Part 2

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##Overview The purpose of this data analysis is to analyze the ToothGrowth dataset by formulating several hypothesis for comparing the tooth growth of guinea pigs by supplement and dose.

```
## '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 ...
```

The dataset has 60 observations, length of odontoblasts (cells responsible for tooth growth) in each of 10 guinea pigs at three dose levels of Vitamin C (0.5, 1 and 2 mg) with two delivery methods (orange juice or ascorbic acid).

```
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
```

##Exploratory Analysis

1. **Plot 1**: The tooth lengths seem to be normally distributed.
2. **Plot 2**: There is a large variation and clear seperation in tooth growth for all dose levels of ascorbic acid. But there appears to be clear seperation only for 0.5 and 1 mg/day dose levels of orange juice.

##Hypothesis Testing

Hypothesis 1:

- H_0: Mean tooth growth from orange juice is same as ascorbic acid.
- H_1: Mean tooth growth from orange juice is higher.

```
h1<-t.test(len ~ supp, ToothGrowth, paired = F, var.equal = T)
h1$conf.int; h1$p.value
```

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

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

The p-value >0.05 and C.I. includes 0. The H_0 cannot be rejected. So orange juice & ascorbic acid seem to deliver the same tooth growth without factoring dose levels.

Hypothesis 2:

- H_0: Mean tooth growth from orange juice is same as ascorbic acid for the dose level of 0.5 mg/day.
- H_1: Mean tooth growth from orange juice is higher for the dose level of 0.5 mg/day.

```
h2<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 0.5), paired = F, var.equal = T)
h2$conf.int; h2$p.value
```

```
## [1] 1.770262 8.729738
## attr(,"conf.level")
## [1] 0.95
```

```
## [1] 0.005303661
```

The p-value is <0.05. The C.I. does not include 0. The H_0 is rejected. So 0.5 mg/day dosage of orange juice seems to deliver more tooth growth than ascorbic acid.

Hypothesis 3:

- H_0: Mean tooth growth from orange juice is same as ascorbic acid for the dose level of 1 mg/day.
- H_1: Mean tooth growth from orange juice is higher for the dose level of 1 mg/day.

```
h3<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 1), paired = F, var.equal = T)
h3$conf.int; h3$p.value
```

```
## [1] 2.840692 9.019308
## attr(,"conf.level")
## [1] 0.95
```

```
## [1] 0.0007807262
```

The p-value is <0.05 and the C.I. does not include 0. The H_0 is rejected. So 1 mg/day dosage of orange juice seems to deliver more tooth growth than ascorbic acid.

Hypothesis 4:

- H_0: Mean tooth growth from orange juice is same as ascorbic acid for the dose level of 2 mg/day.
- H_1: Mean tooth growth from orange juice is higher for the dose level of 2 mg/day.

```
h4<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 2), paired = F, var.equal = T)
h4$conf.int; h4$p.value
```

```
## [1] -3.722999  3.562999
## attr(,"conf.level")
## [1] 0.95
```

```
## [1] 0.9637098
```

The p-value is >0.05 and the C.I. does include 0. H_0 cannot be rejected. So 2 mg/day dosage of orange juice seems to deliver same tooth growth as ascorbic acid.

Hypothesis 5:

- H_0: Mean tooth growth from ascorbic acid (2 mg/day) is same as orange juice (1 mg/day).
- H_1: Mean tooth growth from ascorbic acid (2 mg/day) is higher than orange juice (1 mg/day).

```
temp1 <- rbind(subset(ToothGrowth, (dose == 1) & (supp =="OJ")),
               subset(ToothGrowth, (dose == 2) & (supp =="VC")))
h5<-t.test(len ~ supp, temp1, paired = F, var.equal = T)
h5$conf.int; h5$p.value
```

```
## [1] -7.552325  0.672325
## attr(,"conf.level")
## [1] 0.95
```

```
## [1] 0.09583711
```

The p-value is >0.05 and the C.I. does include 0. The H_0 cannot be rejected. 2 mg/day of ascorbic acid seems to deliver same tooth growth as 1 mg/day of orange juice.

Hypothesis 6:

- H_0: Mean tooth growth from orange juice (2 mg/day) is same as orange juice (1 mg/day).
- H_1: Mean tooth growth from orange juice (2 mg/day) is higher than orange juice (1 mg/day).

```
temp2 <- rbind(subset(ToothGrowth, (dose == 1) & (supp =="OJ")),
               subset(ToothGrowth, (dose == 2) & (supp =="OJ")))
h6<-t.test(len ~ dose, temp2, paired = F, var.equal = T)
h6$conf.int; h6$p.value
```

```
## [1] -6.5005017 -0.2194983
## attr(,"conf.level")
## [1] 0.95
```

