Effect of Vitamin C dose and delivery method on guinea pig tooth growth

Marc T. Henry de Frahan

Synopsis

Load some libraries

```
library(dplyr)
library(ggplot2)
```

Exploratory Data Analysis

Let's first load the data and get some basic information from the data set. We also transform the dose variable to a factor, which will be easier to use later on.

```
df <- ToothGrowth
df <- df %>%
    mutate(dose = as.factor(dose)) %>%
    rename(delivery = supp)
str(df)
```

```
## '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 ...
## $ delivery: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 2 ...
## $ dose    : Factor w/ 3 levels "0.5","1","2": 1 1 1 1 1 1 1 1 1 1 ...
```

We are looking at 60 observations of tooth length where there are 2 delivery methods (orange juice (OJ) and ascorbic acid (VC)) and 3 dose levels (0.5, 1, 2).

Visualisation of the effect of the dose amount on tooth growth

As shown in this figure, there might be an effect of the dose amount on the tooth growth. We will explore this in more detail later.
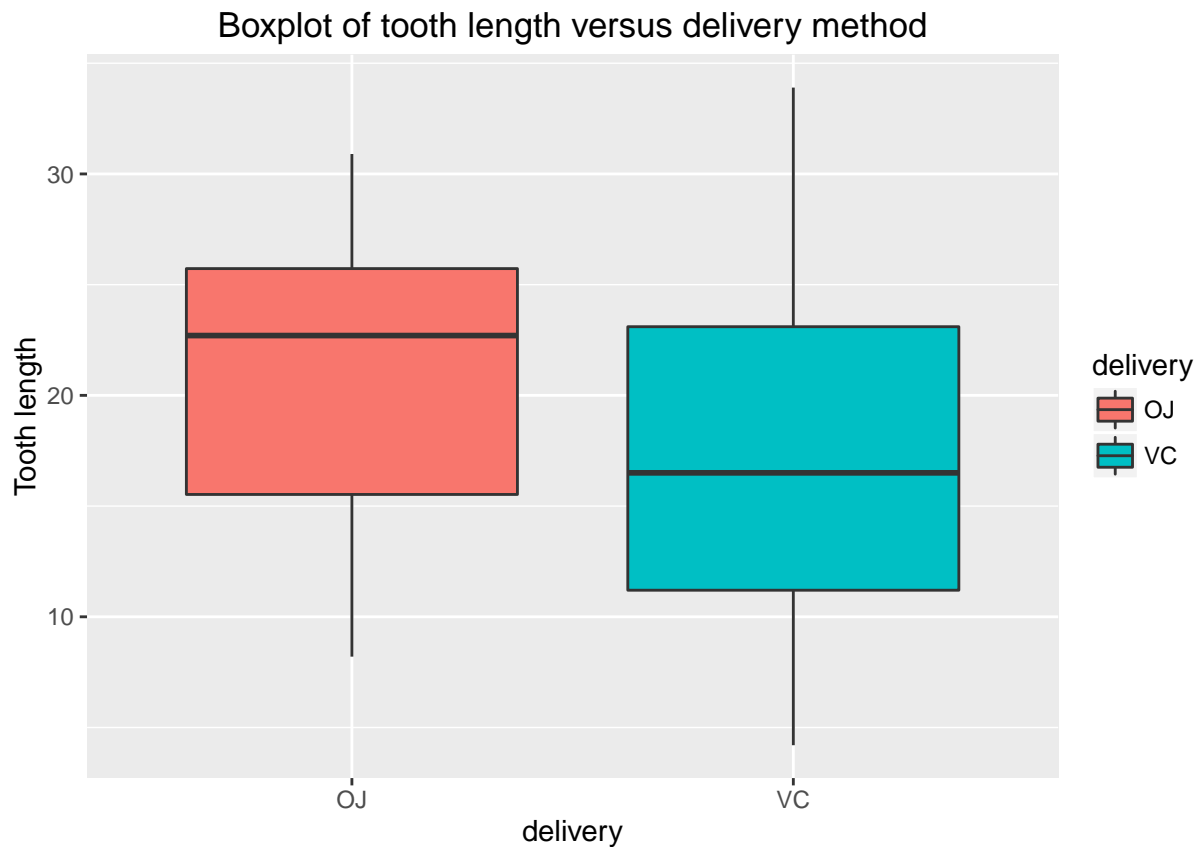
```
ggplot(data=df, aes(x=dose,y=len)) +
    geom_boxplot(aes(fill=dose)) +
    labs(x = "dose",
         y="Tooth length",
         title="Boxplot of tooth length versus dose");
```

