

Statistical Inference Course Project (Part 2)

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Overview

In this second part of a two-part project assignment, we are being asked to investigate the effect of vitamin C on tooth growth in guinea pigs.

This analysis will compare the effects of different doses of vitamin C using two delivery methods to study the tooth growth in guinea pigs. The sample will consist of 60 guinea pigs. Each guinea pig will receive one of three dose levels of vitamin C (0.5, 1, and 2 mg/day) by one of two delivery methods, orange juice or ascorbic acid.

The study will be performed using the ToothGrowth dataset which is included in the R `datasets` package. The dataset is a data frame that contains 60 observations and 3 variables:

- `len` - A numeric vector indicating the measurement of tooth length after Vitamin C delivery
- `supp` - A factor vector describing the delivery method (supplement type) used. Either Orange Juice (OJ) or Ascorbic Acid (VC)
- `dose` - A numeric vector indicating the dosage level in milligrams (0.5, 1, or 2mg)

Further information on the ToothGrowth dataset can be found in the R documentation using `?ToothGrowth`.

Environment Setup

Load packages used in this analysis.

```
if (!require(ggplot2)) {  
  install.packages("ggplot2", repos = "http://cran.us.r-project.org")  
  library(ggplot2)  
}
```

```
## Loading required package: ggplot2
```

```
if (!require(dplyr, warn.conflicts = FALSE)) {  
  install.packages("dplyr", repos = "http://cran.us.r-project.org")  
  library(dplyr, warn.conflicts = FALSE)  
}
```

```
## Loading required package: dplyr
```

Load ToothGrowth dataset.

```
library(datasets)
data(ToothGrowth)
```

Basic Data Summary

After loading the ToothGrowth dataset, provide a basic summary of the data.

```
str(ToothGrowth)
```

```
## 'data.frame': 60 obs. of 3 variables:
## $ len : num 4.2 11.5 7.3 5.8 6.4 10 11.2 11.2 5.2 7 ...
## $ supp: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 ...
## $ dose: num 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

```
summary(ToothGrowth)
```

```
##      len      supp      dose
## Min.   : 4.20   OJ:30   Min.    :0.500
## 1st Qu.:13.07   VC:30   1st Qu.:0.500
## Median :19.25           Median :1.000
## Mean   :18.81           Mean   :1.167
## 3rd Qu.:25.27           3rd Qu.:2.000
## Max.   :33.90           Max.    :2.000
```

```
# tabulate supplement type and dosage level values
```

```
table(ToothGrowth$dose, ToothGrowth$supp)
```

```
##
##      OJ VC
## 0.5 10 10
## 1   10 10
## 2   10 10
```

```
# summary of tooth length data grouped by supplement type and dosage level
```

```
by(data = ToothGrowth$len, INDICES = list(ToothGrowth$supp, ToothGrowth$dose), summary)
```

```
## : OJ
## : 0.5
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   8.20   9.70   12.25   13.23   16.18   21.50
## -----
## : VC
## : 0.5
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   4.20   5.95   7.15    7.98   10.90   11.50
## -----
## : OJ
## : 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  14.50  20.30   23.45   22.70   25.65   27.30
## -----
## : VC
## : 1
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  13.60  15.28   16.50   16.77   17.30   22.50
```