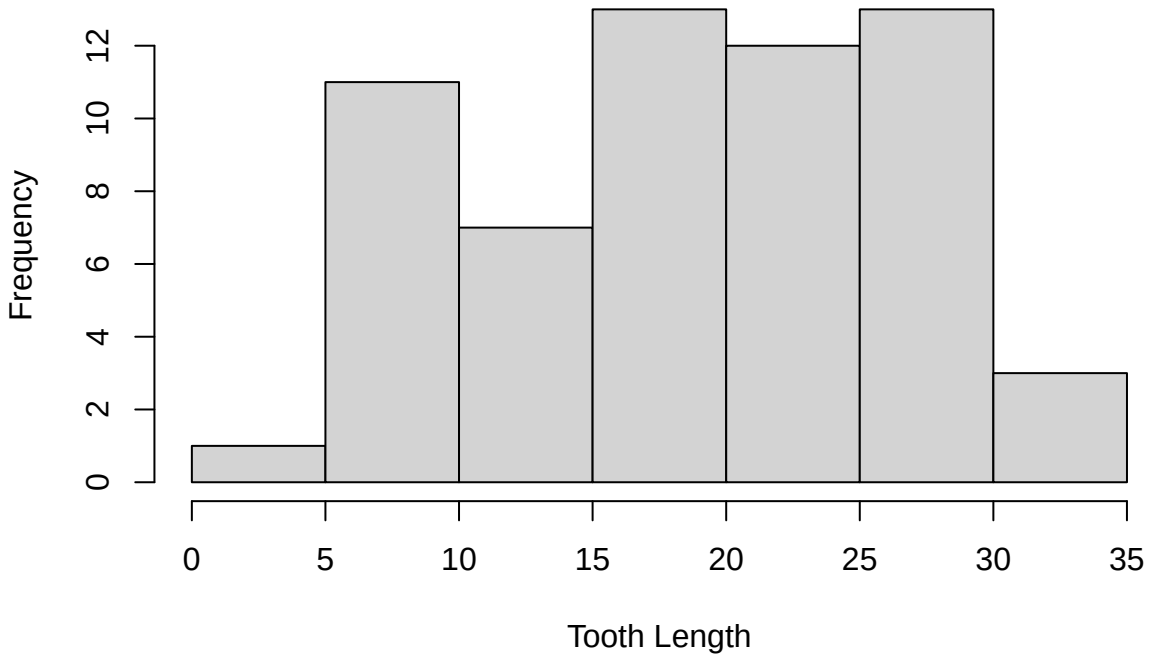
```
## [1] 0.0373628
```

The p-value is <0.05 and the C.I. does not include 0. H_0 is rejected. So 2 mg/day of orange juice seems to deliver higher tooth growth than 1 mg/day.

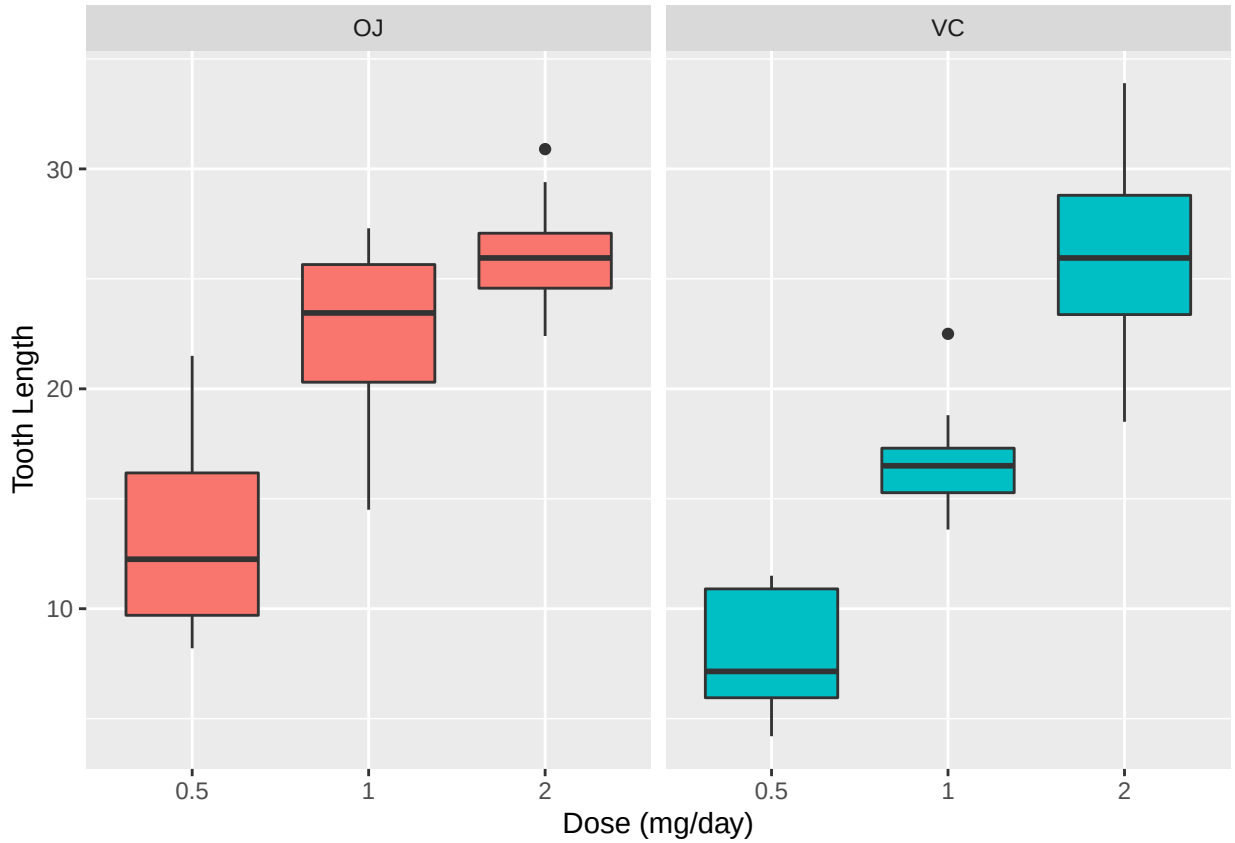
##Conclusion Increase in the dose levels seem to increase the tooth growth. Orange juice is more effective than ascorbic acid for tooth growth when the dosage is 0.5 and 1 mg/day. Both types of supplements are equally as effective when the dose is 2 mg/day. I've assumed there's a common variance in the guinea pigs population (var.equal=TRUE) and that they've used 6 different settings of 10 guinea pigs for the experiment (paired=FALSE) so as not to get biased by an earlier test.