Boxplot of tooth length versus dose
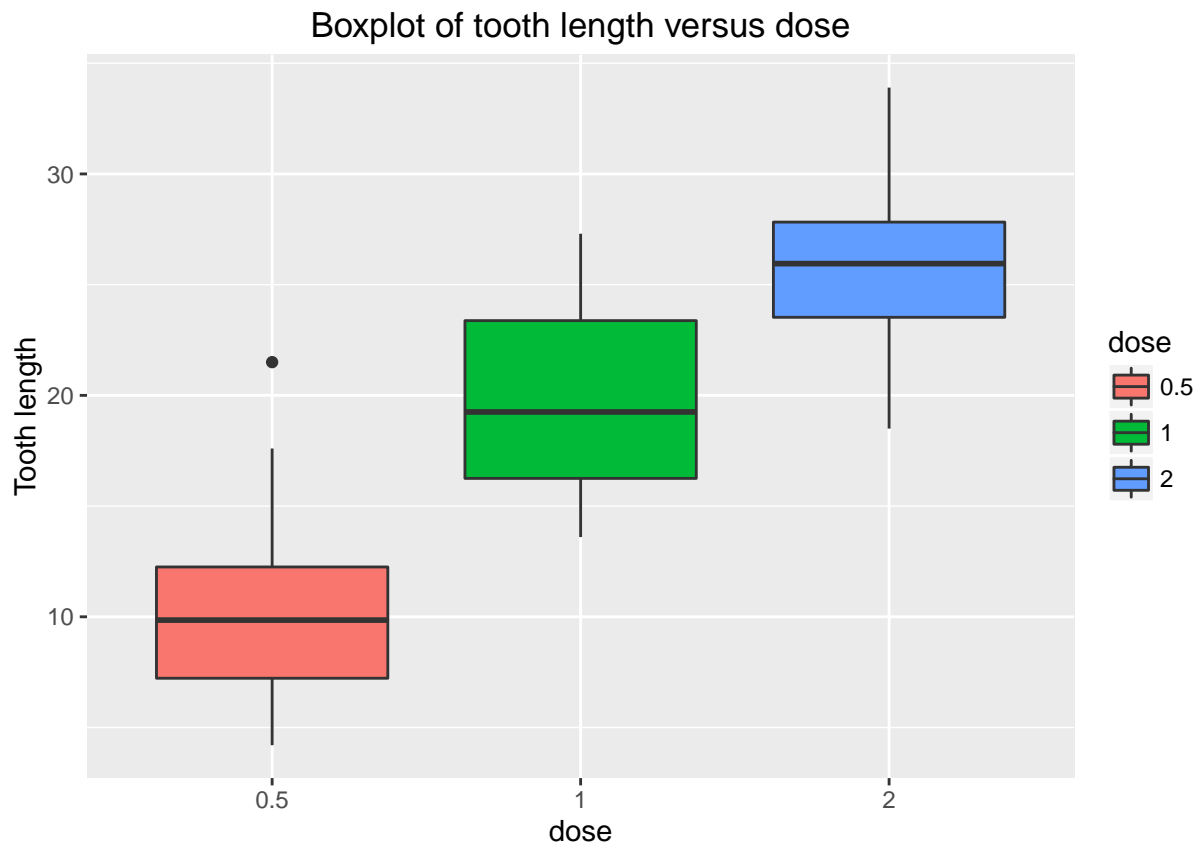
Visualisation of the effect of the delivery method on tooth growth

As shown in this figure, there does not seem to be much of an effect of the delivery method on tooth growth. We will explore this in more detail later.

```
ggplot(data=df, aes(x=delivery,y=len)) +
    geom_boxplot(aes(fill=delivery)) +
    labs(x = "delivery",
         y="Tooth length",
         title="Boxplot of tooth length versus delivery method");
```

Boxplot of tooth length versus delivery method

Visualisation of the effect of dose and the delivery method on tooth growth

For each delivery method, let's look at the effect of the dose on the tooth growth.

```
ggplot(data=df, aes(x=dose,y=len)) +
    geom_boxplot(aes(fill=dose)) +
    facet_wrap(~ delivery) +
    labs(x = "delivery",
        y="Tooth length",
        title="Boxplot of tooth length");
```

