

Coursera Statistical Tooth Growth Analysis

Aman Sinha

07/11/2015

GitHub: <https://github.com/amansinha16/Statistical-inference-project>
(<https://github.com/amansinha16/Statistical-inference-project>)

RPub: <http://rpubs.com/amansinha/124200> (<http://rpubs.com/amansinha/124200>)

Overview

Load the ToothGrowth data and perform some basic exploratory data analyses

```
library(ggplot2)
library(plyr)
library(datasets)
data(ToothGrowth)
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 2 ...
## $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

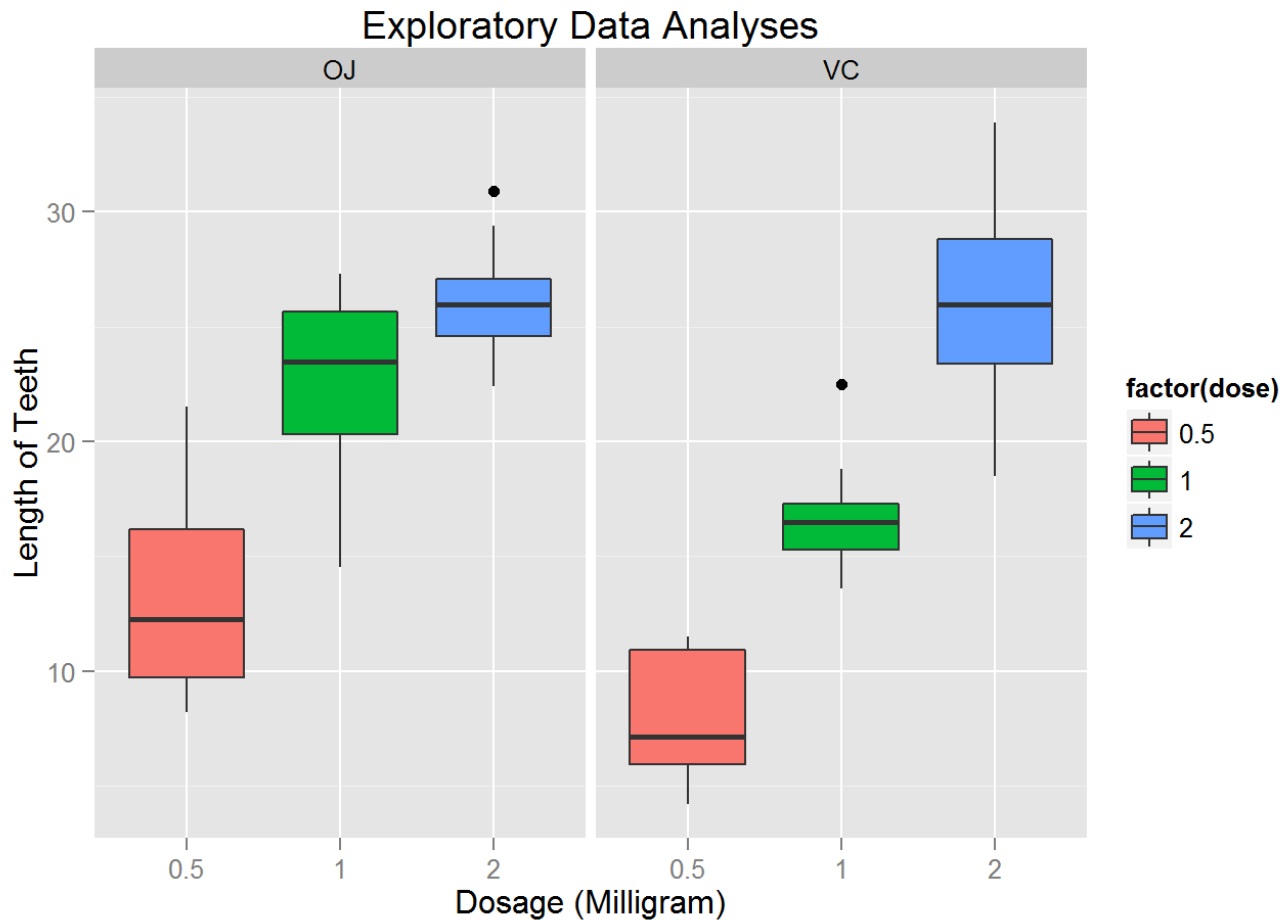
```
head(ToothGrowth)
```

```
##      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
```

Analysis

1.a) Load the data

