

Analysis of toothgrowth data

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2015.12.25

[1] Basic explanatory analysis of ToothGrowth data from datasets

```
library(datasets)
library(ggplot2)
data(ToothGrowth)
help("ToothGrowth")

## starting httpd help server ... done

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 ...

summary(ToothGrowth)

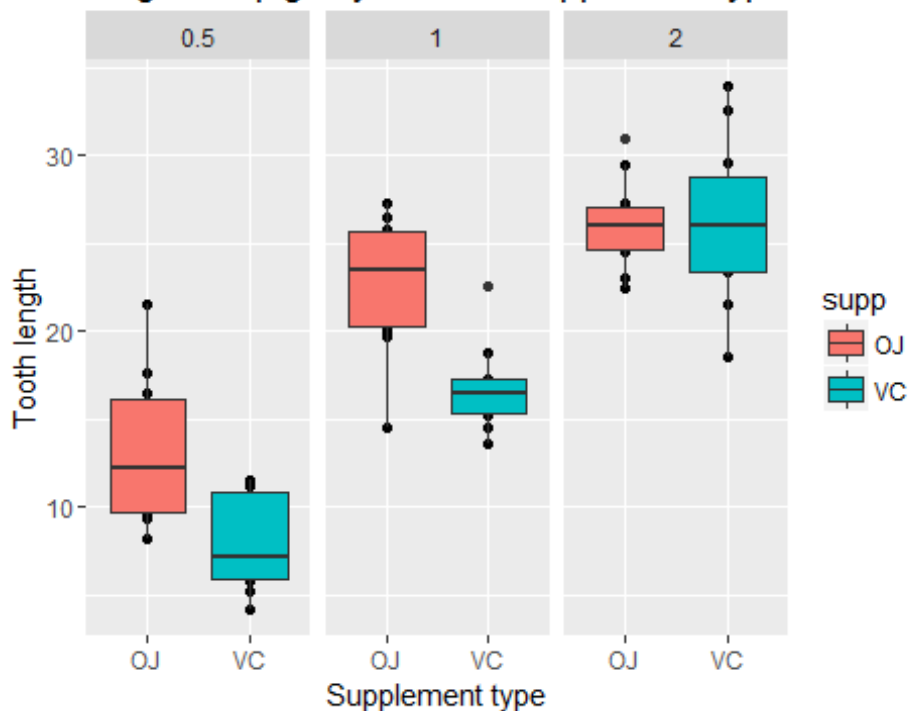
##      len      supp      dose
## Min.   : 4.20    OJ:30   Min.    :0.500
## 1st Qu.:13.07    VC:30   1st Qu.:0.500
## Median :19.25                Median :1.000
## Mean   :18.81                Mean    :1.167
## 3rd Qu.:25.27                3rd Qu.:2.000
## Max.   :33.90                Max.    :2.000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

This data has 60 observation, three variables (1)len(numeric): Tooth length (2) supp(factor): Supplement type (VC or OJ). (3) dose(numeric): Dose in milligrams/day

[2]. Summary of data by comparisons

```
#make plot to compare Tooth length with different supplement type for each dosage
g<-qplot(supp,len,data=ToothGrowth, facets=~dose, main="Tooth growth of guinea pigs by different supplement type in each dose",xlab="Supplement type", ylab="Tooth length")
g<-g+geom_boxplot(aes(fill = supp))
g
```

growth of guinea pigs by different supplement type in each dc



As we can observe in the plot, the average tooth length increases as the dose increases.

[3]. Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose. Hypothesis testing (1). Assumption: the variables are independent and identically distributed. Tooth growth follows a normal distribution. (2). Null hypothesis for different supplement type: There is no difference in tooth growth when using the supplement OJ and VC. Alternative hypothesis: There is a difference in tooth growth when using the supplement OJ and VC.

Null hypothesis for different dose: There is no difference in tooth growth when using different dose. Alternative hypothesis: There is a difference in tooth growth when using different dose.

Here we are going to use two-way ANOVA for identifying effects of supplement type and dose on tooth growth

#Perform two-way ANOVA to identify effects of supplement type, dose and their interaction

```
ToothGrowth$dose = factor(ToothGrowth$dose, levels=c(0.5,1.0,2.0), labels=c("low","med","high"))
ToothGrowth$supp=factor(ToothGrowth$supp,levels=c("OJ","VC"))
replications(len ~ supp+dose+supp:dose, data=ToothGrowth)
```

```
##      supp      dose supp:dose
##      30       20       10
```

```

anova<- aov(len ~ supp+dose+supp:dose, data=ToothGrowth)
summary(anova)

##              Df Sum Sq Mean Sq F value    Pr(>F)
## supp          1   205.3    205.3   15.572 0.000231 ***
## dose          2  2426.4   1213.2   92.000 < 2e-16 ***
## supp:dose      2   108.3     54.2    4.107 0.021860 *
## Residuals     54   712.1     13.2
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

As the result shows, there are two significant main effects and a significant interaction between dose and supp.

#Perform post hoc test to do pairwise comparison in different factors
TukeyHSD(anova)

```

##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = len ~ supp + dose + supp:dose, data = ToothGrowth)
##
## $supp
##      diff      lwr      upr    p adj
## VC-OJ -3.7 -5.579828 -1.820172 0.0002312
##
## $dose
##      diff      lwr      upr    p adj
## med-low  9.130  6.362488 11.897512 0.0e+00
## high-low 15.495 12.727488 18.262512 0.0e+00
## high-med  6.365  3.597488  9.132512 2.7e-06
##
## `$supp:dose`
##      diff      lwr      upr    p adj
## VC:low-OJ:low -5.25 -10.048124 -0.4518762 0.0242521
## OJ:med-OJ:low  9.47  4.671876 14.2681238 0.0000046
## VC:med-OJ:low  3.54 -1.258124  8.3381238 0.2640208
## OJ:high-OJ:low 12.83  8.031876 17.6281238 0.0000000
## VC:high-OJ:low 12.91  8.111876 17.7081238 0.0000000
## OJ:med-VC:low  14.72  9.921876 19.5181238 0.0000000
## VC:med-VC:low  8.79  3.991876 13.5881238 0.0000210
## OJ:high-VC:low 18.08 13.281876 22.8781238 0.0000000
## VC:high-VC:low 18.16 13.361876 22.9581238 0.0000000
## VC:med-OJ:med -5.93 -10.728124 -1.1318762 0.0073930
## OJ:high-OJ:med  3.36 -1.438124  8.1581238 0.3187361
## VC:high-OJ:med  3.44 -1.358124  8.2381238 0.2936430
## OJ:high-VC:med  9.29  4.491876 14.0881238 0.0000069
## VC:high-VC:med  9.37  4.571876 14.1681238 0.0000058
## VC:high-OJ:high 0.08 -4.718124  4.8781238 1.0000000

```

4. **Conclusions** The above results indicate that different supplement types result in different tooth growth. Different doses of a supplement type also result in different tooth growth.