Statistical Inference 2

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May 17, 2020

# Statistical Inference Part-2

## Overview

ToothGrowth data is loaded and some basic exploratory data analyses is peformed Basic Summarixations of the data is done Confidence intervals and/or hypothesis tests are used to compare tooth growth by supp and dose. The finally few conclusions are made along with assumptions needed for those conclusions.

## Data Import

# Libraries  
library(ggplot2)  
library(datasets)  
library(gridExtra)  
library(GGally)

## Registered S3 method overwritten by 'GGally':  
## method from   
## +.gg ggplot2

# Vitamin C effect on Tooth Growth in Guinea Pigs  
data(ToothGrowth)  
toothGrowth <- ToothGrowth   
toothGrowth$dose <- as.factor(toothGrowth$dose)

## Summaries

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: Factor w/ 3 levels "0.5","1","2": 1 1 1 1 1 1 1 1 1 1 ...

summary(toothGrowth)

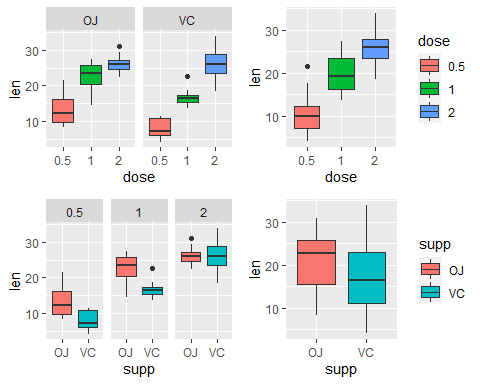
## len supp dose   
## Min. : 4.20 OJ:30 0.5:20   
## 1st Qu.:13.07 VC:30 1 :20   
## Median :19.25 2 :20   
## Mean :18.81   
## 3rd Qu.:25.27   
## Max. :33.90

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

table(toothGrowth$supp, toothGrowth$dose)

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



Analysis of Variance (ANOVA)

anova.out <- aov(len ~ supp \* dose, data=toothGrowth)  
summary(anova.out)

## Df Sum Sq Mean Sq F value Pr(>F)   
## supp 1 205.4 205.4 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

Observation: There is a relationship between the length (len) and dosage (dose) (F(1,54)=15.572;p<0.01) length(len) and supplement type (supp) (F(2,54)=92;p<0.01). Combination of supplement type (supp) and dosage (dose) compared to the length (len) (F(2,54)=4.107;p<0.05).

TukeyHSD(anova.out)

## Tukey multiple comparisons of means  
## 95% family-wise confidence level  
##   
## Fit: aov(formula = len ~ 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  
## 1-0.5 9.130 6.362488 11.897512 0.0e+00  
## 2-0.5 15.495 12.727488 18.262512 0.0e+00  
## 2-1 6.365 3.597488 9.132512 2.7e-06  
##   
## $`supp:dose`  
## diff lwr upr p adj  
## VC:0.5-OJ:0.5 -5.25 -10.048124 -0.4518762 0.0242521  
## OJ:1-OJ:0.5 9.47 4.671876 14.2681238 0.0000046  
## VC:1-OJ:0.5 3.54 -1.258124 8.3381238 0.2640208  
## OJ:2-OJ:0.5 12.83 8.031876 17.6281238 0.0000000  
## VC:2-OJ:0.5 12.91 8.111876 17.7081238 0.0000000  
## OJ:1-VC:0.5 14.72 9.921876 19.5181238 0.0000000  
## VC:1-VC:0.5 8.79 3.991876 13.5881238 0.0000210  
## OJ:2-VC:0.5 18.08 13.281876 22.8781238 0.0000000  
## VC:2-VC:0.5 18.16 13.361876 22.9581238 0.0000000  
## VC:1-OJ:1 -5.93 -10.728124 -1.1318762 0.0073930  
## OJ:2-OJ:1 3.36 -1.438124 8.1581238 0.3187361  
## VC:2-OJ:1 3.44 -1.358124 8.2381238 0.2936430  
## OJ:2-VC:1 9.29 4.491876 14.0881238 0.0000069  
## VC:2-VC:1 9.37 4.571876 14.1681238 0.0000058  
## VC:2-OJ:2 0.08 -4.718124 4.8781238 1.0000000

Observation : There are significant differences between each of the groups in supp and dose Only the interactions between VC:0.5-OJ:0.5; VC:1-OJ:0.5; OJ:2-OJ:1; VC:2-OJ:1 and VC:2-OJ:2 are not significant

confint(anova.out)

## 2.5 % 97.5 %  
## (Intercept) 10.9276907 15.532309  
## suppVC -8.5059571 -1.994043  
## dose1 6.2140429 12.725957  
## dose2 9.5740429 16.085957  
## suppVC:dose1 -5.2846186 3.924619  
## suppVC:dose2 0.7253814 9.934619

print(model.tables(anova.out,"means"),digits=3)

## Tables of means  
## Grand mean  
##   
## 18.81333   
##   
## supp   
## supp  
## OJ VC   
## 20.66 16.96   
##   
## dose   
## dose  
## 0.5 1 2   
## 10.60 19.73 26.10   
##   
## supp:dose   
## dose  
## supp 0.5 1 2   
## OJ 13.23 22.70 26.06  
## VC 7.98 16.77 26.14

## Conclusions

Supplement and the dosage have clear individual effects on the length of teeth in guinea pigs. More the means on average longer teeth. Supplement type has a clear influence but OJ has a greater avarage teethgrowth in combination with dosages 0.5 and 1 then for the VC supplement. While teeth length for the VC supplement vs the OJ in combiantion with dosage 2 has no significant effect (almost same mean & same confidence interval)

These conclusions are based on the assumptions of the facts that

* The guinea pigs are repesentative for the population of guinea pigs,
* The dosage and supplement were randomly assigned and
* The distribution of the means is normal.