Statistical Inference - #2 - Basic inferential data analysis

chris-FR-GitHub

23 novembre 2018

Synopsis

In this second project, we will investigate the **ToothGrowth** dataset from the basic R datasets package.
We will try to quicly analyse the data and to test some hypothesis about the dose and supplement impact on the guinea pigs' tooth growth.

Load the ToothGrowth data

```
library(tidyverse, warn.conflicts = TRUE)
library(gridExtra, warn.conflicts = FALSE)
# Load the dataset
data("ToothGrowth")
# check the data types
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 ...
```

We have :
- 3 doses : 0.5, 1, and 2 mg/day
- 2 delivery methods for the vitamin C : OJ (Orange Juice) and VC (Ascorbic Acid).
Each combination has 10 rows.

Provide a basic summary of the data.

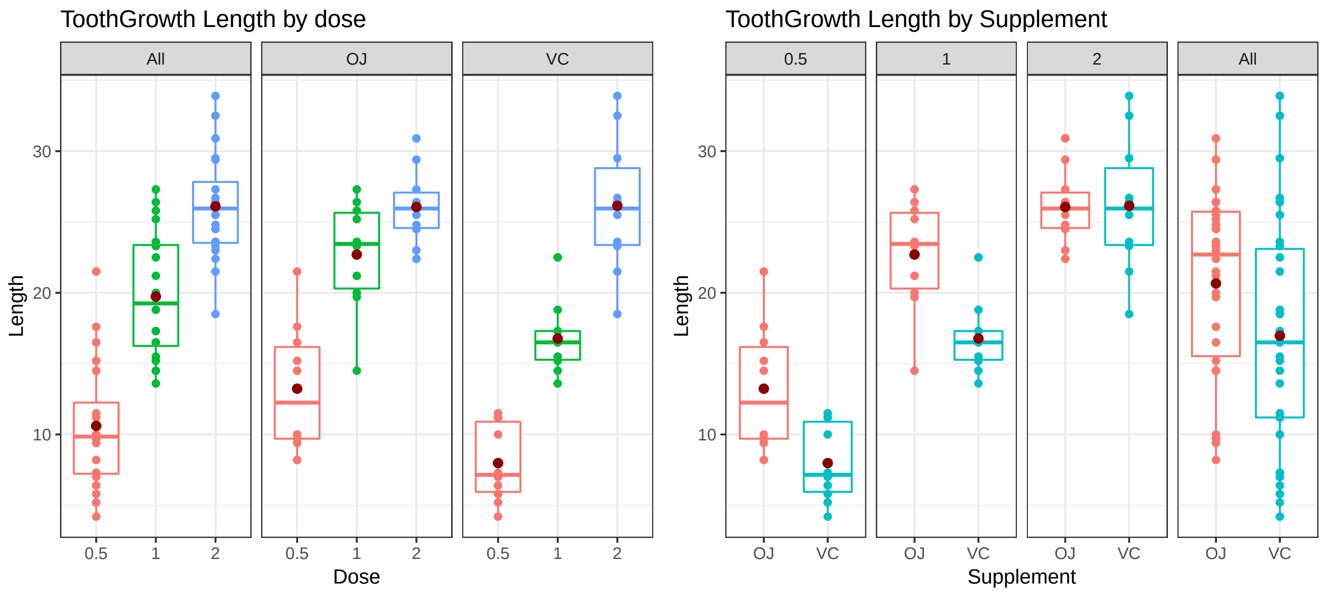
We will run a summary type function but also add all the aggregated records (global data, OJ only, VC only, dose 0.5 only, . . .).

```
# Helper function (replicate the summary base fucntion)
mysummary <- function(dat){
    data.frame(
        Min = min(dat), Quantile25 = quantile(dat, 0.25),
        Median = median(dat), Mean = mean(dat),
        Quantile75 = quantile(dat, 0.75), Max = max(dat)  )}

# convert the factor / numeric in char to aggreagate the data in a single table.
ToothGrowthTab <- ToothGrowth %>% mutate(dose = as.character(dose),
                                          supp = as.character(supp))
# build the summary dataset
ToothGrowthTab  %>% group_by(supp, dose) %>% do( mysummary(.$len)) %>%
    rbind(. , ToothGrowthTab  %>% mutate(dose='-') %>% group_by(supp, dose) %>%
              do( mysummary(.$len)) ) %>%
    rbind(., ToothGrowthTab  %>% mutate(supp='-') %>% group_by(supp, dose) %>%
              do( mysummary(.$len)) )  %>%
    rbind(., ToothGrowthTab  %>% mutate(supp='-', dose = '-') %>%
              group_by(supp, dose) %>%
              do( mysummary(.$len)) ) %>% arrange(supp, dose)
```

```
## # A tibble: 12 x 8
## # Groups:   supp, dose [12]
##    supp  dose    Min Quantile25 Median  Mean Quantile75   Max
##    <chr> <chr> <dbl>      <dbl>  <dbl> <dbl>      <dbl> <dbl>
##  1 -     -       4.2      13.1   19.2  18.8        25.3  33.9
##  2 -     0.5     4.2       7.22   9.85 10.6        12.2  21.5
##  3 -     1      13.6      16.2   19.2  19.7        23.4  27.3
##  4 -     2      18.5      23.5   26.0  26.1        27.8  33.9
##  5 OJ    -       8.2      15.5   22.7  20.7        25.7  30.9
##  6 OJ    0.5     8.2       9.7   12.2  13.2        16.2  21.5
##  7 OJ    1      14.5      20.3   23.5  22.7        25.6  27.3
##  8 OJ    2      22.4      24.6   26.0  26.1        27.1  30.9
##  9 VC    -       4.2      11.2   16.5  17.0        23.1  33.9
## 10 VC    0.5     4.2       5.95   7.15  7.98       10.9  11.5
## 11 VC    1      13.6      15.3   16.5  16.8        17.3  22.5
## 12 VC    2      18.5      23.4   26.0  26.1        28.8  33.9
```

