# Analysis of supplements in tooth growth

Introduction

The response is the length of teeth in each of 10 guinea pigs at each of three dose levels of Vitamin C (0.5, 1, and 2 mg) with each of two delivery methods (orange juice or ascorbic acid).

Data exploration

```
par(mfrow = c(1,2))
p1 <- ggplot(ToothGrowth, aes(x = factor(dose), y = len, fill = factor(dose)))
p1 + geom_boxplot() + guides(fill=FALSE) + facet_grid(. ~ supp)
```
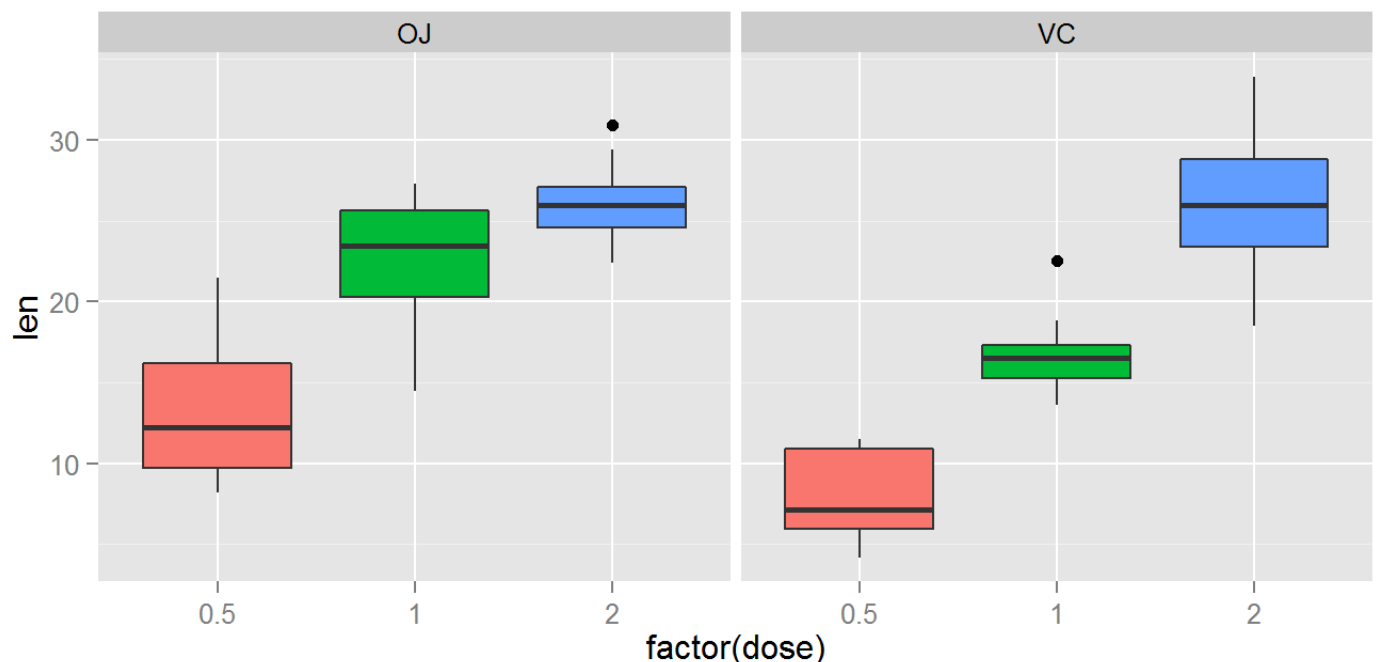

After plotting the data as boxplots a number of correlations were observed. The length of the tooth increases as the dosage increases. The OJ delivery method yields a greater length than the VC (approximately 10mm) for smaller dosages but the difference is negligable by a 2mg dosage.

Statistical inference

The tooth growth was compared by supplement for each dosage under the null hypothesis that each supplement has the same effect at a certain dosage on the tooth.

$H_0 : \mu_{OJ|0.5} = \mu_{VC|0.5}$

$H_0 : \mu_{OJ|1.0} = \mu_{VC|1.0}$

$H_0 : \mu_{OJ|2.0} = \mu_{VC|2.0}$

```
# split the data up by dosages
d0.5 <- subset(ToothGrowth, dose == 0.5)
d1.0 <- subset(ToothGrowth, dose == 1.0)
d2.0 <- subset(ToothGrowth, dose == 2.0)

# conduct a t-test between supplements
test0.5 <- t.test(len ~ supp, paired = FALSE, var.equal = FALSE, data = d0.5)
test0.5$p.value; test0.5$conf[1]
```

```
## [1] 0.006359
```

```
## [1] 1.719
```

```
test1.0 <- t.test(len ~ supp, paired = FALSE, var.equal = FALSE, data = d1.0)
test1.0$p.value; test1.0$conf[1]
```

```
## [1] 0.001038
```

```
## [1] 2.802
```

Dosages 1.0 and 1.5 have significant p-values of 0.006359 and 0.001038 respectively indicating that the difference in mean values between the supplements is significant. Dosage 1.0 has a confidence interval of 1.719-8.781 and dosage 2.0 has a confidence interval of 2.802-9.058.

```
test2.0 <- t.test(len ~ supp, paired = FALSE, var.equal = FALSE, data = d2.0)
test2.0$p.value; test2.0$conf[1]
```

```
## [1] 0.9639
```

```
## [1] -3.798
```

Dosage 3.0 has a very high p-value of 0.9639 and a confidence interval below zero -3.798-3.638. This indicates that there is no significance between the supplements at this dosage. This is also intuitive from the earlier boxplot.

Conclusions

The supplements orange juice and ascorbic acid have different effects on tooth length for lower dosages of vitamin C according to the t-test. Orange juice yields a longer tooth for dosages of 0.5 and 1.0mg. However at a dosage of 3.0mg there is no change in tooth length.

Assumptions

- The supplements have a treatment effect and there are no other fconfounding factors.
- Samples are unpaired, with unequal variances.
- Guinea pigs are essentially identical - size, diet etc.