```
plot <- ggplot(ToothGrowth,
               aes(x=factor(dose),y=len,fill=factor(dose)))
plot + geom_boxplot(notch=F) + facet_grid(.~supp) +
  scale_x_discrete("Dosage (Milligram)") +
  scale_y_continuous("Length of Teeth") +
  ggtitle("Exploratory Data Analyses")
```



1.b) Basic exploratory data analysis

Have a quick glance what this data is like

```
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 2 ...
## $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

It's not immediately self explanatory, reading the help using `help(ToothGrowth)` we gather the following information

We have 3 columns in `ToothGrowth` dataset

Name	Type	Values
len	numeric	Tooth length
supp	factor	VC or OJ
dose	numeric	Dose in milligrams

And it tracks the response is the length of odontoblasts (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, OJ or VC respectively).

2. Summary

Observe R summary result

```
summary(ToothGrowth)
```

```
##          len          supp          dose
##  Min.   : 4.20    OJ:30    Min.   :0.500
##  1st Qu.:13.07    VC:30    1st Qu.:0.500
##  Median :19.25                Median :1.000
##  Mean   :18.81                Mean   :1.167
##  3rd Qu.:25.27                3rd Qu.:2.000
##  Max.   :33.90                Max.   :2.000
```

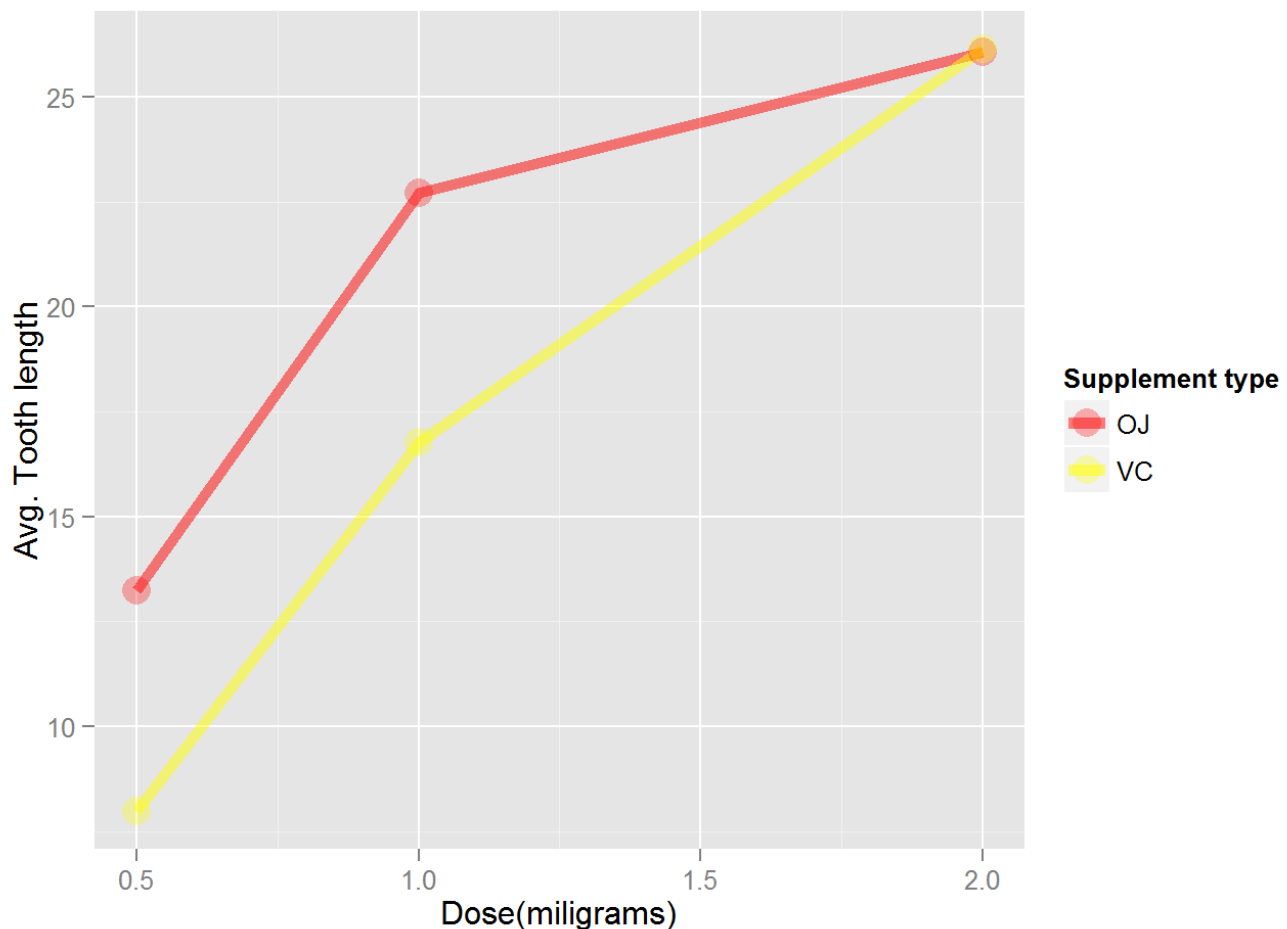
Inspecting test distributions by supplement and dose

```
table(ToothGrowth$dose, ToothGrowth$supp)
```

```
##
##          OJ VC
##  0.5 10 10
##  1   10 10
##  2   10 10
```

