

## Introduction

This report analyzes a dataset containing user ID, company name, and mileage data for 40 users, with 10 users each for four different tire brands. The dataset1 is a one-way between-group design, which means that there is only one independent variable (company name) and multiple groups. The dataset2 would be a within-subject design, meaning that each user tested all four tires. In this report, we will perform ANOVA and pairwise t-tests to analyze the data and gain insights into the differences between tire brands in terms of mileage.

## Method

For both Q1 and Q2, we analyzed the differences in mileage between different tire brands using statistical methods in R. We performed ANOVA tests with mileage as the dependent variable and company name as the independent variable. And then we used the `pairwise.t.test()` function to perform pairwise t-tests between each pair of tire brands, with no adjustment for multiple comparisons. We passed the mileage and company columns of dataset1 and dataset2 to the function as arguments. To visualize the distribution of the data, we used box plots with the mean and standard deviation represented as points and error bars, respectively. The ggplot2 package was used for creating the box plots and adding points and error bars, the red point stands for the mean value, and the red line stands for the standard deviation.

## Result

Q1:

According to the table1, the tire company factor has a significant effect on mileage (F value = 16.09,  $p < 0.001$ ), indicating that at least one pair of tire companies has significantly different mileage.

```
> summary(dataset1_anova)
              Df Sum Sq Mean Sq F value    Pr(>F)    
Company         3   428.6   142.87    16.09 8.47e-07 ***
Residuals      36   319.7     8.88                 
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

**Table1, ANOVA table for the dataset1**

According to the table2, According to the results, there are significant differences in mileage between Michelin and each of the other three tire brands, with very small p-values (all less than 0.001). There were no significant differences in mileage between Bridgestone and Pirelli, or between Goodyear and Pirelli, with p-values of 0.11 and 0.39. However, the p-value for the comparison between Bridgestone and Goodyear was higher at 0.44, indicating no significant difference in mileage between these two brands.

Pairwise comparisons using t tests with pooled SD

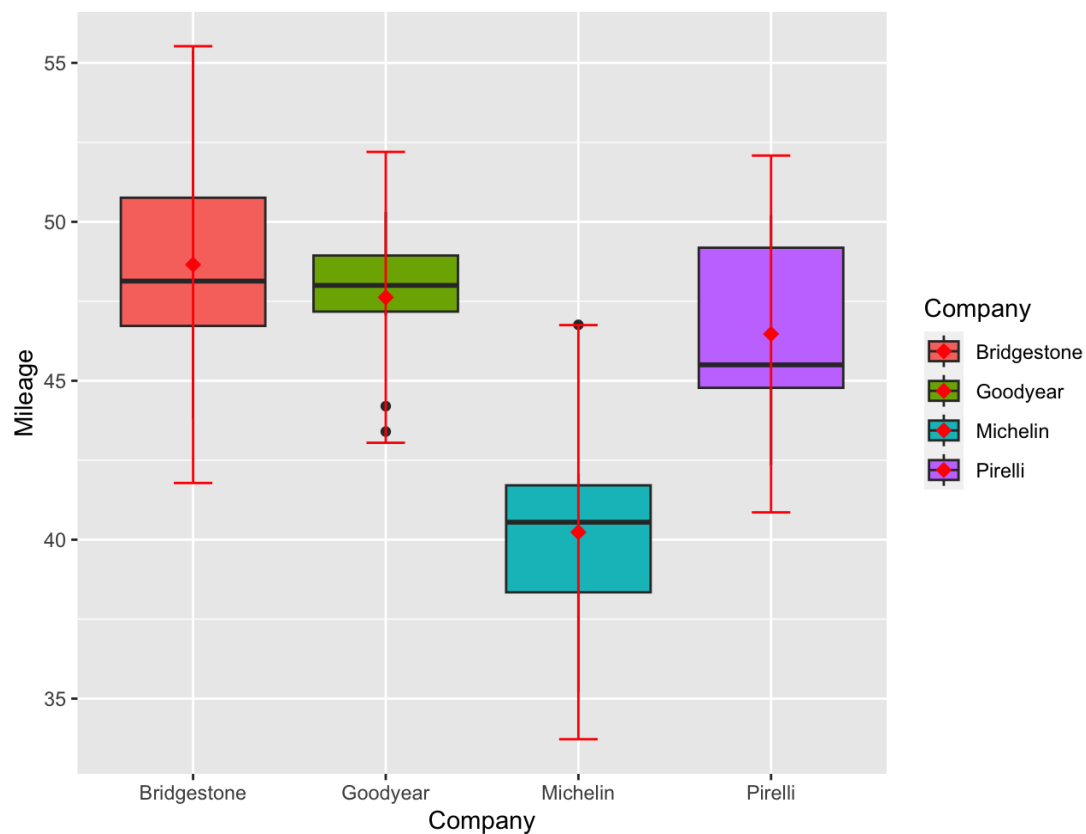
data: dataset1\$Mileage and dataset1\$Company

	Bridgestone	Goodyear	Michelin
Goodyear	0.44	-	-
Michelin	2.6e-07	2.8e-06	-
Pirelli	0.11	0.39	4.0e-05

P value adjustment method: none

**Table2, pairwise t-test for the dataset1**

According to Figure1, the boxplot shows the distribution of mileage for each tire company, with Michelin having the lowest median mileage and lowest mean mileage, Goodyear having the smallest range, and Bridgestone having the highest median mileage, highest mean mileage, and largest range.



**Figure1, distribution of mileage for each tire company for dataset1**

Q2:

According to the table3, the ANOVA analysis showed that the tire brand has a significant effect on the mileage of the car, with a p-value of 0.0182 for the factor “Company”.

