

STATISTICAL INFERENCE COURSE PROJECT - PART 2

Odontoblast Growth Versus Vitamin C Intake in 60 Guinea Pigs

Overview

This study is based on an almost 70-year-old database, “ToothGrowth”, designed to study the effect of an increase in Vitamin C intake (measured in milligrams) on the growth of odontoblasts (measured in microns) in a population of 60 Guinea Pigs. From Wikipedia, we learn that odontoblasts are the cells in the pulp of the tooth that produce dentin. In turn, dentin is the bony tissue beneath the enamel.

Basic Exploratory Data Analysis

```
library(knitr)
library(ggplot2)
library(datasets)
data(ToothGrowth)
#added dev='pdf qui sotto
opts_chunk$set(echo=TRUE, results='asis', fig.align='center', dev='pdf')
```

Here is a summary description of our dataset.

```
summary(ToothGrowth)
```

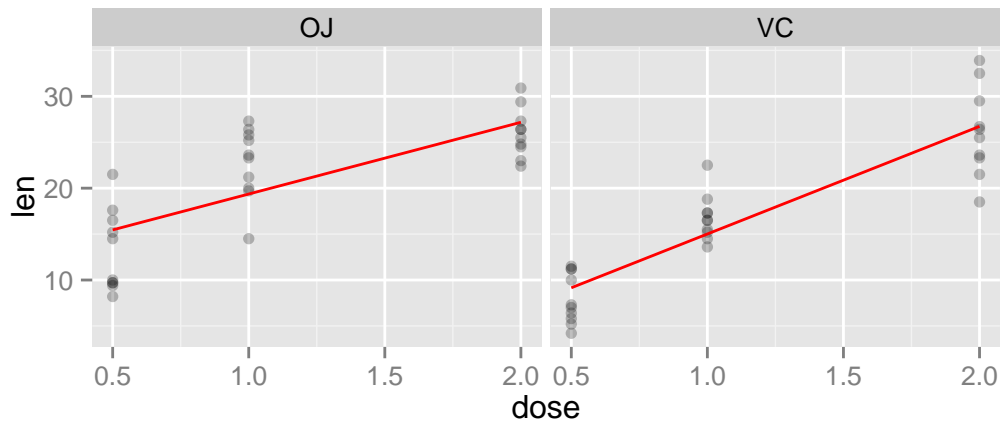
len	supp	dose
Min. : 4.20	OJ:30	Min. :0.500
1st Qu.:13.07	VC:30	1st Qu.:0.500
Median :19.25		Median :1.000
Mean :18.81		Mean :1.167
3rd Qu.:25.27		3rd Qu.:2.000
Max. :33.90		Max. :2.000

Graph 1 shows that larger doses of Vitamin C intake have a likely positive effect on cell's growth both in the case of orange juice and ascorbic acid used as alternative delivery methods.

```
ggplot(ToothGrowth, aes(dose, len))+
  geom_point(alpha=1/4)+
  facet_grid(. ~ supp)+
  geom_smooth(method="lm", color="red", se=F)+
  ggtitle(expression(atop("GRAPH 1",
    atop(italic("Cell's Length Increase Versus Dosage")))))
```