```
## -----
## : OJ
## : 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  22.40  24.57   25.95   26.06   27.07   30.90
## -----
## : VC
## : 2
##   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  18.50  23.38   25.95   26.14   28.80   33.90
```

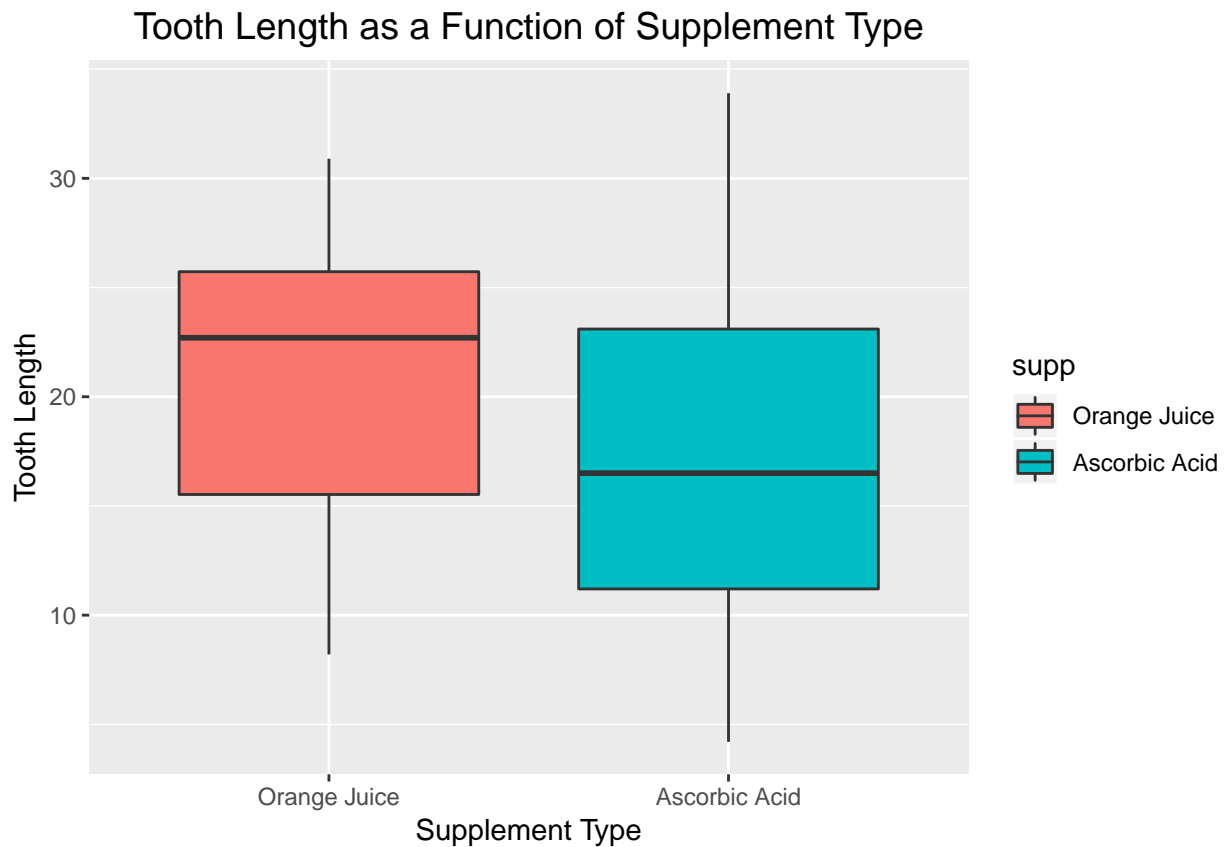
Exploratory Data Analysis

Perform some basic exploratory data analyses of the data. The analyses will explore the following relations:

1. Tooth Length (len) as a function of Supplement Type (supp)
2. Tooth Length (len) as a function of Dosage Level (dose)
3. Tooth Length (len) as a function of Supplement Type (supp) and Dosage Level (dose)

Tooth Length to Supplement Type