10 tests for each pair.

```
agg <- aggregate(len ~ dose + supp, ToothGrowth, mean)
ggplot(agg, aes(x=dose, y=len, colour = supp)) +
  geom_line(size=2, alpha=.5) + geom_point(size=5, alpha=.3) +
  xlab("Dose(miligrams)") + ylab("Avg. Tooth length") +
  guides(colour=guide_legend(title="Supplement type")) +
  scale_color_manual(values = c("red", "yellow"))
```



There seems to be a correlation between the dose and tooth growth, where Orange Juice is more effective for lower doses, where the 2 milligram seems to be the maximum effect point.

3. Comparison of tooth growth by supp and dose

To verify that that our conclusions based on the sample diagram, we need identify the confidence interval for each of the supplement/dose.

```
ddply(ToothGrowth, dose ~ supp, function(x)
c(mean=mean(x$len), sd=sd(x$len),
conf.int=t.test(x$len)$conf.int))
```

```
##   dose supp  mean      sd conf.int1 conf.int2
## 1  0.5   OJ 13.23 4.459709 10.039717 16.420283
## 2  0.5   VC  7.98 2.746634  6.015176  9.944824
## 3  1.0   OJ 22.70 3.910953 19.902273 25.497727
## 4  1.0   VC 16.77 2.515309 14.970657 18.569343
## 5  2.0   OJ 26.06 2.655058 24.160686 27.959314
## 6  2.0   VC 26.14 4.797731 22.707910 29.572090
```

We observe that in 95% confidence interval the Ascorbic Acid(VC) intervals are pairwise disjoint so we can claim with high level of confidence that the length means are distinct, moreover there is a clear growth correlation between dose & length means.

By now we can also immediately identify with high level of confidence that For 0.5 and 1 milligrams Orange Juice have has greater impact on tooth growth (On the merit that for those 2 doses there confidence interval are pairwise disjoint).

For Orange Juice(OJ) supplement type, however, there is an overlap for dose 1 and 2 milligrams, and we are forced to look deeper.

```
t.test(len ~ dose, paired=FALSE, var.equal=TRUE,
data=subset(ToothGrowth, dose %in% c(1.0,2.0) & supp == 'OJ'))
```

```
##
## Two Sample t-test
##
## data: len by dose
## t = -2.2478, df = 18, p-value = 0.03736
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -6.5005017 -0.2194983
## sample estimates:
## mean in group 1 mean in group 2
##          22.70          26.06
```

The t value -2.2477612 being less than **qt(.025, 18) == -2.100922** allows us to assert that the mean length for 2 milligrams as greater than the for the 1 milligram dose.

In the 2.0 milligram dose there is an overlap between Orange Juice (OJ) and Ascorbic Acid (VC) let's dig deeper

```
t.test(len ~ supp, paired=FALSE, var.equal=FALSE,
data=subset(ToothGrowth, dose == 2.0))
```

```
##
## Welch Two Sample t-test
##
## data: len by supp
## t = -0.046136, df = 14.04, p-value = 0.9639
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -3.79807 3.63807
## sample estimates:
## mean in group OJ mean in group VC
##          26.06          26.14
```

The confidence Interval includes 0 and hence difference between the supplements types vis-a-vis mean lengths is insignificant.

4. Conclusion

We have conducted an analysis of the ToothGrowth data based on the assumptions that guinea pigs were randomly chosen and hence the population variance the same. We are also assuming that the samples are independent so the unpaired testing was employed.

Our analysis has shown with high confidence that there is a correlation between the supplement type used and teeth growth in guinea pigs, when for small doses of 0.5 and 1 milligrams, Orange Juice, clearly has an advantage.