

ToothGrowth Data Analysis

Summary

The `ToothGrowth` data set relates to the effect of supplement type, orange juice (OJ) and Vitamin C (VC), on the tooth growth of guinea pigs. It contains 60 samples relating to the tooth length (`len`), supplement type (`supp`), and dosage (`dose`). Refer to [The Effect of Vitamin C on Tooth Growth in Guinea Pigs](https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/ToothGrowth.html) (<https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/ToothGrowth.html>) for a full reference.

In this study, we use the tooth growth data set to explore the correlation between supplement type and tooth growth.

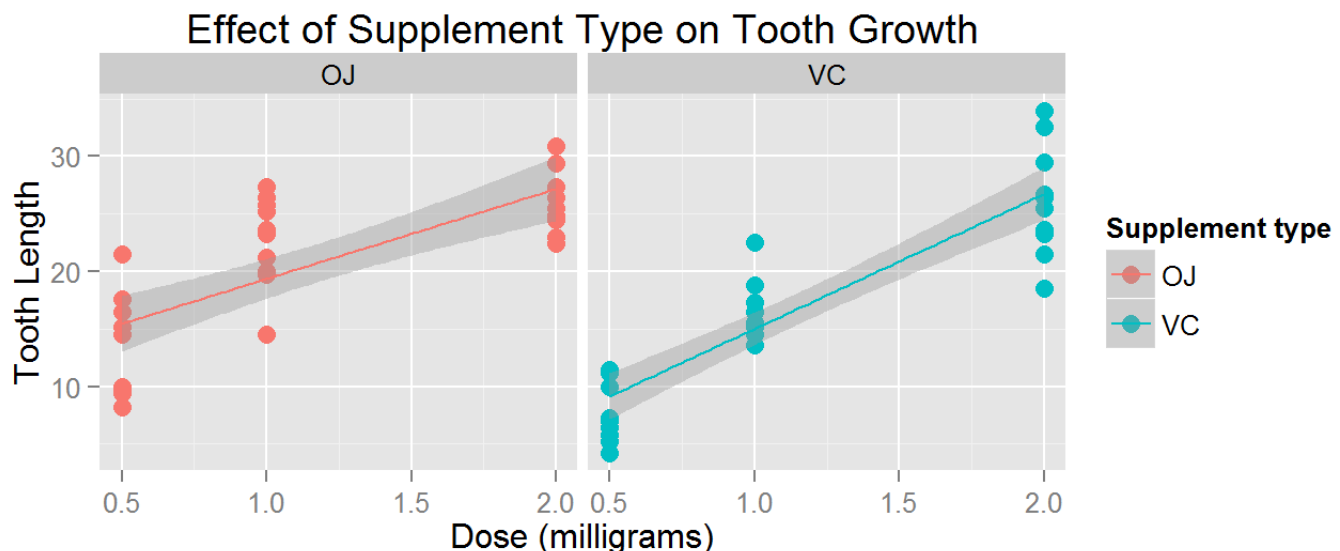
Exploratory Data Analysis

We can see that the data set contains a discrete number of dosages:

```
unique(ToothGrowth$dose)
```

```
## [1] 0.5 1.0 2.0
```

Let's illustrate the effect of supplement type on tooth growth using the following figure.

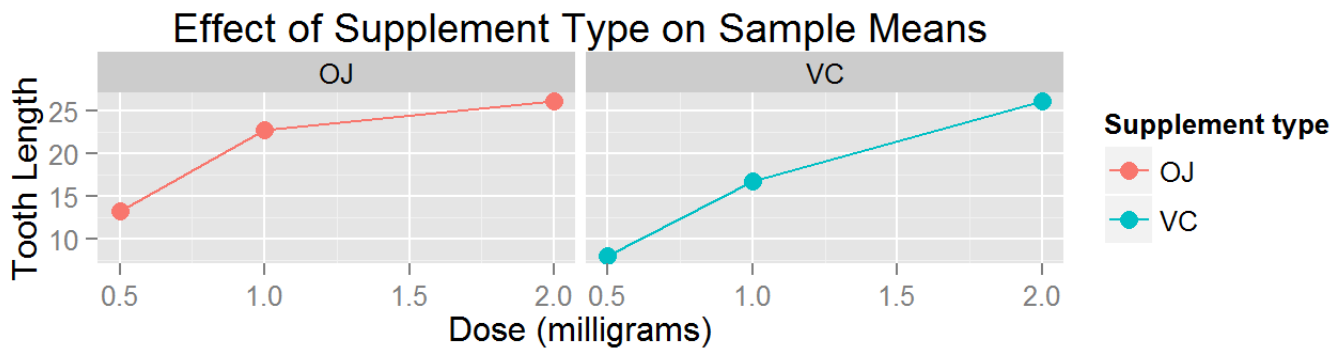


We can see that there seems to be a positive correlation between tooth growth and dosage from the linear regression lines. It seems that tooth growth increases when increasing the supplements dosage for both orange juice and Vitamin C.