GRAPH 1

Cell's Length Increase Versus Dosage

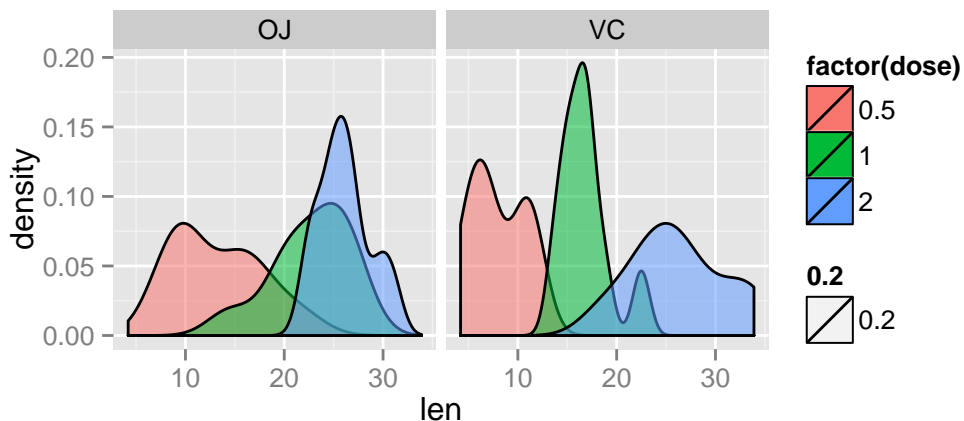


For each delivery method, Graph 2 shows the variability in the density of impact for increased dosage.

```
ggplot(ToothGrowth, aes(x = len))+
  geom_density(aes(fill=factor(dose),alpha=.2))+
  facet_grid(. ~ supp)+
  ggtitle(expression(atop("GRAPH 2",
    atop(italic("Cell's Length Increase Versus Dosage")))))
```

GRAPH 2

Cell's Length Increase Versus Dosage



Given our limited space, this preliminary analysis suggests that attention should be specially devoted to whether a radical dosage's increase impacts sensibly cell's growth and whether, at given dosages, a switch on delivery method to the other has a sensible impact.

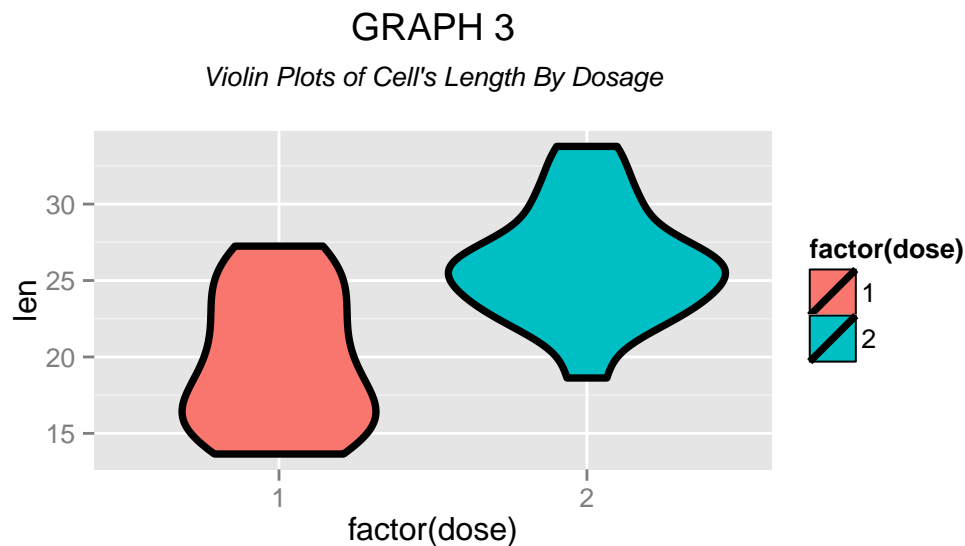
Confidence Intervals

Question 1: Does a doubling of the dose of Vitamin C from 1 milligram to 2 milligrams make a difference in the growth of odontoblasts in guinea pigs?

```
a<-ToothGrowth[ToothGrowth[, "dose"]==1,]
b<-ToothGrowth[ToothGrowth[, "dose"]==2,]
c<-rbind(b,a)
```

Let us compare variances between the effects of mg. 1 versus those of mg. 2, regardless of delivery method:

```
ggplot(c, aes(x = factor(dose), y = len, fill = factor(dose)))+
  geom_violin(col = "black", size = 1.3)+
  ggtitle(expression(atop("GRAPH 3",
    atop(italic("Violin Plots of Cell's Length By Dosage")))))
```



Graph 3 suggests we ought to gauge our confidence intervals also on the presumptions that the results from different dosages come from different distributions.

```
t.test(len ~dose,paired=F,var.equal=T,data=c)$conf
```

```
[1] -8.994387 -3.735613 attr(,"conf.level") [1] 0.95
```

```
t.test(len ~dose,paired=F,var.equal=F,data=c)$conf
```

