

# Price difference between the starting total price and the dealing price of Nintendo Wii Mario Kart

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## Introduction

Have you ever played Mario Kart on a Nintendo Wii? Many children in the US played it growing up. While you can still buy the game today, older versions are only available on second sale sites, like Ebay. Ebay is interesting because you can sell things through an online auction. You set the start price, but others can bid higher prices to get the item. The data set used took all the auctions of Mario Kart games that happened during one week in October 2009 (OpenIntro 2009). In this study, we look into the correlation between the start price, shipping price, and total price of Mario Kart games sold on Ebay, and investigate whether the total starting price (the sum of starting price and shipping price collected from our data set) is equivalent to the total auction price (the total price in our data set). Through this study, we are able to see the correlation of the prices for Mario Kart games and apply these findings to other things for auction on Ebay to help people make decisions about what they are going to pay.

## Exploratory Analysis

### Dataset

The data was collected from Ebay and includes all auctions for a full week in early October of 2009. Auctions were only included if they fulfilled certain requirements. The auctions were in a search for “wii mario kart” on ebay.com; items were under the Video Games -> Games -> Nintendo Wii section of Ebay; the listing was an auction and not only a “Buy It Now” listing; the item listed was the actual Mario Kart game; the item was being sold from the United States; the item had at least one bidder; there were no other items included in the auction listing (except for racing wheels); and the auction did not end with a “Buy It Now” option.

### Description of Variables

- id: Auction ID assigned by Ebay
- duration: How long the auction happened, in days
- n\_bids: Number of bids on the auction
- cond: Condition of the game, new or used
- start\_pr: Start price of the auction
- ship\_pr: Shipping price

- `total_pr`: Total price, the auction price plus the shipping price
- `ship_sp`: Shipping speed or method (first class, standard, etc)
- `seller_rate`: The seller's rating on Ebay. Calculated by the number of negative ratings subtracted from the number of positive ratings.
- `stock_photo`: Whether or not the auction feature photo was a stock photo
- `wheels`: Number of wheels included in the action. The wheels are pieces of silicon that go over the controller to make the game feel more realistic.
- `title`: The title of the auction

The original data set includes 12 variables and 143 observations, but we only look at 3 specific variables. The variables studied are the `start_pr` (starting price of the auction in USD), `ship_pr` (shipping price of the item in USD), and `total_pr` (total price of the item in USD). In the hypothesis testing, we are using the sum of the shipping prices and starting prices, summarized as total starting price, total prices, renamed as dealing price, and the difference between total starting price and dealing price, framed as price difference. Total starting price, dealing price, and price difference are summarized in dataset `price_Table`. Furthermore, there are two outliers in the total price variable in the original data set. We decided to delete those two rows of data because these two data collected include price of games and product other than Nintendo Wii Mario Kart. Since our study focuses only on the correlation and difference of starting price, shipping price, total start price, and dealing price of Nintendo Wii Mario Kart, we removed 2 data points from the original data set.

