Exponential Distribution - Analyzing ToothGrowth Dataset

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Date: 14Jun 2015

Overview

We need to analyze `ToothGrowth` Dataset that comes with R package. `ToothGrowth` dataset contatins **the effect of Vitamin C on the Tooth Growth in Guinea Pigs.

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).

Load the ToothGrowth data and perform some basic exploratory data analyses

Below scripts loads the dataset and peek into it.

```
library(datasets)
data(ToothGrowth)
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
```

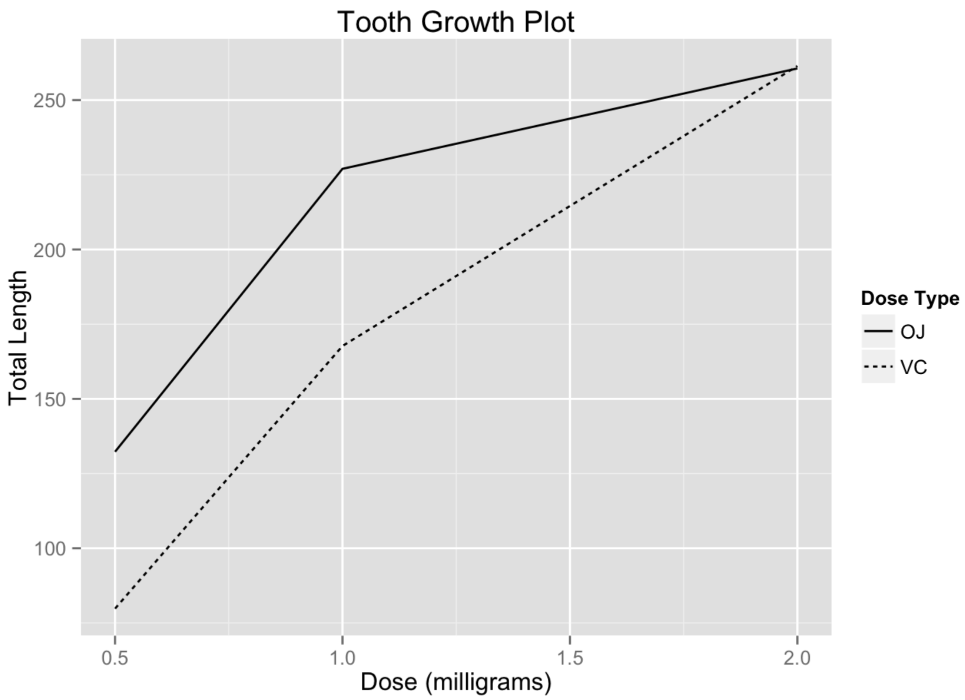
```
str(ToothGrowth)
```

```
## '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 ...
```

Some basic exploratory data analyses.

```
library(ggplot2,warn.conflicts = FALSE, verbose = FALSE)
# Total length of tooth by each levels of vitamin doses(0.5,1,2) for each supplement type
tooth.len.data <- aggregate(ToothGrowth$len ~ ToothGrowth$supp + ToothGrowth$dose, data = ToothGrowth, sum)
colnames(tooth.len.data) <- c("supplement_type", "dose", "length_total")

plot <- qplot(tooth.len.data$dose, tooth.len.data$length_total, data=tooth.len.data, geom ="line", linetype=to
oth.len.data$supplement_type)
plot <- plot + ggtitle("Tooth Growth Plot")
plot <- plot + xlab("Dose (milligrams)") + ylab("Total Length")
plot <- plot + labs(linetype = "Dose Type")
plot
```



Information from graph :

- For higher values of dosages (2.0 mg) for both dose types (OJ,VC), tooth length is almost equal.
- For lower values of dosages (1.0 mg), dose type (OJ) has more tooth length than dose type (VC).
- As dosage values increases, tooth length are increasing for both dose types.