We will plot these data to have a better view.

```r
addallfacet <- function(dat, col){
    dat$facet <- dat[[col]]
    newdat <- dat
    newdat$facet <- "All"
    return(rbind(newdat, dat))
}

plot1 <- addallfacet(ToothGrowth, 'supp')  %>% mutate(dose = as.factor(dose)) %>%
    ggplot(aes(dose, len, color=dose)) +
    geom_boxplot() + geom_point() + facet_grid(~facet) + theme_bw() +
    theme(legend.position = "none") +
    stat_summary(fun.y = mean, geom="point",colour="darkred", size=2) +
    labs(title="ToothGrowth Length by dose", x="Dose", y="Length")
plot2 <- addallfacet(ToothGrowth, 'dose')  %>%
    ggplot(aes(supp, len, color=supp)) + geom_boxplot() + geom_point() + facet_grid(~facet) +
    theme_bw() + theme(legend.position = "none") +
    stat_summary(fun.y = mean, geom="point",colour="darkred", size=2) +
    labs(title="ToothGrowth Length by Supplement", x="Supplement", y="Length")
grid.arrange(plot1, plot2, ncol = 2)
```



Hypothesis tests to compare tooth growth by supp and dose

We will use t-tests to validate / invalidate the 2 following hypothesis :
- The hiher the dose, the higher the effect,
- Orange juice seem to have a higher effect than Ascorbic Acid.

```
# t-test helmper function
getPValue <- function(pdose1 = 0, pdose2 = 0, psupp1 = 'All', psupp2 = 'All', alt){
    t.test(
    ToothGrowth %>%
        filter(pdose1 == 0 | dose==pdose1, psupp1 == 'All' | supp==psupp1) %>% select(len),
    ToothGrowth %>%
        filter(pdose2 == 0 |dose==pdose2, psupp2 == 'All' | supp==psupp2) %>% select(len),
    alternative = alt, paired = FALSE, var.equal = FALSE,
    conf.level = 0.95)$p.value
}
```

We assume that
- the pigs where selected randomly and are **representative of the population**
- and that the experiment were **independant** (no paired test)

Dose impact

Dose difference	from 0.5 to 1 mg/day	from 1 to 2 mg/day	from 0.5 to 2 mg/day
All	6.3415036×10^{-8}	9.5321476×10^{-6}	$2.1987625 \times 10^{-14}$
OJ	4.3924595×10^{-5}	0.0195976	6.6189194×10^{-7}
VC	3.4055089×10^{-7}	4.5778015×10^{-5}	2.3407887×10^{-8}

The higher the dose, the higher is the impact for the tooth length. It is true for both supplement.
Even if there is a difference for Orange Juice between 1 and 2 mg/day, it is a little bit less important tahn between .5 and 1 mg/day.

Supplement difference impact

Supplement	At 0.5 mg/day	At 1 mg/day	At 2 mg/day	All
OJ vs VC	0.0031793	5.1918794×10^{-4}	0.5180742	0.0303173

Orange Juice (OJ) seems to have a better effect than Ascorbic Acid (VC).
This statement is only false at 2 mg/day - at this dose, the 2 supplements have the same effect (p-value > 0.05)