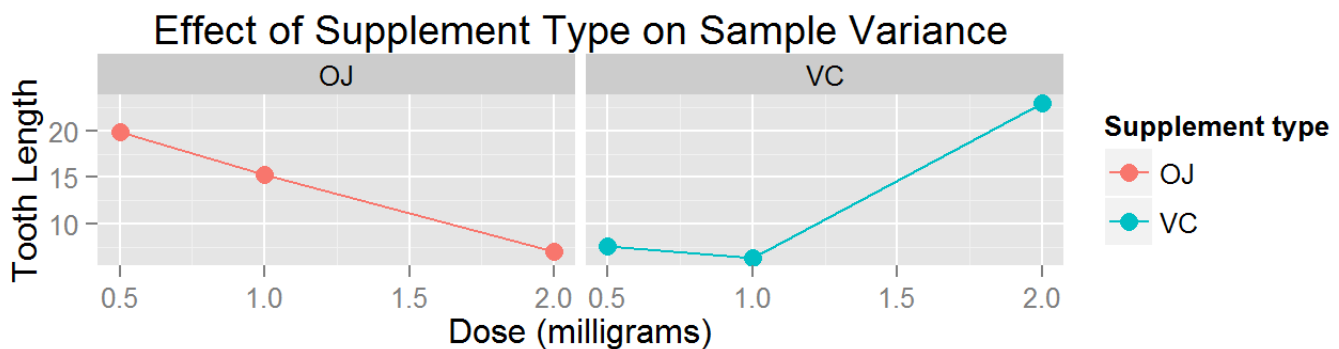
The following code calculates the tooth length means and variances by dosage and supplement type.

```
library(data.table)
tooth.data <- as.data.table(ToothGrowth)
tooth.summary <- tooth.data[, list(mean=mean(len), var=var(len)), keyby=list(dose, supp)]
```

Sample means also point towards a positive correlation. Orange juice seems to have higher growth than Vitamin C for 0.5mg and 1mg dosages while both supplements seem to exhibit the same growth for 2mg. These can be seen in the following figure.



Orange juice variance is high for 0.5mg and 1mg dosages while low for 2mg. Vitamin C variance is low for 0.5mg and 1mg dosages while high for 2mg. These are illustrated in the following figure.



Relevant Confidence Intervals

We use t-confidence intervals to analyze the impact of supplement type on tooth growth. The following tests if orange juice is better than Vitamin C for a 0.5mg dosage.

```
t.test(tooth.data[dose==0.5 & supp=='OJ',len], tooth.data[dose==0.5 & supp=='VC',len], 'greater')
```

```
##
## Welch Two Sample t-test
##
## data:  tooth.data[dose == 0.5 & supp == "OJ", len] and tooth.data[dose == 0.5 & supp == "VC", len]
## t = 3.1697, df = 14.969, p-value = 0.003179
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  2.34604      Inf
## sample estimates:
## mean of x mean of y
##    13.23    7.98
```

We can see that orange juice is indeed better than Vitamin C for 0.5mg with 95% confidence. Performing the same for 1mg yields the following.

```
t.test(tooth.data[dose==1 & supp=='OJ',len], tooth.data[dose==1 & supp=='VC',len], 'greater')
```

```
##
## Welch Two Sample t-test
##
## data:  tooth.data[dose == 1 & supp == "OJ", len] and tooth.data[dose == 1 & supp == "VC", len]
## t = 4.0328, df = 15.358, p-value = 0.0005192
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  3.356158      Inf
## sample estimates:
## mean of x mean of y
##    22.70    16.77
```

Again, we can see that orange juice is indeed better than Vitamin C with 95% confidence. Performing the same for 2mg yields the following.

```
t.test(tooth.data[dose==2 & supp=='OJ',len], tooth.data[dose==2 & supp=='VC',len], 'greater')
```

```
##
## Welch Two Sample t-test
##
## data:  tooth.data[dose == 2 & supp == "OJ", len] and tooth.data[dose == 2 & supp == "VC", len]
## t = -0.0461, df = 14.04, p-value = 0.5181
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
## -3.1335      Inf
## sample estimates:
## mean of x mean of y
##    26.06    26.14
```

Having a negative correlation implies that orange juice isn't statistically significantly better than Vitamin C.

Assumptions and Conclusions

We found that orange juice enables higher tooth growth than Vitamin C for 0.5mg and 1mg dosages with 95% confidence. Based on our exploratory analysis, we also found that both supplement types enable a higher tooth growth rate. At 2mg dosage, we found that there is no statistical significance in growth rate between both supplement types.