### Distribution of Variables

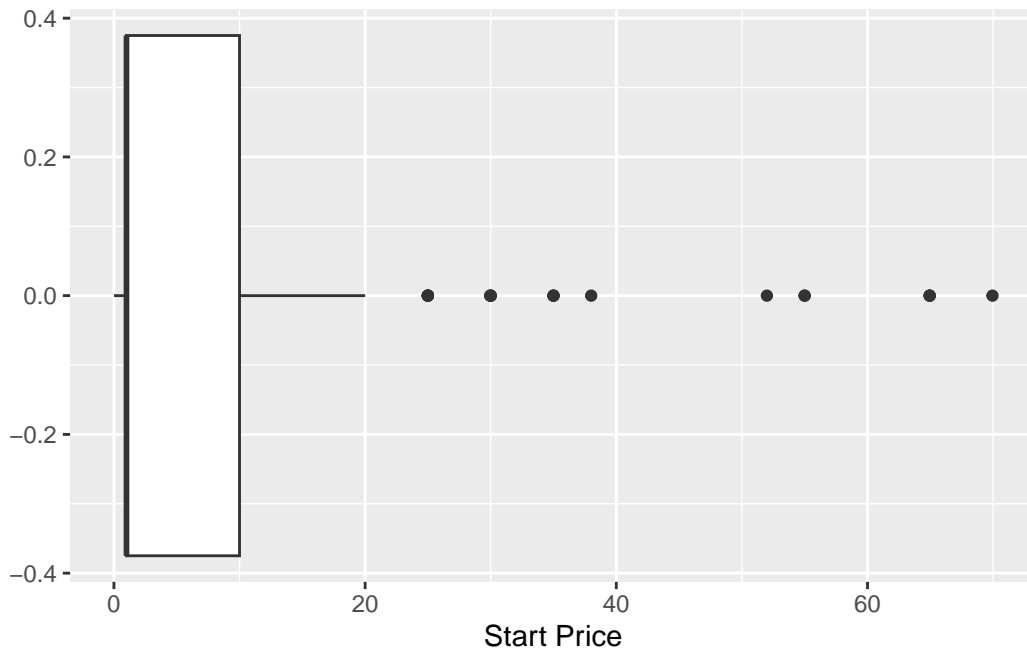


Figure 1: Distribution of the Start Prices

Figure 1 is a boxplot that shows the distribution of the start prices. The distribution is skewed to the right with 8 outliers. The mean start price is \$8.85.

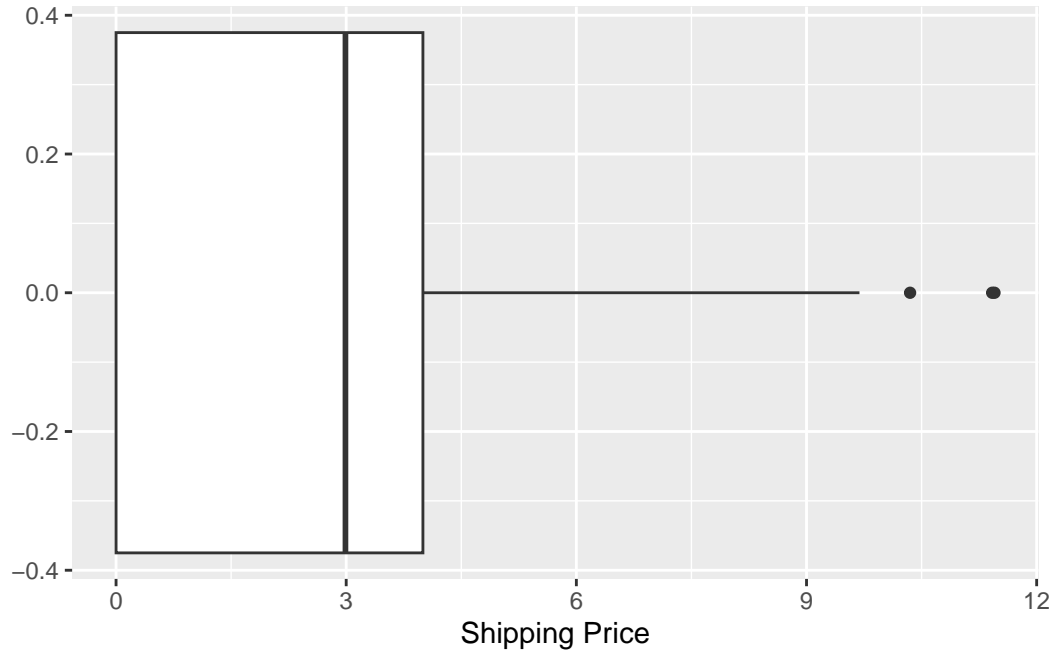


Figure 2: Distribution of the Ship Prices

Figure 2 is a boxplot showing the distribution of the shipping prices. The distribution of shipping price is roughly normal with 2 outliers. The mean shipping price is \$2.98.

Figure 3 is a boxplot showing the distribution of the sum of shipping prices and starting prices. The distribution is skewed to the right and has 12 outliers. The mean total starting price is \$11.82.

Figure 4 is a boxplot that shows the distribution of the total auction price. The distribution is roughly normal. The mean total auction price is \$47.43.

### Relationships Between Variables

Figure 5 is a scatter plot of the relationship between the start price and the total auction price. The line of best fit shows a slightly positive relationship between the two variables.

Figure 6 is a scatter plot of the relationship between the shipping price and total auction price. The line of best fit shows that there is no linear relationship between the two variables.

Figure 7 is a scatter plot of the relationship between the total starting price and total auction price. The line of best fit shows a moderate positive relationship between two variables.

