Basic analysis of ToothGrowth dataset

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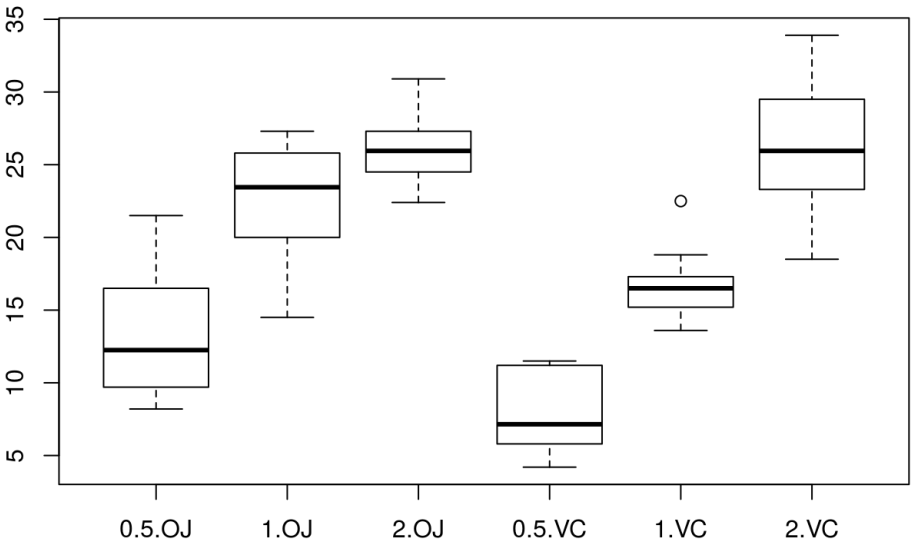
`ToothGrowth` dataset describes the effect of vitamin C on tooth growth in guinea pigs.

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) (source: `?ToothGrowth`).

Explore basic features

I found the most convenient to look at this data using the following `boxplot`:

```
data(ToothGrowth)
boxplot(len ~ dose + supp, data = ToothGrowth)
```



From this plot we can assume that length increases as the dose increases, and that orange juice method is more effective for small concentrations. For concentration of `2 mg` method choice does not make much difference, although for asorbic acid we see higher variance.

Significance of results

For each concentration (dose), do we have significant difference in mean values?

```
t.test(len ~ supp,  data=subset(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
```

```
t.test(len ~ supp,  data=subset(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
```

```
t.test(len ~ supp,  data=subset(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
```

We see that for concentrations of `0.5 mg` and `1.0 mg` the `95%` confidence interval is above zero, and for concentration of `2.0 mg` confidence interval contains zero, which supports initial observation.

Study assumptions

Fundamental assumption we are making is that guinea pigs for each group had equal qualities. For example, if orange juice and Vitamin C where given to guinea pigs of different breeds, or one group contained only male pigs while another group only female than non-homogenuity could be the driving factor. One way to archive homogenuity is to form groups *at random*.

To see that this is really the case it worth checking data source. In our case detailed description of the data set could be found in *Bliss (1952) The Statistics of Bioassay. Academic Press, pp. 499-500*:

Example 9a. A biological assay of the vitamin C activity of fresh orange juice may be used as a second example. The response of `10` guinea pigs on each of three doses of ascorbic acid (`S`) and of fresh orange juice (`U`) during a six-week test period was measured by Crampton (26) from the average length of the odontoblasts in each animal (p. 257), with the results given in `Table XXVIII`. Five of the animals at each treatment combination were males and five were females but except for this sex restriction the guinea pigs were assigned to doses entirely at random. The assay could be considered, therefore, as forming a `2 X 3 X 2` factorial experiment and has been so analyzed. The complete analysis (not given here) showed that the effect of sex could be neglected, so that in the interests of simplicity the data will be treated here as a `2 X 3` assay with `10` responses at each dose.

Table skipped

The fresh orange juice or unknown was analyzed chemically for its ascorbic acid content and on this basis fed without alteration at the same three levels of ascorbic acid as the standard. The ascorbic acid standard was administered at `0.5`, `1.0` and `2.0 mg` per day in a mixture of corn starch and corn meal. Hence the objective of the assay was to determine whether under these conditions the antiscorbutic activity of the orange juice was greater than would be predicted from its content of ascorbic acid as determined chemically in the present experiment.