Part 2: Basic Inferential Data Analysis Instructions

OVERVIEW

In the second portion of the project, we're going to analyze the ToothGrowth data in the R datasets package

DATA SUMMARY

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

```
# load the sample dataset containing ToothGrowth data
data ("ToothGrowth")

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 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
```

```
head(ToothGrowth, 10)
```

```
##     len supp dose
## 1   4.2   VC  0.5
## 2  11.5   VC  0.5
## 3   7.3   VC  0.5
## 4   5.8   VC  0.5
## 5   6.4   VC  0.5
## 6  10.0   VC  0.5
## 7  11.2   VC  0.5
## 8  11.2   VC  0.5
## 9   5.2   VC  0.5
## 10  7.0   VC  0.5
```

```r
# tabulate delivery method and dosage level values
table(ToothGrowth$supp, ToothGrowth$dose)
```

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

```r
# summary of tooth length data grouped by delivery method 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

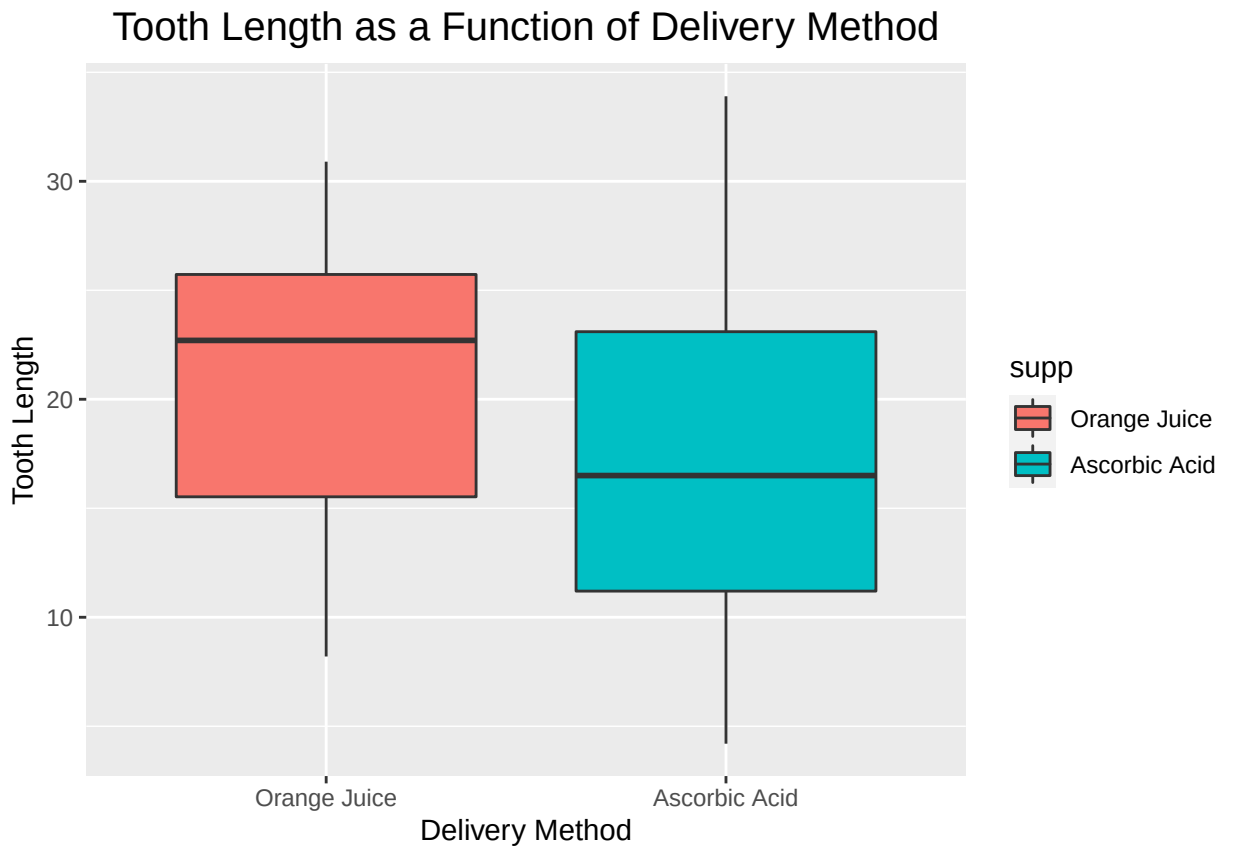
Perform some basic exploratory data analyses of the data. The analyses will explore the following relations:

1. Tooth Length as a function of Delivery Method
2. Tooth Length as a function of Dosage Level
3. Tooth Length as a function of Delivery Method (supp) and Dosage Level

1- Tooth Length to Delivery Method