Boxplot of tooth length
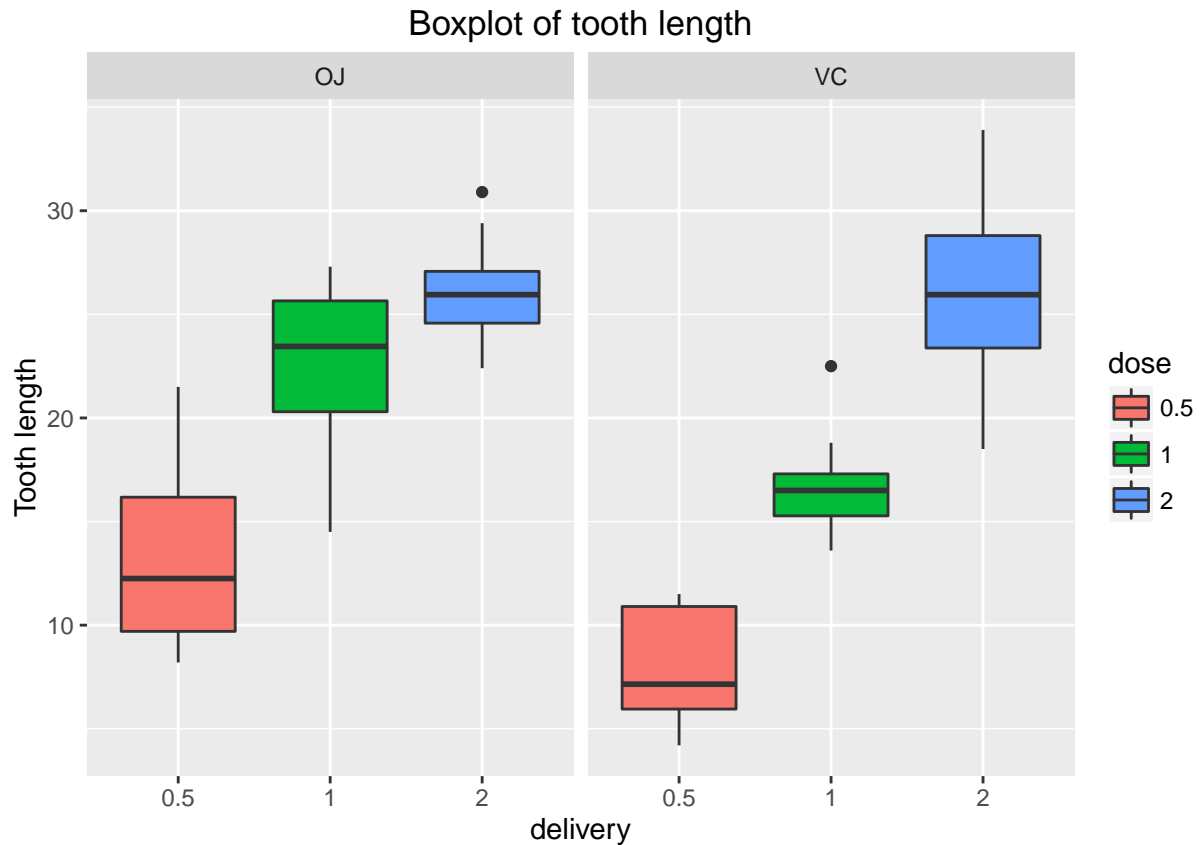
Our exploratory analysis seems to indicate that increasing the dose amount increases the tooth length. Using orange juice might boost the tooth length at lower doses compared to ascorbic acid but that effect looks like it dissappears for a dose of 2 mg.

Questions and Key Assumptions

Our analysis will seek to answer two questions:

1. Does the dose amount change the tooth growth?
2. Does the delivery method change the tooth growth?

For our analysis to hold, we make the following key assumptions about the data:

*

Hypothesis Tests

Does the dose amount change the tooth growth?

The null hypothesis is that the dose amount does not affect the tooth growth, i.e. for the difference doses, the difference in the means is zero. The alternative the is that the dose amount does affect the tooth growth. We perform hypothesis testing between each of the difference doses to see if we can reject the null hypothesis.

```
dose_test12 <- t.test(len ~ dose, data = df[df$dose %in% c(0.5,1),], paired = F, var.equal = F)
```

The resulting confidence interval is [-11.9837813, -6.2762187] and does not contain zero.

```
dose_test23 <- t.test(len ~ dose, data = df[df$dose %in% c(1,2),], paired = F, var.equal = F)
```

The resulting confidence interval is [-8.9964805, -3.7335195] and does not contain zero.

```
dose_test13 <- t.test(len ~ dose, data = df[df$dose %in% c(0.5,2),], paired = F, var.equal = F)
```

The resulting confidence interval is [-18.1561665, -12.8338335] and does not contain zero.

None of the confidence intervals contain zero so we can reject the null hypothesis. Increasing the dose does indeed increase the tooth growth.

Does the delivery method change the tooth growth?

The null hypothesis is that the delivery method does not affect the tooth growth, i.e. the difference in the means is zero. The alternative then is that the delivery method does affect the tooth growth. We perform hypothesis testing to see if we can reject the null hypothesis:

```
delivery_test <- t.test(len ~ delivery, data = df, paired = F, var.equal = F)
```

The resulting confidence interval is [-0.1710156, 7.5710156]. Since this interval contains zero, we can not reject the null hypothesis. This means that the delivery method does not affect tooth growth.

Conclusions

Appendix