Provide a basic summary of the data

We are reporting the mean and standard deviation.

```
tooth.mean.data <- aggregate(ToothGrowth$len ~ ToothGrowth$supp + ToothGrowth$dose, data = ToothGrowth, mean)
colnames(tooth.mean.data) <- c("supplement_type", "dose", "average")

tooth.sd.data <- aggregate(ToothGrowth$len ~ ToothGrowth$supp + ToothGrowth$dose, data = ToothGrowth, sd)
colnames(tooth.sd.data) <- c("supplement_type", "dose", "sd")

tooth.mean.data
```

```
##   supplement_type dose average
## 1              OJ  0.5   13.23
## 2              VC  0.5    7.98
## 3              OJ  1.0   22.70
## 4              VC  1.0   16.77
## 5              OJ  2.0   26.06
## 6              VC  2.0   26.14
```

```
tooth.sd.data
```

```
##   supplement_type dose       sd
## 1              OJ  0.5 4.459709
## 2              VC  0.5 2.746634
## 3              OJ  1.0 3.910953
## 4              VC  1.0 2.515309
## 5              OJ  2.0 2.655058
## 6              VC  2.0 4.797731
```

Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose. (Only use the techniques from class, even if there's other approaches worth considering)

We will be using `t test` for the comparisons.

Null hypothesis says

- Population means are equal.
- Two groups are from the sample population.

Normally, we want to reject the Null hypothesis and support the alternative hypothesis.

Often we assume 5 % p-value as the boundary to assume we have evidence to reject the null hypothesis.

- If p <= 5 %, sufficient evidence of difference and reject null hypothesis
- If p > 5 %, not sufficient evidence of difference and accept null hypothesis.

Whether different supplement types(OJ and VC) results in equal length of tooth growth?

- Null hypothesis : OJ and VC results in equal tooth lengths.
- Alternative hypothesis: OJ and VC results in unequal tooth lengths.

```
print(supp.test <- t.test(len ~ supp, data = ToothGrowth))
```

```
##
##  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
```

We can see that `p-value` from out test is 6.0634508 %. That means probability of the sampling data we sampled given that there is no difference in lengths in the two supplement types is 6.0634508 %.

Interpretation:

- Different supplements types results in equal tooth lengths.

Whether different supplement types having dose quantities (0.5,1.0,2.0) results in equal length of tooth?

- Null hypothesis : Different dosage quantites results in equal tooth lengths.
- Alternative hypothesis: Different dosage quantites results in unequal tooth lengths.

```
print(dose0.5 <- t.test(len ~ supp, data = ToothGrowth[ToothGrowth$dose == 0.5, ]))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 3.1697, df = 14.969, p-value = 0.006359
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.719057 8.780943
## sample estimates:
## mean in group OJ mean in group VC
##            13.23             7.98
```

```
print(dose1.0 <- t.test(len ~ supp, data = ToothGrowth[ToothGrowth$dose == 1.0, ]))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 4.0328, df = 15.358, p-value = 0.001038
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  2.802148 9.057852
## sample estimates:
## mean in group OJ mean in group VC
##            22.70            16.77
```

```
print(dose2.0 <- t.test(len ~ supp, data = ToothGrowth[ToothGrowth$dose == 2.0, ]))
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = -0.0461, 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
```

Dose (mg)	p-value (%)
0.5	0.6358607
1.0	0.1038376
2.0	96.3851589

p-values for (0.5 and 1.0) dosages are < 5 %. p-values for (2.0) dosages are > 5 %.

Interpretation:

- Dose quantites (0.5 and 1.0) for both supplement results in different tooth lengths.
- Dose quantity (2.0) for both supplement results in equal tooth lengths.

Our plot graph also depicts the same results.

State your conclusions and the assumptions needed for your conclusions

Conclusions

- Both supplement types results in equal tooth lengths when dose quantities are not considered.
- Increased dose quantities for both supplement types results in increase in tooth length i.e. difference becomes smaller.
- Supplement type (OJ) has more tooth length than (OJ) with lower dose quantites.
- Dose quantity (2.0) for both supplements do not have different tooth lengths.

Assumptions

- Variance is estimated separately for groups.
- Data is not paired.
- Guniea Pigs are measured only once for every measurment parameters.
- Sample population is not too big.