```
levels(ToothGrowth$supp) <- c("Orange Juice", "Ascorbic Acid")

ggplot(data = ToothGrowth, aes(x = supp, y = len)) +
    geom_boxplot(aes(fill = supp)) +
    xlab("Delivery Method") +
    ylab("Tooth Length") +
    theme(plot.title = element_text(size = 15, hjust = 0.5)) +
    ggtitle("Tooth Length as a Function of Delivery Method")
```



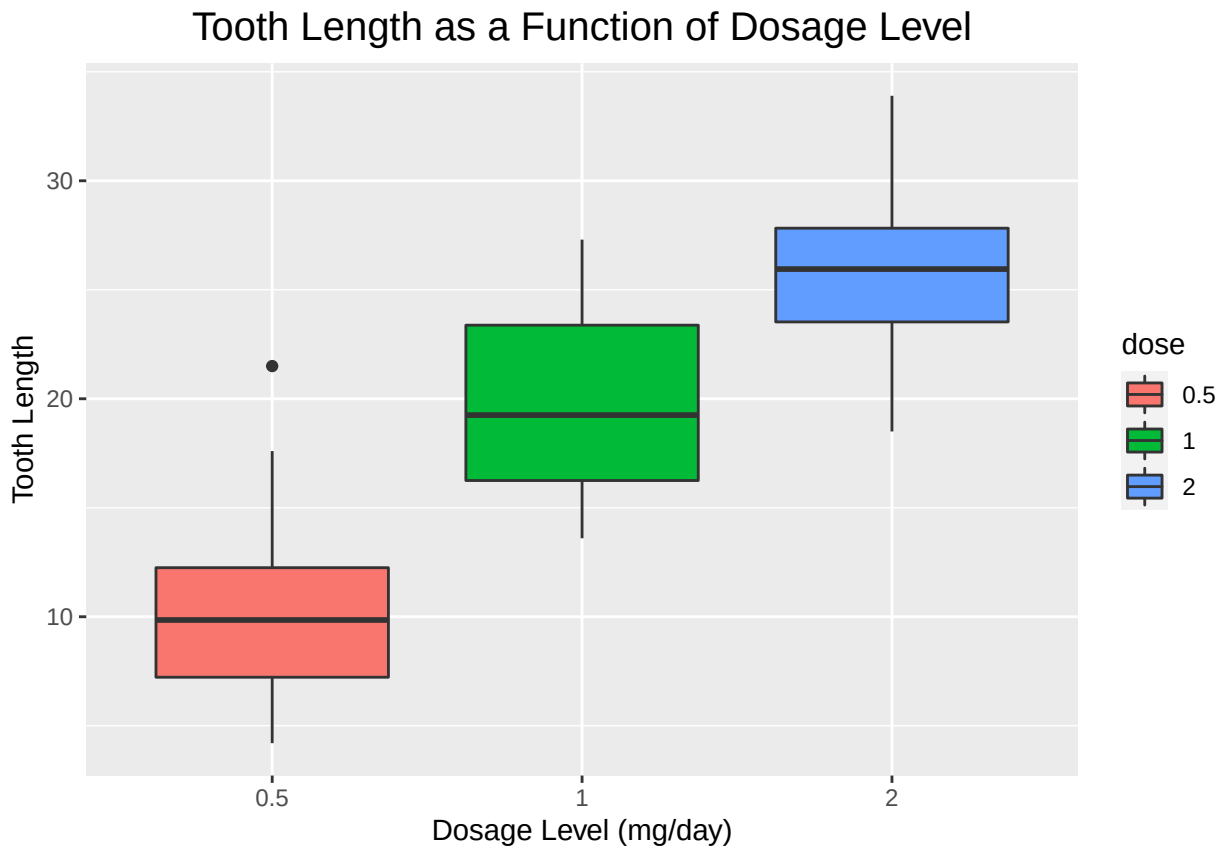
Findings

Based on the graph, it is observed that, regardless of the dosage level, the use of orange juice as a method of administration had a more favorable effect on tooth growth than ascorbic acid.

2- Tooth Length to Dosage Level

