

Guinea Pig Tooth Growth Experiment

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04 settembre 2017

Overview

In this document we analyze the ToothGrowth dataset, taken from the R datasets package and titled “The Effect of Vitamin C on Tooth Growth in Guinea Pigs”. This dataset shows the response is the length of odontoblasts (cells responsible for tooth growth) in 60 guinea pigs. We start the analysis providing some summary of the data. Then we perform some basic exploratory data analysis and at the last we use the hypothesis test to compare tooth growth by quantity and delivery method.

Data Summary

After loading the data, we start showing the dimensions of the dataset.

```
data(ToothGrowth)
dim(ToothGrowth)
```

```
## [1] 60  3
```

Then we print the first rows of the dataset, to show the kind of data it contains.

```
head(ToothGrowth)
```

```
##      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
## 6  10.0   VC  0.5
```

To know the type of the column of the dataset we use the command ‘str’

```
str(ToothGrowth)
```

```
## '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 ...
##  $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

The ‘len’ indicates the odontoblasts length in mm. The ‘dose’ is the amount of vitamin C in mg/day. The ‘supp’ is the delivery method, with OJ which stands for orange juice and VC for ascorbic acid. At the last we show some statistics about the measures of the tooth in the dataset:

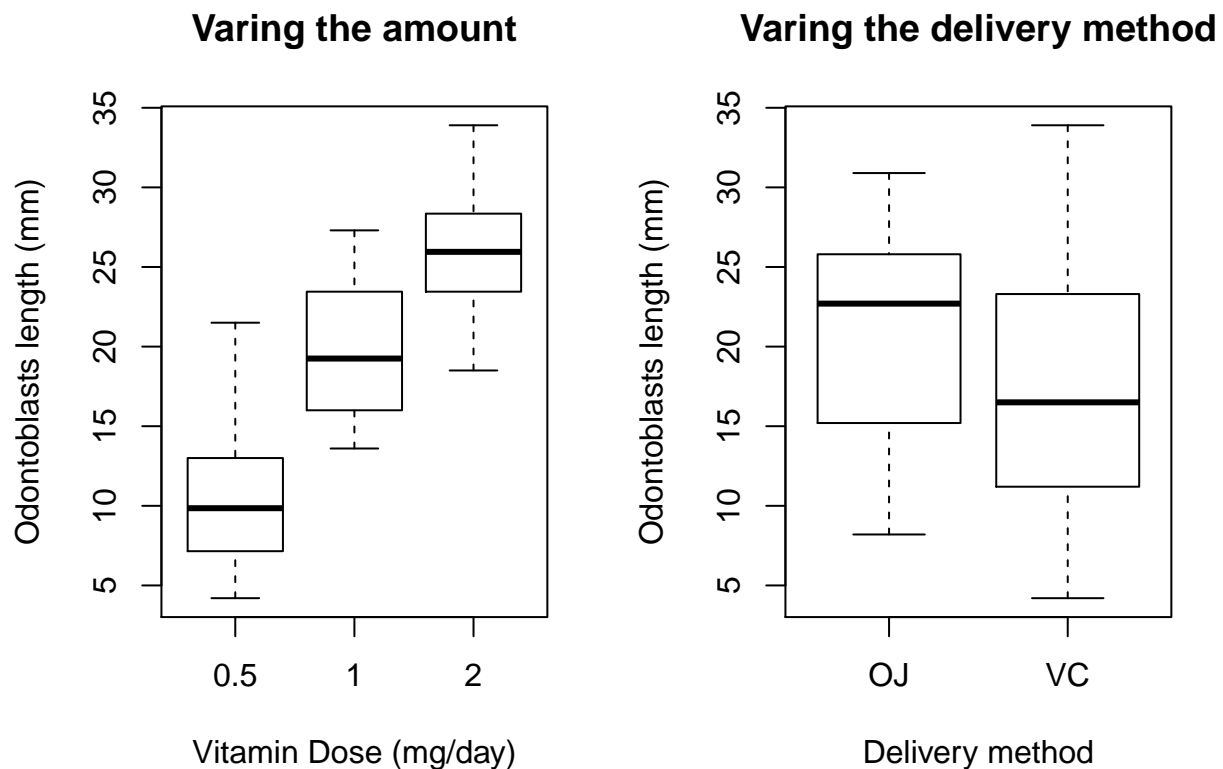
```
summary(ToothGrowth$len)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      4.20   13.07   19.25   18.81   25.27   33.90
```

Exploratory data analysis

We draw two boxplot to show graphically how the grows of the teeth changes when the amount and the delivery method of the vitamin C change.

```
par(mfrow=c(1,2))
boxplot(len ~ dose, data = ToothGrowth, main = "Varing the amount" ,
        xlab="Vitamin Dose (mg/day)", ylab="Odontoblasts length (mm)")
boxplot(len ~ supp, data = ToothGrowth, main = "Varing the delivery method",
        xlab="Delivery method", ylab="Odontoblasts length (mm)")
```



We note that the lenght of the teeth grows very much when we increase the dose of the vitamin C and doesn't grow so much when we change the delivery method.

Hypothesis Test

Starting with what we saw in the exploratory data analysis, we use the hypothesis test to prove that the lenght of the teeth depends of the dose of vitamin C:

```
library(dplyr)

dose2.0 <- filter(ToothGrowth, dose == 2)
dose1.0 <- filter(ToothGrowth, dose == 1)

t.test(dose2.0$len, dose1.0$len, paired = F, var.equal = T, alternative = "greater")

##
```

```
## Two Sample t-test
##
## data: dose2.0$len and dose1.0$len
## t = 4.9005, df = 38, p-value = 9.054e-06
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  4.175196      Inf
## sample estimates:
## mean of x mean of y
##    26.100    19.735

dose1.0 <- filter(ToothGrowth, dose == 1)
dose0.5 <- filter(ToothGrowth, dose == 0.5)

t.test(dose1.0$len, dose0.5$len, paired = F, var.equal = T, alternative = "greater")

##
## Two Sample t-test
##
## data: dose1.0$len and dose0.5$len
## t = 6.4766, df = 38, p-value = 6.331e-08
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  6.753344      Inf
## sample estimates:
## mean of x mean of y
##    19.735    10.605

Then we do the same for the delivery method:

VC <- filter(ToothGrowth, supp == 'VC')
OJ <- filter(ToothGrowth, supp == 'OJ')

t.test(OJ$len, VC$len, paired = F, var.equal = T, alternative = "greater")

##
## Two Sample t-test
##
## data: OJ$len and VC$len
## t = 1.9153, df = 58, p-value = 0.0302
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  0.4708204      Inf
## sample estimates:
## mean of x mean of y
##  20.66333  16.96333
```

Conclusions

The hypothesis test confirms the exploratory data analysis. The growth of the teeth depends a lot on the quantity of the vitamin C given to the Guinea pigs (proven by a p-value very little) and also depends on the delivery method of the vitamin C, even if less (bigger value of the p-value).