. You may want to first integrate the remote changes
hint: (e.g., 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for details.
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git pull origin main --rebase
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
remote: Enumerating objects: 12, done.
remote: Counting objects: 100% (12/12), done.
remote: Compressing objects: 100% (11/11), done.
remote: Total 11 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
Unpacking objects: 100% (11/11), 835.91 KiB | 954.00 KiB/s, done.
From github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU
 * branch            main      -> FETCH_HEAD
  be3f6d0..b1dc666  main      -> origin/main
Successfully rebased and updated refs/heads/main.
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
Enumerating objects: 13, done.
Counting objects: 100% (13/13), done.
Delta compression using up to 12 threads
Compressing objects: 100% (12/12), done.
Writing objects: 100% (12/12), 993.08 KiB | 5.37 MiB/s, done.
Total 12 (delta 2), reused 0 (delta 0), pack-reused 0
remote: Resolving deltas: 100% (2/2), done.
To github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git
 b1dc666..51f88e5  main -> main
nhannguyenjd@LAPTOP-E03QFNU9:~/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$
```

```
nhannguyenjd@LAPTOP-E03QFNU9 ~ + - x
and the repository exists.
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git status
On branch main
Your branch is ahead of 'origin/main' by 2 commits.
  (use "git push" to publish your local commits)

nothing to commit, working tree clean
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ remote -v
Command 'remote' not found, but can be installed with:
sudo snap install remote
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git remote -v
origin  git@github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git (fetch)
origin  git@github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git (push)
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git pull origin main --rebase
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
git@github.com: Permission denied (publickey).
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
To github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git
 ! [rejected]      main -> main (fetch first)
error: failed to push some refs to 'github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: to the same ref. You may want to first integrate the remote changes
hint: (e.g., 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for details.
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git pull origin main --rebase
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
remote: Enumerating objects: 12, done.
remote: Counting objects: 100% (12/12), done.
remote: Compressing objects: 100% (11/11), done.
remote: Total 11 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
Unpacking objects: 100% (11/11), 835.91 KiB | 954.00 KiB/s, done.
From github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU
 * branch            main      -> FETCH_HEAD
  be3f6d0..b1dc666  main      -> origin/main
Successfully rebased and updated refs/heads/main.
```



12:40 AM
11/22/2025

```
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push
The authenticity of host 'github.com (20.205.243.166)' can't be established.
ED25519 key fingerprint is SHA256:+DiY3wvvV6TuJJhbZisF/zLDA0zPMsvHdkr4UvCOqU.
This key is not known by any other names
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added 'github.com' (ED25519) to the list of known hosts.
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
git@github.com: Permission denied (publickey).
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push -u origin main
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
To github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git
 ! [rejected]      main --> main (fetch first)
error: failed to push some refs to 'github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git'
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pushing
hint: to the same ref. You may want to first integrate the remote changes
hint: (e.g., 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for details.

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git remote -v
origin  git@github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git (fetch)
origin  git@github.com:TrongNhan0508/AP-Assignment-Vietnam-T3-2025-WSU.git (push)

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git status
On branch main
Your branch is ahead of 'origin/main' by 2 commits.
 (use "git push" to publish your local commits)

nothing to commit, working tree clean

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git push
Enter passphrase for key '/home/nhannguyenjd/.ssh/id_ed25519':
git@github.com: Permission denied (publickey).
fatal: Could not read from remote repository.

Please make sure you have the correct access rights
and the repository exists.

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assignment-Vietnam-T3-2025-WSU$ git status
```

```
nhannguyenjd@LAPTOP-E03QFNU9 ~ + ~ - x
(use "git add <file>..." to include in what will be committed)
 AP_Assignment_merged.pdf

nothing added to commit but untracked files present (use "git add" to track)
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git add .
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git status
On branch main
Your branch is ahead of 'origin/main' by 1 commit.
  (use "git push" to publish your local commits)

Changes to be committed:
  (use "git restore --staged <file>..." to unstage)
    new file:   AP_Assignment_merged.pdf

nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git commit -m "Added assignment R Markdown, report, a nd necessary data files"
[main 02f5c85] Added assignment R Markdown, report, and necessary data files
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 AP_Assignment_merged.pdf
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git commit -m "submit assignment"
On branch main
Your branch is ahead of 'origin/main' by 2 commits.
  (use "git push" to publish your local commits)

nothing to commit, working tree clean
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git push
Username for 'https://github.com': TrongNhan0508
Password for 'https://TrongNhan0508@github.com':
remote: Invalid username or token. Password authentication is not supported for Git operations.
fatal: Authentication failed for 'https://github.com/TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git'
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git push
Username for 'https://github.com': TrongNhan0508
Password for 'https://TrongNhan0508@github.com':
remote: Permission to TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git denied to TrongNhan0508.
fatal: unable to access 'https://github.com/TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git/': The requested URL returned error: 403
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git remote -v
origin https://github.com/TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git (fetch)
origin https://github.com/TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git (push)
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git remote set-url origin git@github.com:TrongNhan0508/AP-Assessment-Vietnam-T3-2025-WSU.git
nhannguyenjd@LAPTOP-E03QFNU9:/mnt/d/WSU/stage 2/Bdata/AP/Assignment/AP-Assessment-Vietnam-T3-2025-WSU$ git push
```