```
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 = 15, hjust = 0.5)) +
    ggtitle("Tooth Length as a Function of Dosage Level")
```



Findings

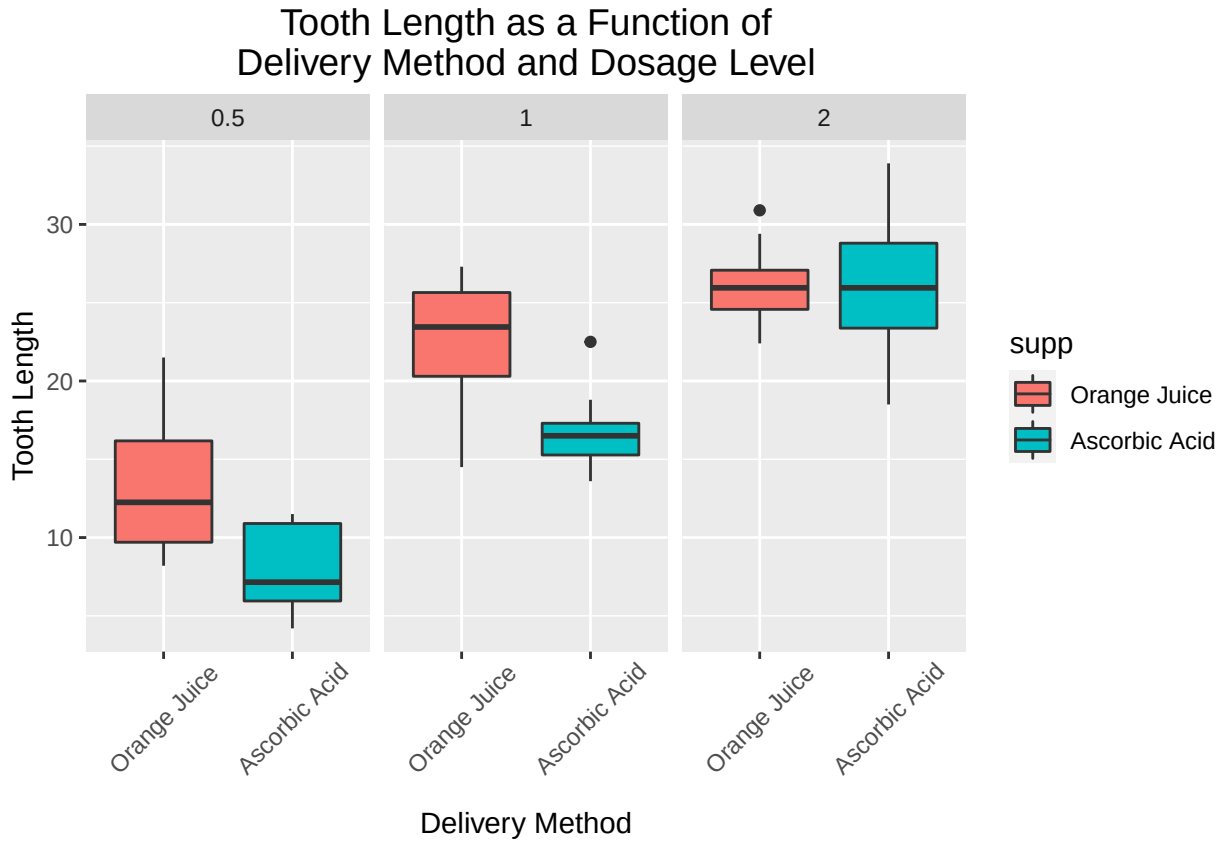
Based on the graph, it is observed that higher levels of vitamin C dosage, regardless of the method of administration, had a more favorable effect on tooth growth.

3- Tooth Length to Delivery Method and Dosage Level