##Appendix

Plot 1: Distribution of Tooth Length

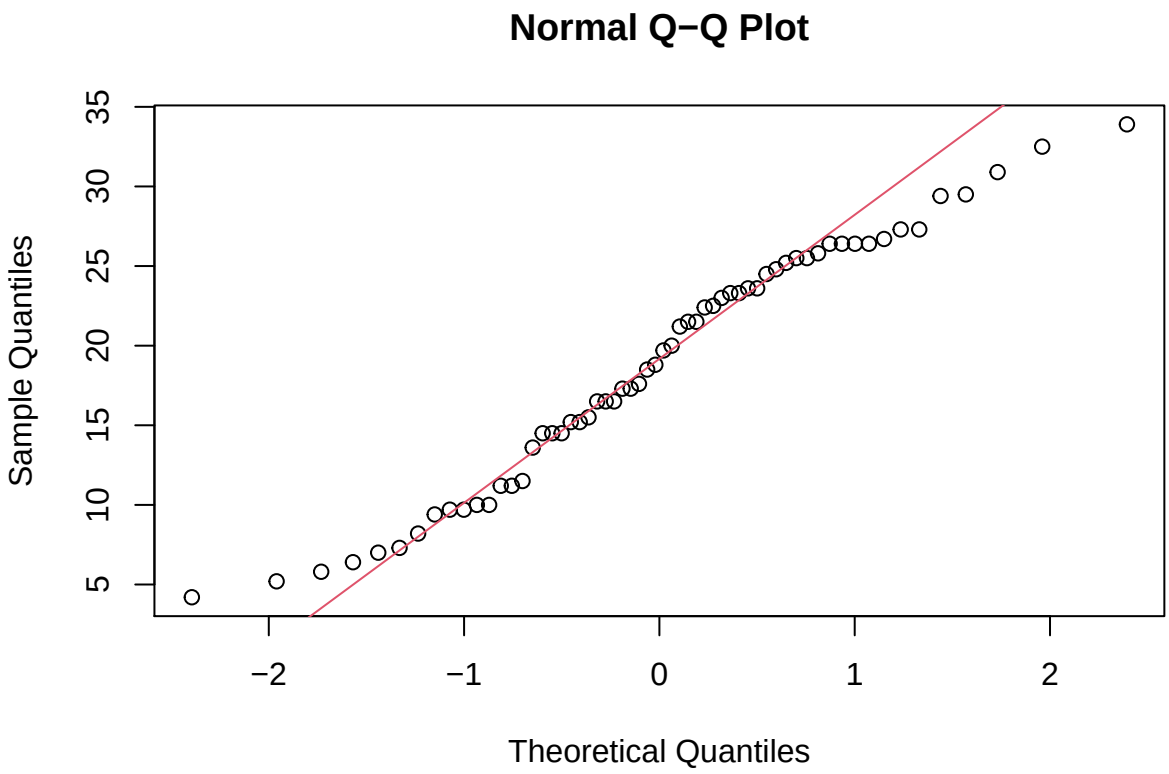


Plot 2: Tooth Length vs Supplement and Dose Levels



Plot 3:

```
qqnorm(ToothGrowth$len); qqline(ToothGrowth$len, col = 2)
```


Normal Q−Q Plot
Sample Quantiles
Theoretical Quantiles
5
10
15
20
25
30
35
−2
−1
0
1
2