### Result

#### Hypotheses

Before starting hypothesis testing, we need to bring out null hypothesis and alternative hypothesis of our research question. Our null hypothesis is that there is no difference between the mean total starting price and the mean total auction price for game Mario Kart on EBay. Our alternative

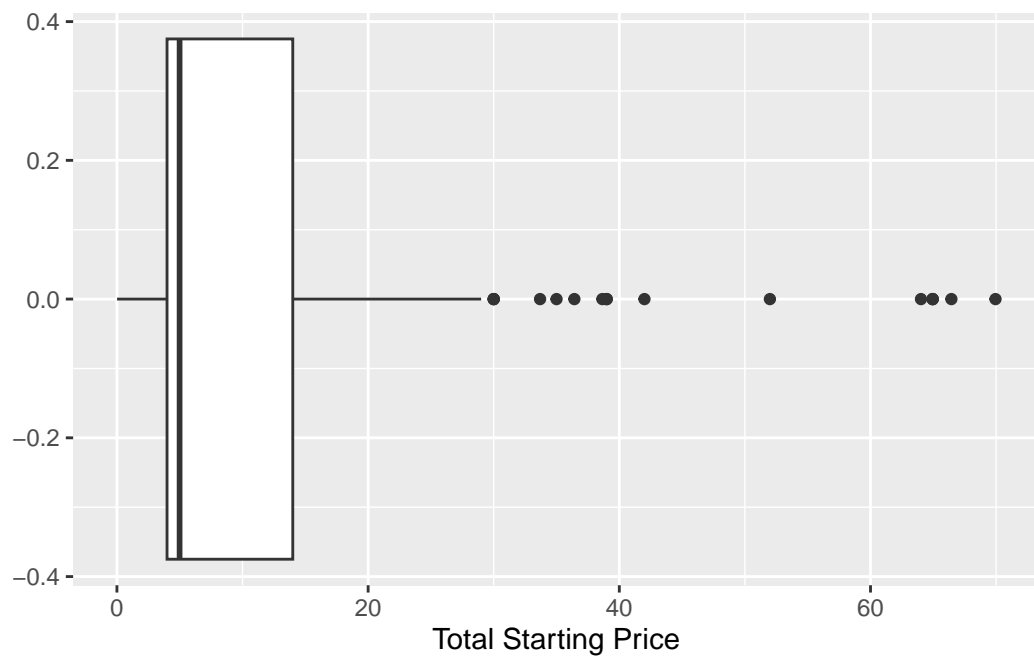


Figure 3: Distribution of the Total Starting Prices



Figure 4: Distribution of Total Auction Price

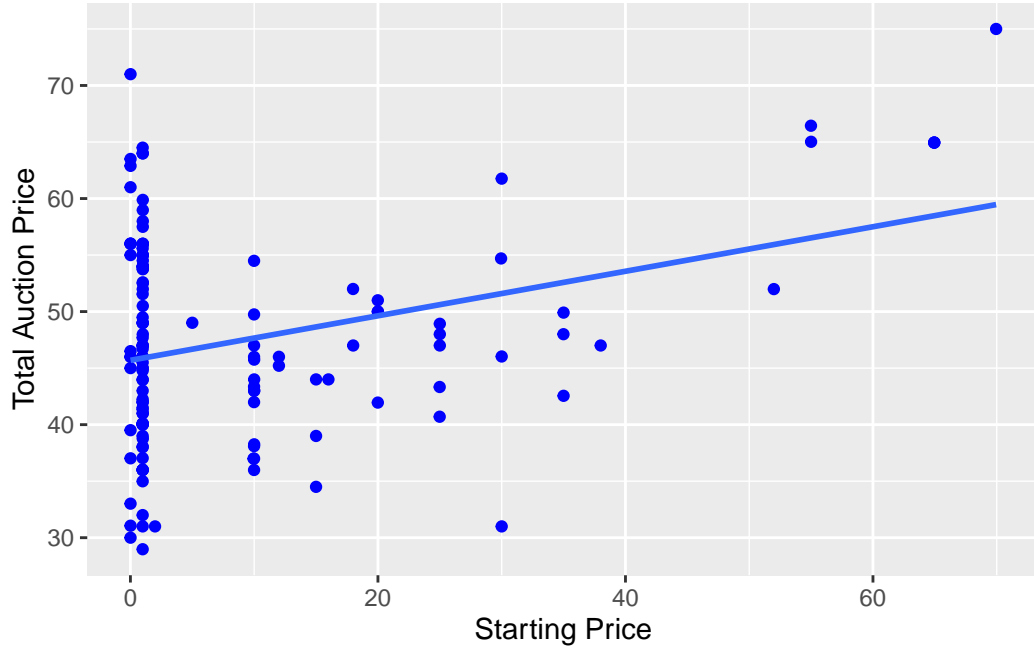


Figure 5: Relationship Between Starting Price and Total Auction Price

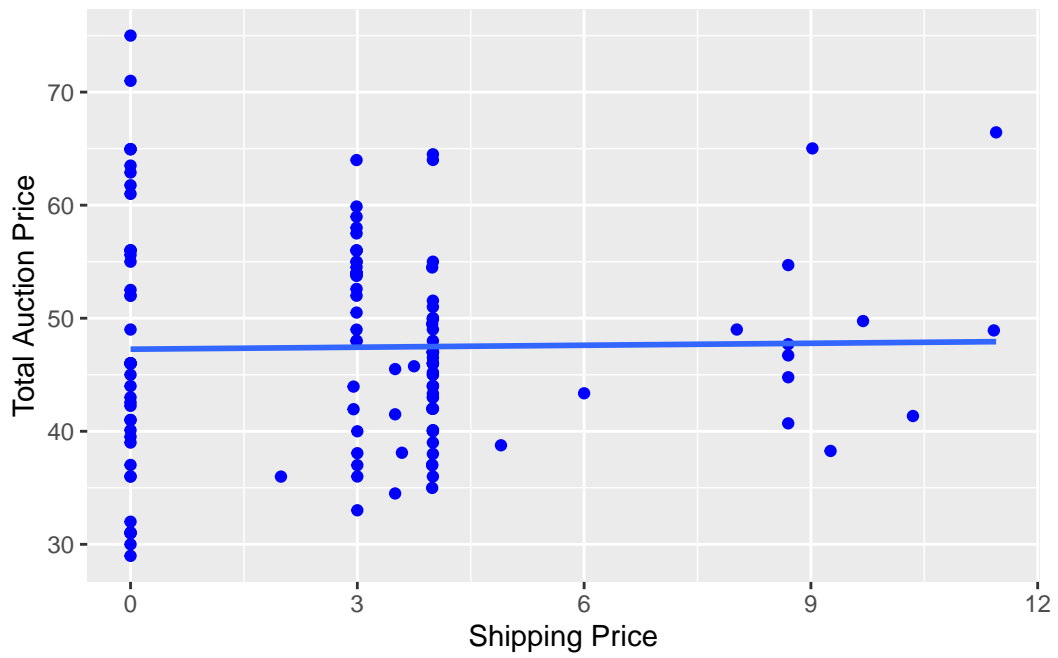


Figure 6: Relationship Between Shipping Price and Total Auction Price

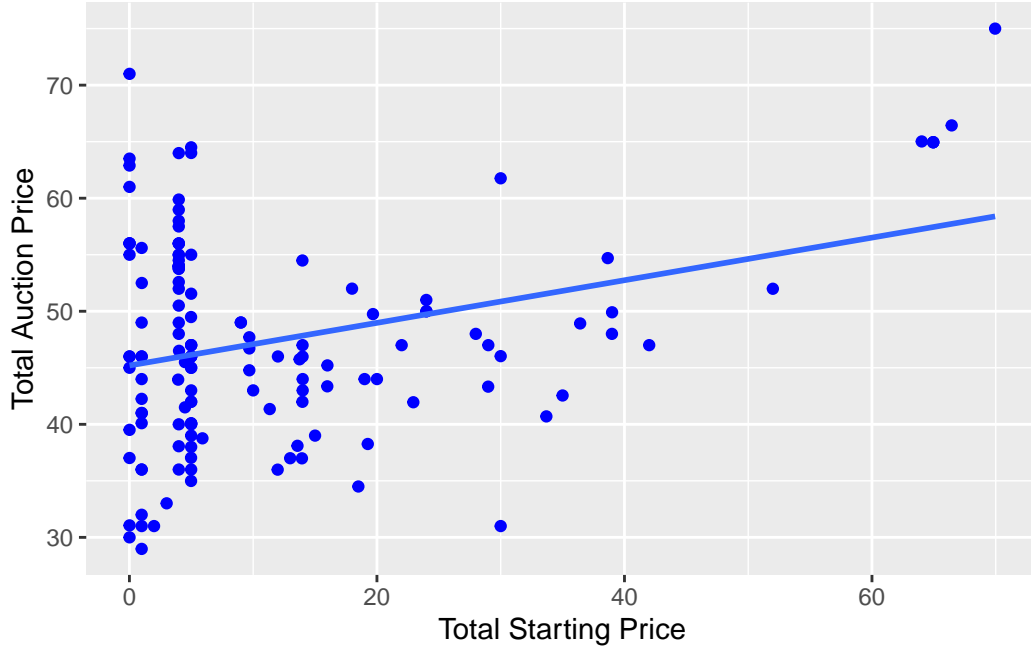


Figure 7: Relationship Between Total Starting Price and Total Auction Price

