Effect of Vitamin C on Tooth Growth in Guinea Pigs

Omid

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Introduction

In this project, we explore the ToothGrowth data set and compare the guinea tooth growth by supplement and dose. We begin by an exploratory data analysis of the data set and then use confidence intervals and hypothesis tests to compare them and draw conclusions.

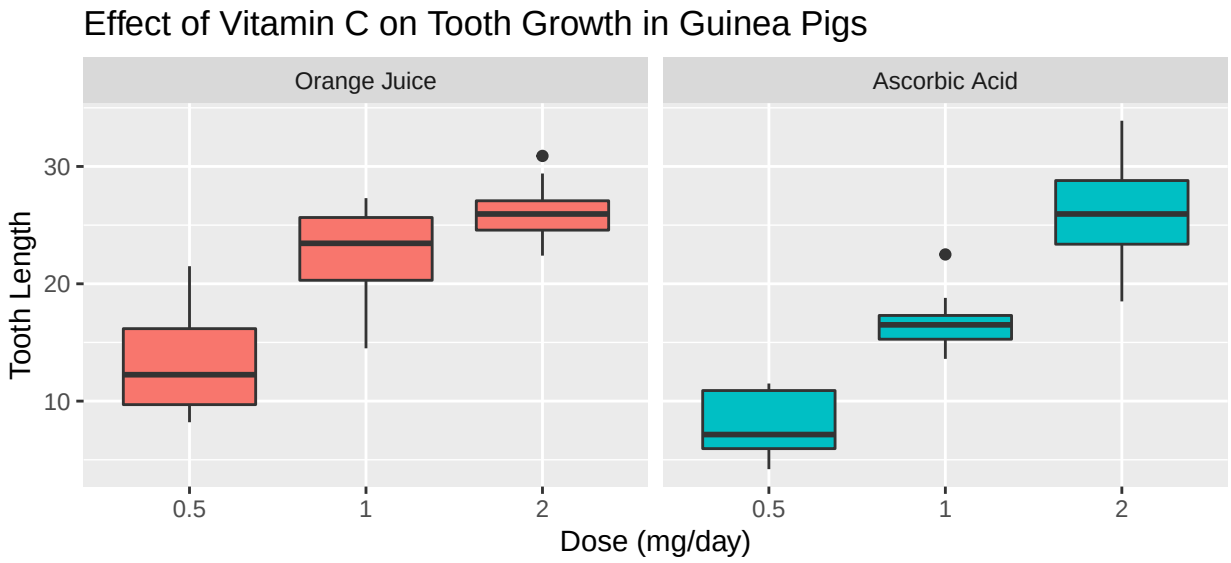
Load the Data Set and Perform an Exploratory Data Analysis

The following R functions, load the ToothGrowth data set, and provide some information about the data structre, the head of the data and a summary of the variables.

```
library(datasets)
data(ToothGrowth)
str(ToothGrowth)
head(ToothGrowth)
summary(ToothGrowth)
```

We next take a look at the Box plots of the data set to compare different variables visually. The box plots suggest that increasing the dosage leads to the tooth growth in both orange juice as well as ascorbic acid. In addition, Orange juice is more effective than ascorbic acid for tooth growth when the dosage is 0.5 and 1.0 milligrams per day while both types of supplements are equally as effective when the dosage is 2.0 milligrams per day.

```
options(warn=-1)
library(ggplot2)
Tooth_data = ToothGrowth
levels(Tooth_data$supp) <- c("Orange Juice", "Ascorbic Acid")
g<-ggplot(Tooth_data, aes(x=factor(dose), y=len))
g+ facet_grid(.~supp) + geom_boxplot(aes(fill = supp), show_guide = FALSE) +
labs(title="Effect of Vitamin C on Tooth Growth in Guinea Pigs",
     x="Dose (mg/day)", y="Tooth Length")
```



Confidence Intervals & Hypothesis Tests

We now construct some confidence intervals and use hypothesis testing to compare tooth growth by supplement and dose.

Hypothesis #1

We test whether orange juice and ascorbic acid deliver the same tooth growth across different dosages versus the tooth growth in each supplements is different.

```
hyp1<- t.test(ToothGrowth[ToothGrowth$supp=="OJ","len"],
              ToothGrowth[ToothGrowth$supp=="VC","len"], var.equal = TRUE)
hyp1$conf.int
```

```
## [1] -0.1670064  7.5670064
## attr(,"conf.level")
## [1] 0.95
```

```
hyp1$p.value
```

```
## [1] 0.06039337
```

The confidence intervals includes 0 and the p-value is greater than 0.05. Hence, we fail to reject the null hypothesis at 5% significance level. That is, the two supplements deliver the same tooth growth.

Hypothesis #2

We also test whether, for the dosage of 0.5 mg/day, the two supplements deliver the same tooth growth vesus they deliver different tooth growth.

```
hyp2<-t.test(len ~ supp, data = subset(Tooth_data, dose == 0.5))
hyp2$conf.int
```

```
## [1] 1.719057 8.780943
## attr(,"conf.level")
## [1] 0.95
```

```
hyp2$p.value
```

```
## [1] 0.006358607
```

The confidence interval does not include 0 and the p-value is less than 0.05. We hence reject the null hypothesis at 5% significance level.

Hypothesis #3

We also test whether, the dosage of 1 mg/day, the two supplements deliver the same tooth growth vesus they deliver different tooth growth.

```
hyp3<-t.test(len ~ supp, data = subset(Tooth_data, dose == 1))
hyp3$conf.int
```

```
## [1] 2.802148 9.057852
## attr(,"conf.level")
## [1] 0.95
```

```
hyp3$p.value
```

```
## [1] 0.001038376
```

The confidence interval does not include 0 and the p-value is less than 0.05. We hence reject the null hypothesis at 5% significance level. That is, for 1 mg/day dosage, the supplements deliver differnt growth.

Hypothesis #4

Finally, we test whether, for the dosage of 2 mg/day, the two supplements deliver the same tooth growth vesus they deliver different tooth growth.

```
hyp4<-t.test(len ~ supp, data = subset(Tooth_data, dose == 2))
hyp4$conf.int
```

```
## [1] -3.79807  3.63807
## attr(,"conf.level")
## [1] 0.95
```

```
hyp4$p.value
```

```
## [1] 0.9638516
```

The confidence interval includes 0 and the p-value is greater than 0.05. We hence fail to reject the null hypothesis at 5% significance level. That is, there is not enough evidence that the two supplements deliver different tooth growth.

Conclusions & Assumptions

We conclude that Orange juice delivers more tooth growth than ascorbic acid for dosages 0.5 and 1.0 at 5% significance level. Orange juice and ascorbic acid deliver the same amount of tooth growth for dose amount 2.0 mg/day. Furthermore, there is no evidence that orange juice is more effective than ascorbic acid at 5% significance level.

We made the below assumptions in our analysis:

- Tooth lengths in both orange juice and ascorbic acid follow a normal distribution.
- Orange juice and ascorbic acid are independent.
- The variances of tooth lengths in orange juice and ascorbic acid are equal.