Analysis of the ToothGrowth Data in the R Datasets Package

DocOfi

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Introduction

This document constitutes the second part of a two-part project submitted as part of the requirements for the Statistical Inference class in Coursera offered by the JOHNS HOPKINS Bloomberg School of Public Health. In this project we are asked to demonstrate what we have learned from the course by performing a basic exploratory and inferential analysis of the ToothGrowth data contained in the R datasets package that comes with a standard R installation.

Overview of the experiment

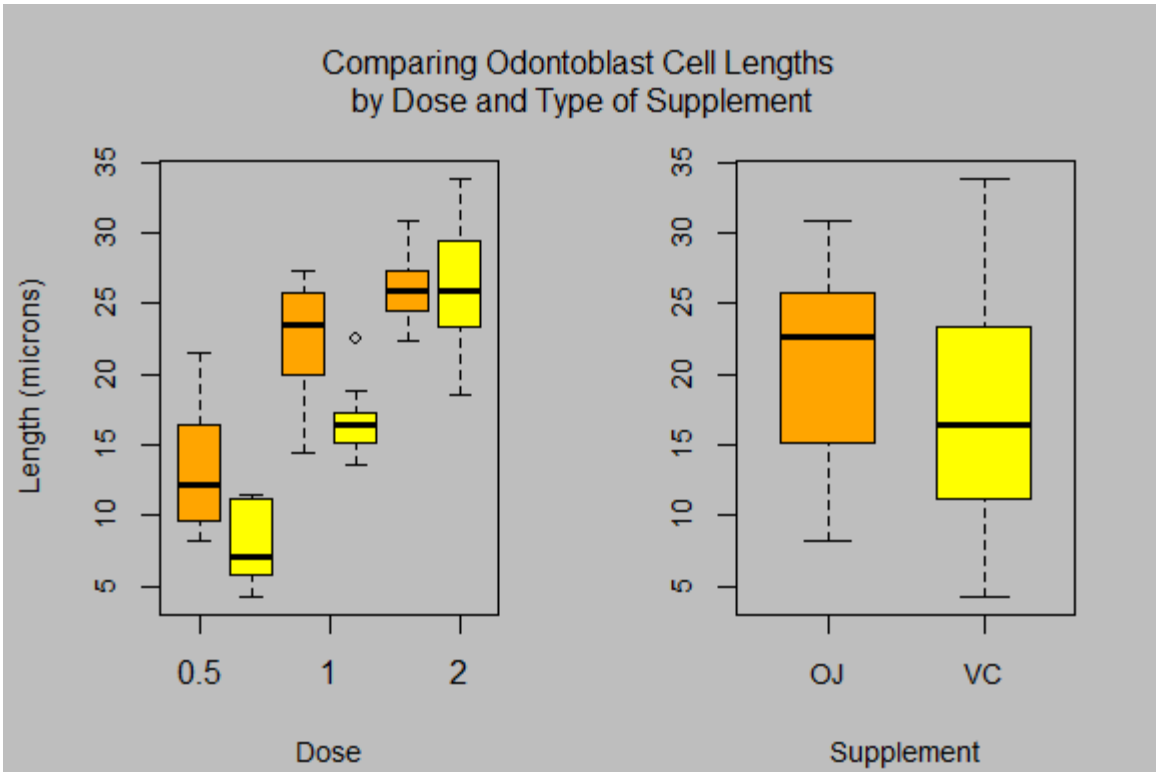
The dataset ToothGrowth, contains a subset of the results from experiments conducted in the 1940's by EW Crampton of the Department of Nutrition, Macdonald College, McGill University, P.O., Prov. Quebec, Canada, to establish a vitamin C bioassay which might be used as a check against chemical procedures. The experiment included the assessment of the effects of varying doses of Vitamin C on tooth growth in guinea pigs.

28 +/-3 days, sex- matched, 250-400 gm weight guinea pigs were enrolled in this experiment and fed a diet supplemented with varying doses (0.25, 0.50, 1.0, 2.0, 4.0, and 8 mg/day) of vitamin c in the form of orange juice or aquaeous solutions of ascorbic acid. At the conclusion of a 42 day period, the animals were sacrificed and measurements of the length of the incisor's odontoblasts (tooth-forming cells) were made under 440 magnification by means of an ocular micrometer and the readings are subsequently converted to microns.