hypothesis is that there is a difference between the mean total starting price and the mean total auction price of Mario Kart on EBay. In symbols:

$$H_0 : \mu_{diff} = 0$$

$$H_A : \mu_{diff} \neq 0$$

Our goal is to use hypothesis testing to reject our null hypothesis. To investigate whether our null hypothesis is false, we need to conduct a **Paired T-Test**.

### Checking Conditions

Before conducting the hypothesis testing, we need to check two conditions: **independence** and **normality**.

Independence checks whether the data within the groups are independent. Since the `mariokart` dataset is collected from 143 different auctions, we can assume that each pair of the initial total price and the dealing price are independent.

Normality checks whether the difference of the paired data is roughly symmetric without large outliers.

Figure 8 is a boxplot representing the distribution of the price difference of game Mario Kart on EBay in 2009. Based on the boxplot above, the distribution of the difference of total starting price and total auction price are roughly normal with three outliers. There is no outlier that significantly differs from the distribution and therefore satisfies the condition.

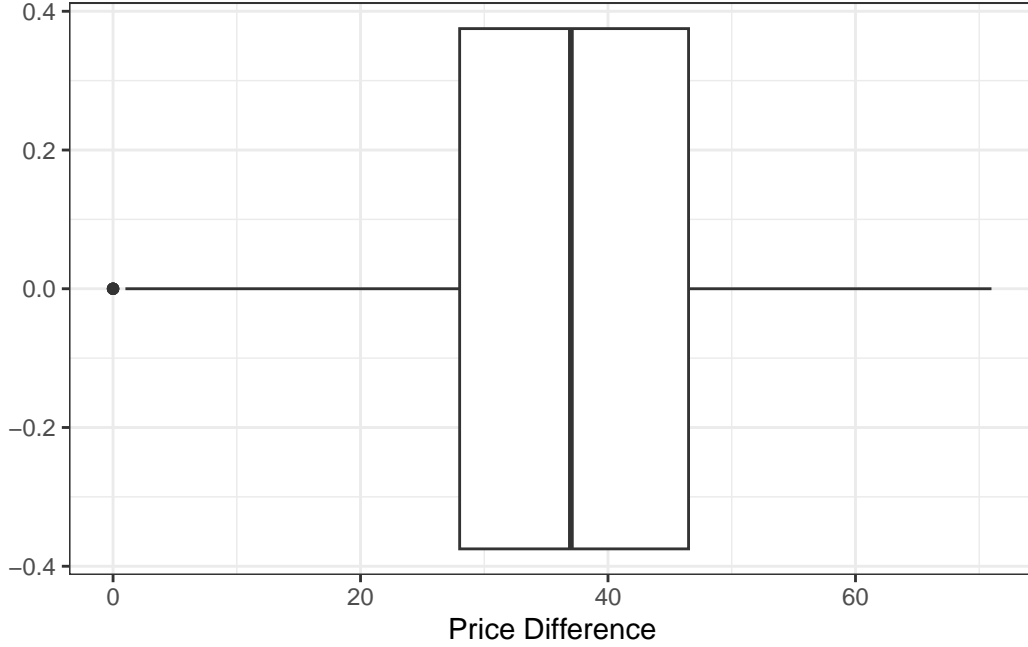


Figure 8: Distribution of price difference between initial and dealing price of Mario Kart on EBay

### Calculation

Using t test for paired means, we will compute T-Statistics, degrees of freedom, p-value, and confidence interval with a significance level  $\alpha = 0.05$ . The significance level is a predetermined threshold representing how rare an incident should be so that we can reject the null hypothesis (Çetinkaya-Rundel and Hardin 2024).