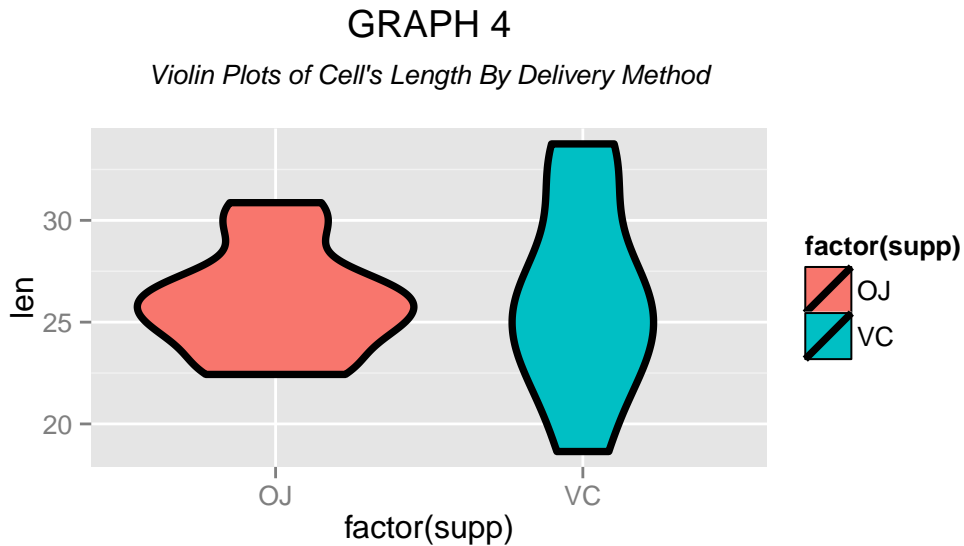
```
[1] -8.996481 -3.733519 attr(,"conf.level") [1] 0.95
```

The resulting confidence intervals indicate that both in the case of equal or unequal distribution, a dosage increase from mg. 1 to mg. 2 makes a positive and sensible difference.

Question 2: Does changing the delivery method from OJ to VC and keeping the dose at mg. 2 impact the growth of odontoblasts?

Let us compare variances between the effects of different delivery method, while keeping the dosage constant at mg. 2.

```
ggplot(b, aes(x = factor(supp), y = len, fill = factor(supp)))+
  geom_violin(col = "black", size = 1.3)+
  ggtitle(expression(atop("GRAPH 4",
    atop(italic("Violin Plots of Cell's Length By Delivery Method")))))
```



Graph 4 suggests we ought to gauge our confidence intervals also on the presumptions that the results from different delivery methods come from different distributions.

```
t.test(len ~supp,paired=F,var.equal=T,data=b)$conf
```

```
[1] -3.722999 3.562999 attr(,"conf.level") [1] 0.95
```

```
t.test(len ~supp,paired=F,var.equal=F,data=b)$conf
```

```
[1] -3.79807 3.63807 attr(,"conf.level") [1] 0.95
```

The resulting confidence intervals indicate that both in the case of equal or unequal distribution, a change in delivery method makes no sensible difference when dosage is mg. 2.

Question 3: Does changing the delivery method from OJ to VC and keeping the dose at 1 mg. impact the growth of odontoblasts?

```
t.test(len ~supp,paired=F,var.equal=T,data=a)$conf
```

```
[1] 2.840692 9.019308 attr(,"conf.level") [1] 0.95
```

```
t.test(len ~supp,paired=F,var.equal=F,data=a)$conf
```

```
[1] 2.802148 9.057852 attr(,"conf.level") [1] 0.95
```

Interestingly, the resulting confidence intervals indicate that both in the case of equal or unequal distribution, a change in delivery method makes a sensible difference when dosage is mg. 1.

Conclusions

As a caveat to these conclusions and also to Part One of this project: In the spirit of the principles of Literate Statistics, taught in another class of this series on Big Data, my two PDF incorporate report, coding, and sources in one body, with no appendix, so as to enable the reader to efficiently reproduce and verify my work. As a conclusion to this report, I'll say that Graphs 1 and 2 make it evident that it'd be a waste of time

to verify the obvious hypothesis that more Vitamin C brings about longer odontoblasts. I deemed it more worthwhile to test the hypothesis that an increase in dosage from mg. 1 to mg. 2 does not bring about longer odontoblasts as well as the hypothesis that a change in delivery method makes no difference. My results are that a larger dosage makes an obvious difference, a change in delivery method while taking mg. 2 of vitamin C makes no significant difference, but a change in delivery method while taking mg. 1 of vitamin C makes a significant difference. Owing to the shape of Graphs 3 and 4, I have tested my hypotheses both for equal and unequal distribution, and the results were consistent with one another.