Guinea Pig Tooth Growth Experiment

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September 18 2016

Overview

The effect of Supplement type and Dose of supplement in the tooth growth of guinea pigs will be tested A brief summary of the data will be presented and means of the tooth growth of guinea pigs with different Supplement type and different Dose of supplement will be compared using confidence intervals and significance levels produced by t tests.

Exploratory statistics

There are three variables and 60 observations. According to the summary and documentation called by `?ToothGrowth`, the variables are *Tooth length* (len, numeric); *Supplement type* (supp, factor with two levels. OJ: Orange Juice, VC: Ascorbic acid); and *Dose* in miligrams per day (dose, numeric) (Appendix X).

At a aglance there seems to be differences in *Tooth growth* by *Supplement*, and *Tooth growth* seems to increase as *Dose* increases (Appendix X).

Assumptions

After conducting a *Shapiro-Wilks test* (Appendix X) and visually exploring *Tooth length* (Appendix X), this variable seems to be **normally distributed**.

After a conducting a *Levene's test* for homogeneity of variance (Appendix X), there's evidence that the groups to compare **don't have equal variance**.

There's no evidence that the observations are paired, so it's assumed they are *independent groups.*

Choice of test

Consideting our assumptions, a *t test* for non paired groups and inequal variance will be conducted.

Comparison by Supplement type

Orange juice vs Ascorbic acid

```
    Welch Two Sample t-test

data:  len by supp
t = 1.9153, df = 55.309, p-value = 0.06063
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.1710156  7.5710156
sample estimates:
mean in group OJ mean in group VC
        20.66333         16.96333
```

The 95% confidence interval contains 0 and the significance level is not less or equal to 0.05. There are no differences in the Tooth Growth mean by *Supplement*.

Comparison by Dose

0.5 miligrams per day vs 1 miligram per day

```
    Welch Two Sample t-test

data:  dose_0.5 and dose_1
t = -6.4766, df = 37.986, p-value = 6.342e-08
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval:
      -Inf -6.753323
sample estimates:
mean of x mean of y
   10.605    19.735
```

The 95% confidence interval is entirely below 0 and the significance level is less than 0.05. A dose of 0.5 miligrams has a lower Tooth growth mean than a dose of 1 miligram.

0.5 miligram per day vs 2 miligram per day

```
    Welch Two Sample t-test

data:  dose_0.5 and dose_2
t = -11.799, df = 36.883, p-value = 2.199e-14
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval:
      -Inf -13.27926
sample estimates:
mean of x mean of y
   10.605    26.100
```

The 95% confidence interval is entirely below 0 and the significance level is less than 0.05. A dose of 0.5 miligrams has a lower Tooth growth mean than a dose of 2 miligrams.

1 miligram per day vs 2 miligram per day

```
    Welch Two Sample t-test

data:  dose_1 and dose_2
t = -4.9005, df = 37.101, p-value = 9.532e-06
alternative hypothesis: true difference in means is less than 0
95 percent confidence interval:
     -Inf -4.17387
sample estimates:
mean of x mean of y
   19.735    26.100
```

The 95% confidence interval is entirely below 0 and the significance level is less than 0.05. A dose of 1 miligram has a lower Tooth growth mean than a dose of 2 miligrams.

Conclusion

There's a diference in tooth growth by

There's no difference by supp.

There's a difference by dose. Lower doses correspond to lower growth.

No difference by supp at a dose equal to 2.