**T statistics** stands for the ratio of how the sample mean difference varies from zero as compared to how the observations vary (Çetinkaya-Rundel and Hardin 2024). The T test statistics obtained from formula

$$T = \frac{\bar{x}_{paired}}{\sqrt{\frac{S_{paired}^2}{n}}}$$

is -27.645. The large absolute value of t test statistics means that if our null hypothesis that there is no difference between the total starting price and the total auction price for Wii Mario Kart on EBay is true, the result is relatively largely deviated from what we expect based on our null hypothesis.

**The degrees of freedom** is used to describe the shape of t-distribution (Çetinkaya-Rundel and Hardin 2024). Its formula is  $df = n - 1$ . In this case, the degrees of freedom is 140. The large degrees of freedom means that the t-distribution is closer to normal distribution.

After calculating the t statistics and degrees of freedom, we can calculate **p-value**. P-value is the probability that views the alternative hypothesis for the data least agreeable if the null hypothesis is true (Çetinkaya-Rundel and Hardin 2024). Since our alternative hypothesis is  $H_A : \mu_{diff} \neq 0$ , our p-value is two-tailed. Based on R code `t.test(total_start_pr, total_auction_pr, paired = TRUE, alternative = "two.sided")`, the p-value is to  $2.2 * 10^{-16}$ . Since our p-value is very small and approximately equals to zero, our p-value is smaller than the significance level  $\alpha = 0.05$ .

Therefore, we reject the null hypothesis that there is no difference between the mean total starting price and the mean total auction price of game Mario Kart on EBay on 2009.

To find a range of the true difference between initial price and dealing price, we compute **confidence interval**. Confidence interval is a range of plausible values where we can find true population value (Çetinkaya-Rundel and Hardin 2024). In this case, we are using confidence interval to calculate a range of plausible values of true difference of paired means. A Based on R Code `t.test(total_start_pr, total_auction_pr, paired = TRUE, alternative = "two.sided")`, The 95% confidence interval is  $(-38.15405, -33.06113)$ . It means that we are 95% confident that true mean difference between total starting price and total auction price is in the range  $(-38.15405, -33.06113)$ .

## Discussion

This study investigate whether there is a difference between the total starting price and the dealing price of game Mario Kart on EBay. Based on the result we gathered, there is a difference between the total starting price and the total auction price of game Mario Kart on EBay in 2009. The true mean difference between the total starting price and total auction price of Nintendo Wii Mario Kart lies in the range  $(-38.15405, -33.06113)$ . Based on our result, the total auction price of game Mario Kart is more expensive than its total starting price. There are some limitations in this study. The `mariokart` data set was collected in 2009. After decades, due to inflation and preciousness of second-hand game, the current starting price and auction price for second-hand Nintendo Wii Mario Kart might be different from what was collected in the data set. Therefore, the result of our hypothesis testing might not match the distribution of price difference of the current second-hand price for Wii Mario kart and hence might not provide useful suggestions for people to decide whether they should buy the second-hand game or not. Moreover, this data set is not representative to the population - the price of all Nintendo Wii Mario Kart on EBay. The data set used took all the auctions of Mario Kart games that happened during one week in October 2009. This sample is not representative because it only contains all auction for a week on October on EBay in 2009. If the data are collected at a another time, the price distribution might be different because on holidays or at the end of the season, there might be discounts that potentially affect the dealing price of the game. Further direction for this project is to collect more data of Nintendo Wii Mario Kart on EBay. For example, we can collect data from a week in every month so that we would have a better comparison of price difference at different period of time. Then, we can compare which month has the lowest price difference, which month has the highest price difference, and what are the potential influential factors of high or low price difference. With more updated larger sample data, we will be able to provide people with more up-to-date information and analysis before their purchase.

## Bibliography

- Çetinkaya-Rundel, Mine, and Johanna Hardin. 2024. "Introduction to Modern Statistics." <https://openintro-ims.netlify.app/inference-paired-means>.
- OpenIntro. 2009. "Mariokart." <https://www.openintro.org/data/index.php?data=mariokart>.