```
tg <- ToothGrowth
levels(tg$supp) <- c("Orange Juice", "Ascorbic Acid")
gLenSupp <- ggplot(data = tg, aes(x = supp, y = len)) +
  geom_boxplot(aes(fill = supp)) +
  xlab("Supplement Type") +
  ylab("Tooth Length") +
  theme(plot.title = element_text(size = 14, hjust = 0.5)) +
  ggtitle("Tooth Length as a Function of Supplement Type")
print(gLenSupp)
```

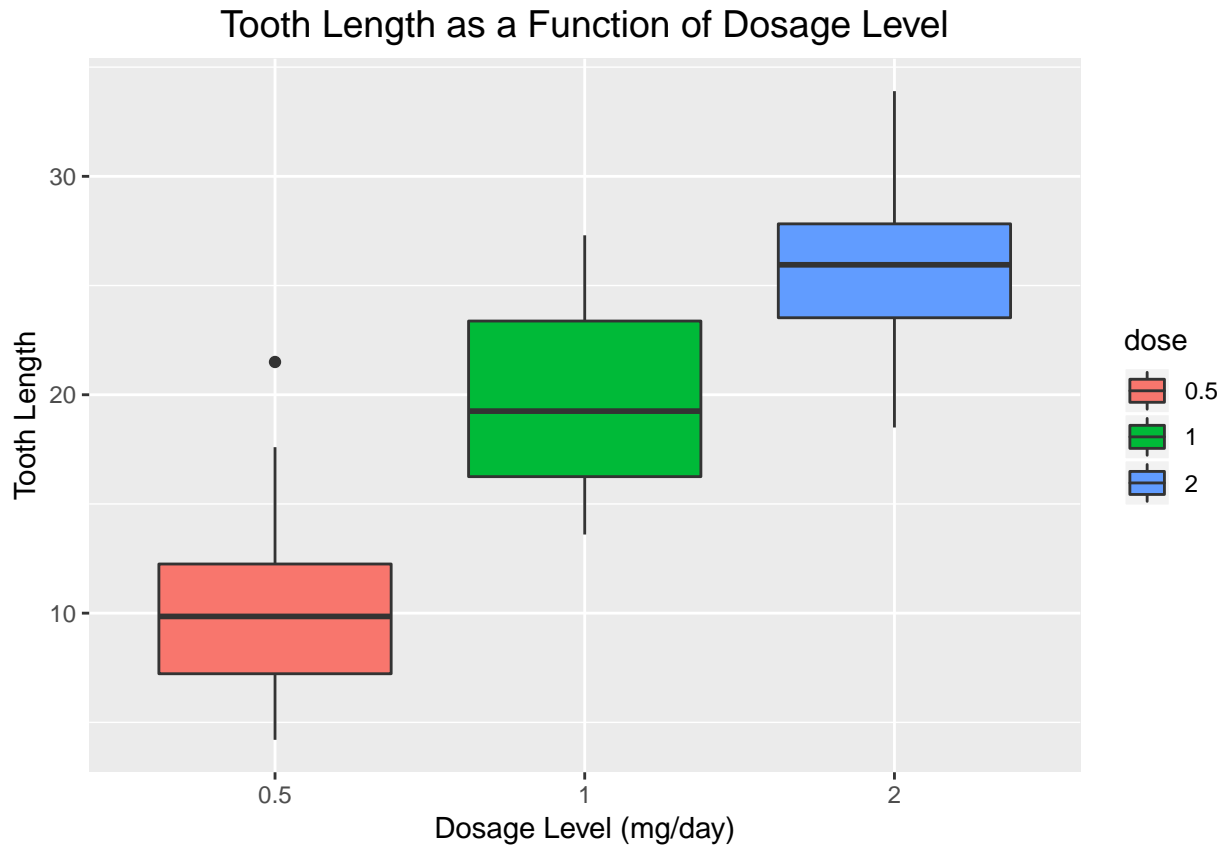


Observation

The above chart shows that using Orange Juice (OC) as the delivery method had a more favorable effect on tooth growth than Ascorbic Acid (VC) independent of dosage level.

Tooth Length to Dosage Level