```
levels(ToothGrowth$supp) <- c("Orange Juice", "Ascorbic Acid")

ggplot(data = ToothGrowth, aes(x = supp, y = len)) +
    geom_boxplot(aes(fill = supp)) +
    facet_wrap(~ dose) +
    xlab("Delivery Method") +
    ylab("Tooth Length") +
    guides(fill=guide_legend(title="supp")) +
    theme(plot.title = element_text(size = 14, hjust = 0.5, vjust = 0.5),
          axis.text.x = element_text(angle = 45,
                                     hjust = 0.5,
                                     vjust = 0.5,
```

```
                                    margin = margin(b = 10))) +
  ggtitle("Tooth Length as a Function of\nDelivery Method and Dosage Level")
```



Findings

Based on the graph, for dosages of 0.5 to 1 mg/day, orange juice was better. As for the 2mg/day dosage by the median, there was no difference between the means of administration, however if we look at the quartiles, orange juice has a more robust result.

INFERENTIAL STATISTICS

Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose. For this a t-test will be performed crescimento do dente.

Hypothesis 1

Test if whether is any correlation between tooth grow and dogase level
The null hypothesis that the two delivery methods have no effect on tooth growth.

```
t.test(len ~ supp, data = ToothGrowth, conf.level = 0.95)
```

```
##
```

```
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 1.9153, df = 55.309, p-value = 0.06063
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1710156  7.5710156
## sample estimates:
##  mean in group Orange Juice mean in group Ascorbic Acid
##                    20.66333                    16.96333
```

P-value is 0.06063 (>0.05) Confidence Interval is -0.17 to 7.57 (contains 0) This indicates weak evidence against the null hypothesis so we fail to reject the null hypothesis. So the dosage seems to have no impact on Tooth growth

Hypothesis 2

Study the impact of delivery method on tooth growth for a single dosage level. A t-test will be performed by comparing Tooth Grow with Dose Amount looking at the different pairs of dose values

```
# Dose amounts 0.5 and 1.0
t.test(len~dose,data=subset(ToothGrowth, ToothGrowth$dose %in% c(1.0,0.5)))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by dose
## t = -6.4766, df = 37.986, p-value = 1.268e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -11.983781  -6.276219
## sample estimates:
## mean in group 0.5   mean in group 1
##            10.605            19.735
```

P-value is 1.268e-07 (>0.05) Confidence Interval is -11.983781 to -6.276219 (doesn't contains 0) Based on these results, it was found that between 0.05mg/day and 1 mg/day there is a difference in tooth growth

```
# Dose amounts 0.5 and 2.0
t.test(len~dose,data=subset(ToothGrowth, ToothGrowth$dose %in% c(2.0,0.5)))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by dose
## t = -11.799, df = 36.883, p-value = 4.398e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -18.15617 -12.83383
## sample estimates:
## mean in group 0.5   mean in group 2
##            10.605            26.100
```

P-value is 4.398e-14 (>0.05) Confidence Interval is -18.15617 to -12.83383 (doesn't contains 0) Based on these results, it was found that between 0.05mg/day and 2mg/day there is a difference in tooth growth

```
# Dose amounts 1.0 and 2.0
t.test(len~dose,data=subset(ToothGrowth, ToothGrowth$dose %in% c(2.0,1.0)))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by dose
## t = -4.9005, df = 37.101, p-value = 0.00001906
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.996481 -3.733519
## sample estimates:
## mean in group 1 mean in group 2
##          19.735          26.100
```

P-value is 0.00001906 (>0.05) Confidence Interval is -8.996481 to -3.733519 (doesn'tcontains 0) Based on these results, it was found that between 0.05mg/day and 1 mg/day there is a difference in tooth growth

CONCLUSION

Assumptions

- Tooth growth follows a normal distribution.
- The sample is representative of the population

Conclusions

Based on exploratory data analysis and confirmed by hypothesis tests and associated confidence intervals, we can safely infer that an increase in dosage levels of vitamin C increases tooth growth. However, the delivery method had any effect on tooth growth.