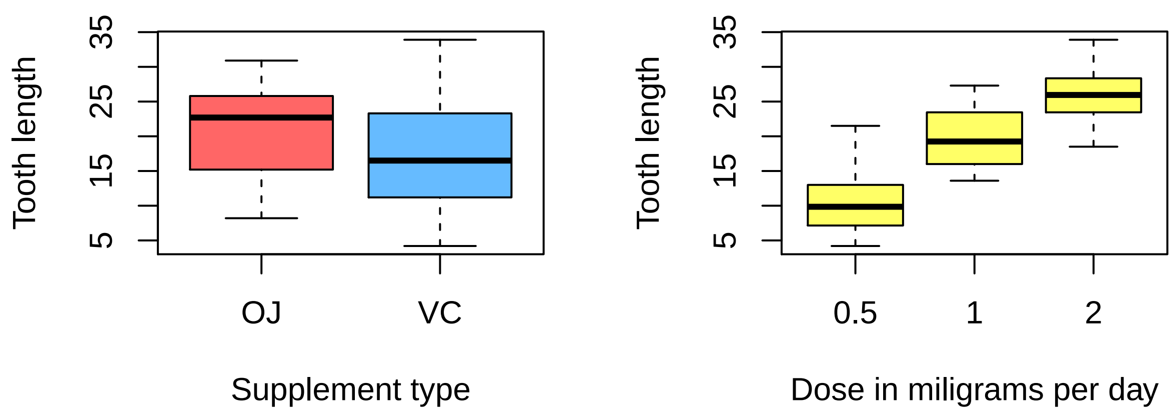
Appendix

Structure of the ToothGrowth data set.

```
'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 ...
```

```
      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  
```

A. Visualization of the groups



C. Test of normality of Tooth length

The ¨*Shapiro-Wilk Normality Test* is used, The null hypothesis for this test is that the given data is normally distributed. Results indicate we can't reject this hypotesis, so **we assume the distribution is normal**.

```r
shapiro.test(ToothGrowth$len)
```

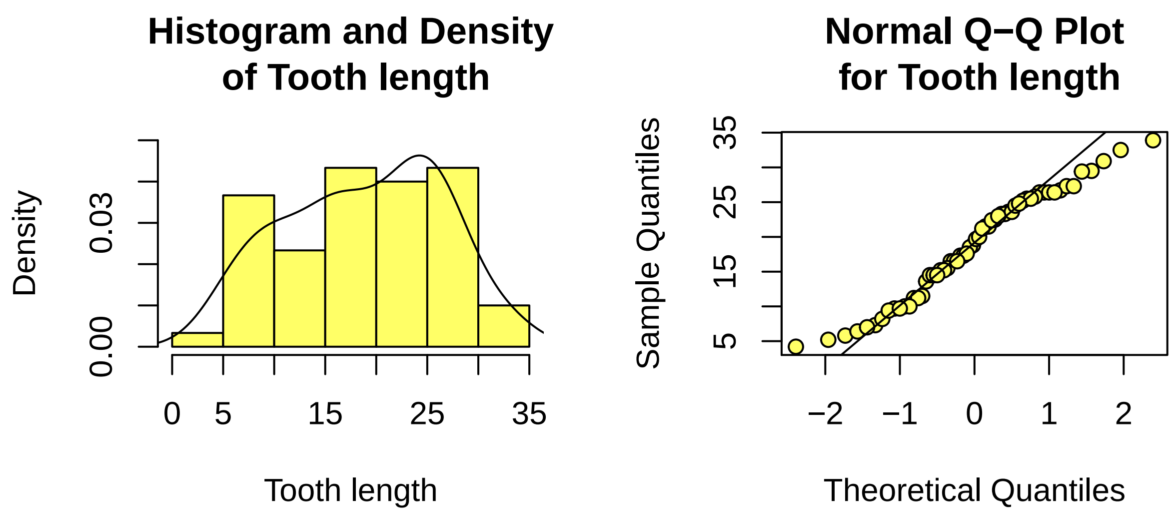
```
    Shapiro-Wilk normality test

data:  ToothGrowth$len
W = 0.96743, p-value = 0.1091
```

A histogram with an overlaid density curve of this variable and a Normal Q-Q plot are generated to support the assumtion its distribution is normal.

```r
par(mfrow = c(1, 2))
hist(ToothGrowth$len, probability = T, ylim = c(0, 0.05),
    main = "Histogram and Density\n of Tooth length",
    xlab = "Tooth length",
    col = "#FFFF66"
    )
lines(density(ToothGrowth$len))

qqnorm(y = ToothGrowth$len,
    main = "Normal Q-Q Plot\n for Tooth length",
    pch = 21, bg = c("#FFFF66"))
qqline(y = ToothGrowth$len)
```



D. Test if variance is equal across groups

The *Levene's test of homogenity of variance is used.* Groups are: *Supplement type*; *Dose in miligrams per day*; and *Supplement type* and *Dose in miligrams per day.* Results indicate groups **don't have equal variance**.

```r
library(car)
leveneTest(len ~ supp, data = ToothGrowth)
```

```
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  1  1.2136 0.2752
      58
```

```r
leveneTest(len ~ as.factor(dose), data = ToothGrowth)
```

```
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  2  0.6457 0.5281
      57
```

```r
leveneTest(len ~ supp * as.factor(dose), data = ToothGrowth)
```

```
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.7086 0.1484
      54
```