```
gLenDose <- ggplot(data = ToothGrowth, aes(x = factor(dose), y = len)) +
  geom_boxplot(aes(fill = factor(dose))) +
  xlab("Dosage Level (mg/day)") +
  ylab("Tooth Length") +
  guides(fill=guide_legend(title="dose")) +
  theme(plot.title = element_text(size = 14, hjust = 0.5)) +
  ggtitle("Tooth Length as a Function of Dosage Level")
print(gLenDose)
```

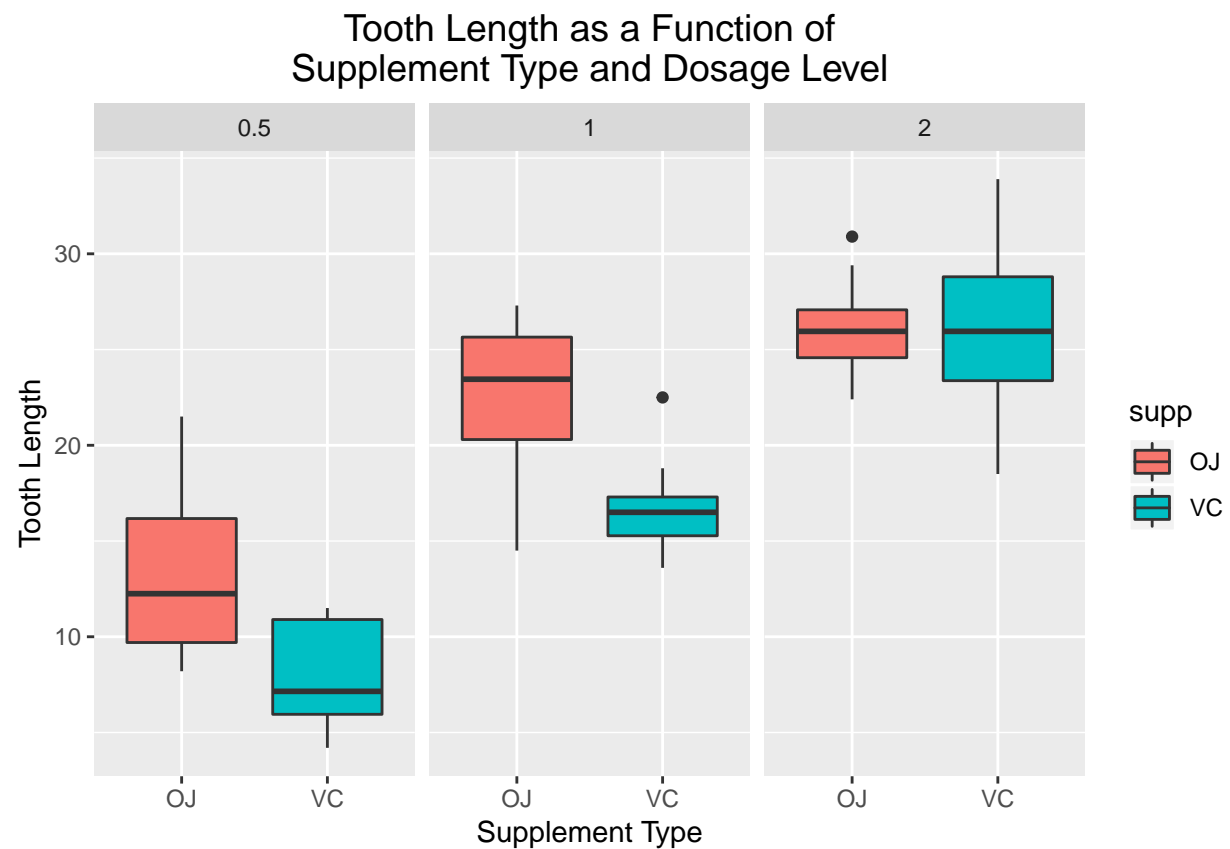


Observation

The above chart shows a positive correlation that higher dosage levels of vitamin C, independent of delivery method, had a more favorable effect on tooth growth than lower dosages of vitamin C.

Tooth Length to Supplement Type and Dosage Level

```
gLenSuppDose <- ggplot(data = ToothGrowth, aes(x = supp, y = len)) +
  geom_boxplot(aes(fill = supp)) +
  facet_wrap(~ dose) +
  xlab("Supplement Type") +
  ylab("Tooth Length") +
  guides(fill=guide_legend(title="supp")) +
  theme(plot.title = element_text(size = 14, hjust = 0.5)) +
  ggtitle("Tooth Length as a Function of\nSupplement Type and Dosage Level")
print(gLenSuppDose)
```



Observation

Pending

Confidence Intervals

Hypothesis Test

Conclusion