```
Error: user
      Df Sum Sq Mean Sq F value Pr(>F)
Residuals  1  0.1131   0.1131

Error: user:Company
      Df Sum Sq Mean Sq
Company  3  412.2   137.4

Error: Within
      Df Sum Sq Mean Sq F value Pr(>F)
Company  3  182.7   60.90   3.863 0.0182 *
Residuals 32  504.4   15.76
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

**Table3, ANOVA table for dataset2**

According to the table4, the pairwise t-tests revealed significant differences between Michelin and both Goodyear ( $p = 0.00097$ ) and Bridgestone ( $p = 0.00011$ ). However, there were no significant differences between Goodyear and Bridgestone ( $p = 0.45442$ ) or between Pirelli and any of the other brands.

Pairwise comparisons using t tests with pooled SD

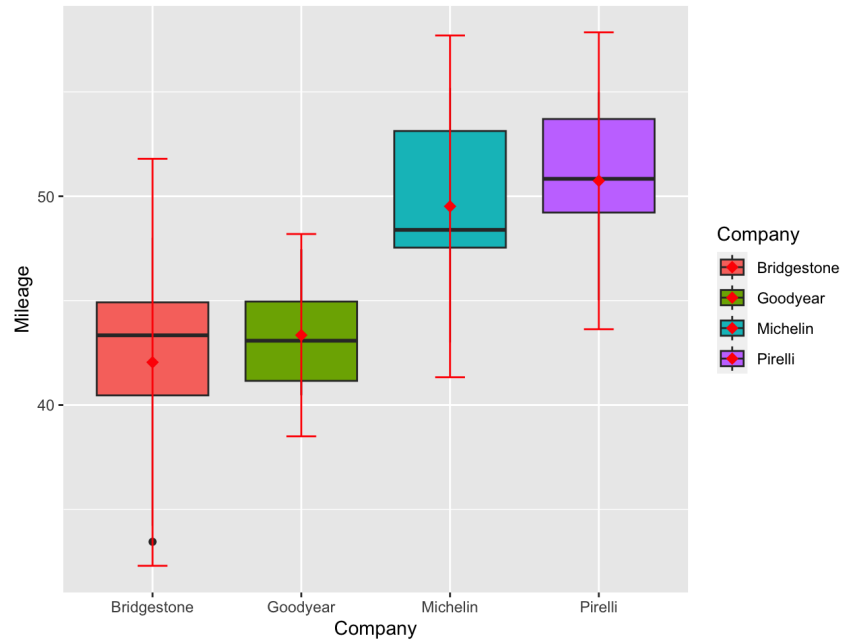
data: dataset2\$Mileage and dataset2\$Company

	Bridgestone	Goodyear	Michelin
Goodyear	0.45442	-	-
Michelin	0.00011	0.00097	-
Pirelli	1.2e-05	0.00012	0.48034

P value adjustment method: none

**Table4, pairwise t-test for dataset2**

The box plot(figure2) shows that Goodyear had the lowest median mileage, followed by Bridgestone and Michelin, while Pirelli had the highest median mileage. And Bridgestone has the lowest mean mileage, while Pirelli has the highest mean mileage.



**Figure2, distribution of mileage for each tire company for dataset2**

## Conclusion

The analysis indicates significant differences in mileage between Michelin and the other three tire brands (Bridgestone, Goodyear, and Pirelli) in the first dataset. In the second dataset, there were significant differences in mileage between tire brands, but only when considering the within-subject design. The results from both datasets could be useful for consumers and tire manufacturers in making informed decisions about which tire brand to choose based on mileage performance.