Exploratory Data Analysis

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

```
## Source: local data frame [6 x 6]
## Groups: dose
##
##   dose supp  n  mean       sd       var
## 1  0.5   OJ 10 13.23 4.459709 19.889000
## 2  0.5   VC 10  7.98 2.746634  7.544000
## 3  1.0   OJ 10 22.70 3.910953 15.295556
## 4  1.0   VC 10 16.77 2.515309  6.326778
## 5  2.0   OJ 10 26.06 2.655058  7.049333
## 6  2.0   VC 10 26.14 4.797731 23.018222
```



The dataset contained 60 rows of observation from 60 Guinea pigs. The animals were divided into 2 groups of 30 based on the type of supplement they received (orange juice = oj and vitamin c = vc) and further subdivided into three groups (10 each) according to doses received (0.5, 1.0, 2.0 mg/day). There are (0) missing values in our data.

- A direct relationship between dose and length of odontoblasts was observed in both groups. The length of odontoblast cells increased as the dose of vitamin c or orange juice increased.
- The median and the mean length of odontoblast cells from animals that were given orange juice were generally higher compared to those who received vitamin c in the 0.5 and 1 mg/day doses. However, the difference in the mean and median between the two groups seemed to have equalized in the highest dose (2 mg/day), suggesting a possible saturation point where an increase in concentration will not have the same increase in odontoblast length.
- The higher mean and median values from guinea pigs who received orange juice also suggest, greater bio-availablity of ascorbic acid from orange juice compared to synthetically produced vitamin c.

Comparing tooth growth by supp and dose using confidence intervals and/or hypothesis tests

Effect of Dosage

Effect of type of Supplement

Assumptions

Conclusions

Vitamin c and orange juice contain the same ingredient,ascorbic acid.

Appendix

References

1. Crampton E.W., “THE GROWTH OF THE ODONTOBLASTS OF THE INCISOR TOOTH AS A CRITERION OF THE VITAMIN C INTAKE OF THE GUINEA PIG”, J. Nutr., 1947, 491-504.
2. Bliss C.I., “The Statistics of Bioassay”. Academic Press Inc., 1952, 499-501.

Brief of summary of the original experiment

The principal findings of the experiment were:

1. 28 days on intakes of 0.25mg of ascorbic acid have shown frank scurvy including capillary hemorrhage in the hind legs. No cases of clinical scurvy were seen on intakes of 0.5mg per day.
2. At the upper end of the range, no increased response with intakes of 4.0 or 8.0mg over that shown for 2.0 mg were observed.
3. The length of odntoblast cells in guniea pigs is apparently limited by the level of vitamin C intake, and ranges from about 30 microns with intakes of 0.5 mg of ascorbic acid daily, to a maximum of about 70 microns with intakes of 2 mg or over. Within this range of intake, the odontoblast length bears a logarithmic relation to the vitamin C fed.

NOTE Information about the experiment was obtained from a copy of the article “THE GROWTH OF THE ODONTOBLASTS OF THE INCISOR TOOTH AS A CRITERION OF THE VITAMIN C INTAKE OF THE GUINEA PIG” by EW Crampton (Downloaded from jn.nutrition.org on November 9, 2015)

```
sessionInfo()
```

```
## R version 3.2.1 (2015-06-18)
## Platform: i386-w64-mingw32/i386 (32-bit)
## Running under: Windows 8 (build 9200)
##
## locale:
## [1] LC_COLLATE=English_United States.1252
## [2] LC_CTYPE=English_United States.1252
## [3] LC_MONETARY=English_United States.1252
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] dplyr_0.4.2
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.0     digest_0.6.8    assertthat_0.1  R6_2.1.0
##  [5] DBI_0.3.1       formatR_1.2     magrittr_1.5    evaluate_0.7.2
##  [9] stringi_0.5-5   lazyeval_0.1.10 rmarkdown_0.7   tools_3.2.1
## [13] stringr_1.0.0   yaml_2.1.13     parallel_3.2.1  htmltools_0.2.6
## [17] knitr_1.11
```