Tooth Growth Analysis: Correlation with diet and Vitamin C

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Summary

This analysis pulls in the R data set looking at Tooth Growth. There is a strong correletion between the amount of supplement and tooth growth. At lower doses Orange Juice is found to be more effective but this difference disappears at higher does levels.

Get the data and take a quick look at it

```
data(ToothGrowth)   ##load data
```

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

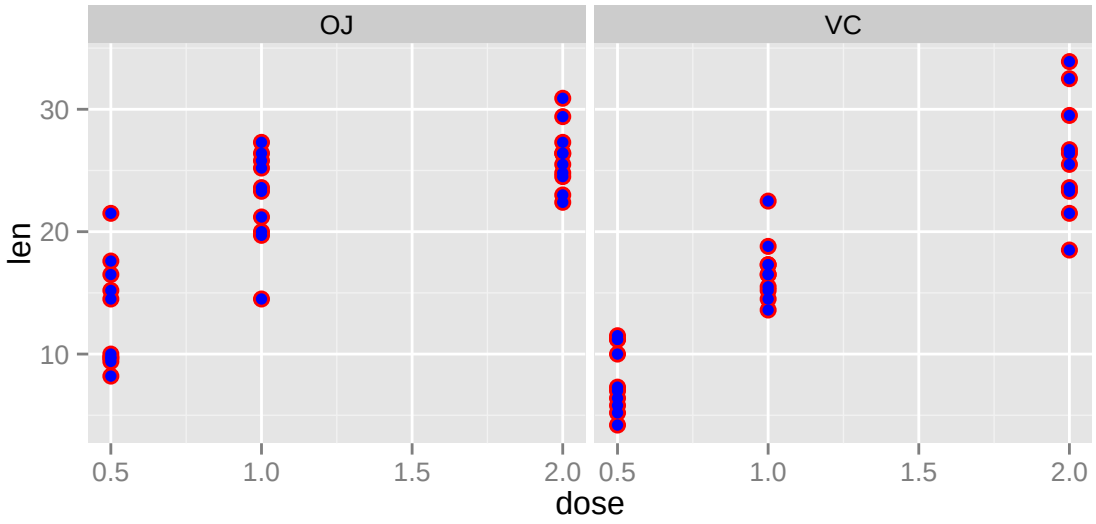
Exploratory Analysis

Here is a plot of the data showing behavior trends in tooth growth factored by supplement.

```
require(ggplot2)
```

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

```
pA<-ggplot(ToothGrowth, aes(x=dose, y = len))+geom_point(size = 3, colour="red")
pA<-pA+geom_point(size = 2, colour="blue")+facet_grid(. ~ supp)
pA ##Display Plot
```



A summary of the data shows they appear to be well behaved (10 unpaired observations at each condition) and do not require cleaning for this anlaysis.

```
##    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
```

Confidence Interval Analysis

The first step is to establish correlation of dose and tooth growth by looking at the statistical significance of the shift in the data with increasing dose. The conclusion after looking at all the pairs is that there is an upward trend (meaning higher doses correlate to statistically significant higher length) among all the data.

To keep the analysis part clean, first split up the data by Supplement and Dose

```
##Group the data into individual sets with somewhat descriptive names (Supplement and Dose)
        ##Vitamin C set
        VC05<-ToothGrowth[1:10,]
        VC10<-ToothGrowth[11:20,]
        VC20<-ToothGrowth[21:30,]
        ##Ornage Juice Set
        OJ05<-ToothGrowth[31:40,]
        OJ10<-ToothGrowth[41:50,]
        OJ20<-ToothGrowth[51:60,]
```

Vitamin C Data

Analysis shows that tooth growth is a monotonic function of dose. Some sample analysis (did not include all of it here for length reasons).

```
##T-test
a<- t.test(VC10$len, VC05$len, paried=FALSE)
lcb<-a$conf.int[1]
ucb<-a$conf.int[2]
```

Dose0.5 to Dose1.0 The confidence interval difference between tooth length at these doses is 6.3143 to 11.2657 which does not contain 0.

Dose1.0 to Dose2.0 The confidence interval difference between tooth length at these doses is 5.6857 to 13.0543 which does not contain 0.

Orange Juice Data

We can draw a similar conclusion that the correlation of increased does and tooth length is significnat statistically.

```
a<- t.test(OJ10$len, OJ05$len, paried=FALSE)
lcb<-a$conf.int[1]
ucb<-a$conf.int[2]
```

Dose0.5 to Dose1.0 The confidence interval difference between tooth length at these doses is 5.5244 to 13.4156 which does not contain 0.

```
a<- t.test(OJ10$len, OJ20$len, paried=FALSE)
lcb<-a$conf.int[1]
ucb<-a$conf.int[2]
```

Dose1.0 to Dose2.0 The confidence interval difference between tooth length from the Orange Juice and Vitamin C at doses of 1.0 is -6.5314 to -0.1886 which does contain 0.

Conclusion In all the cases above the shifts in the mean, both with increasing dose and the comparison of Vitamin C to Orange Juice are significant.

Compare Orange Juice and Vitamin C Data

With the trend now established we can check the hypothesis.

Hypothesis to be tested: ***Orange Juice is more effective (produces more tooth growth) than Vitamin C***

Test at dose of 1.0. The difference in tooth growth for Orange Juice and Vitamin C at a does on 1.0 can be compared.

```
b<-t.test(OJ10$len, VC10$len, paired=FALSE, var.equal=TRUE)
```

The anlaysis shows that for OJ10 and VC10 using the Two Sample t-test the t-statistic is 18 and the confidence interval is 2.8407 and 9.0193.

For var.equal=FALSE There is an explicit assumpthion that the variances of the two data are the same. We can check to see whether this has an influence on the outcome as below.

Note that for the assumption var.equal=FALSE analysis shows the t-statistic is 15.3577 and the confidence interval is 2.8021 and 9.0579. Not significantly different than above.

```
b<-t.test(OJ20$len, VC20$len, paired=FALSE, var.equal=TRUE)
```

Test at dose of 2.0 The anlaysis shows that for OJ20 and VC20 using the Two Sample t-test the t-statistic is 18 and the confidence interval is -3.723 and 3.563. This confidence interval spans zero.

Assumptions

The comparision anlaysis assumes that the variances of the distributions are equal between the Orange Juice and the Vitamin C populations. I tested this in one case and found that removing the assumption did not change the outcome.

Conclusion

The hypothesis that Orange Juice is more effective than Vitamin C in tooth length increases is **FALSE** since at higher doses the difference in the outcome includes zero.

However, at lower dose = 1.0, Orange Juice is more effective than vitamin C to a high degree of statistical signifance since the confidence interval does not contain zero.