Inferential Exercise

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The Effect of Vitamin C on Tooth Growth in Guinea Pigs

Introduction

The `ToothGrowth` dataset in `R` is a set of measurements on:

"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)."

```
data(ToothGrowth)
```

See:

```
help(ToothGrowth)
```

In this exercise, we will perform some basic exploratory and inferential data analysis on the `ToothGrowth` dataset.

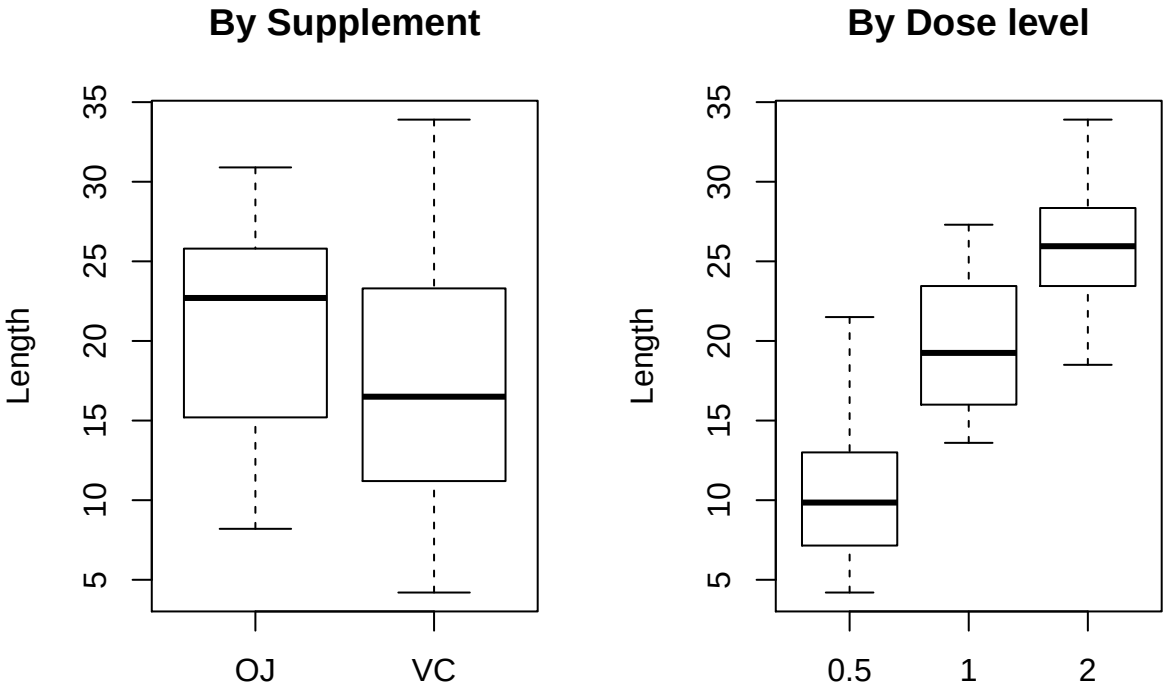
Basic Summary of the ToothGrowth Data

```
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
head(ToothGrowth)
##    len supp dose
## 1  4.2   VC  0.5
## 2 11.5   VC  0.5
## 3  7.3   VC  0.5
## 4  5.8   VC  0.5
## 5  6.4   VC  0.5
## 6 10.0   VC  0.5
with(ToothGrowth, table(dose,supp))
##      supp
## dose  OJ VC
##   0.5 10 10
##   1   10 10
##   2   10 10
```

Statistical Effects of Dose & Supplement

Overview

Summary boxplots from the data suggest some inferential questions to test.



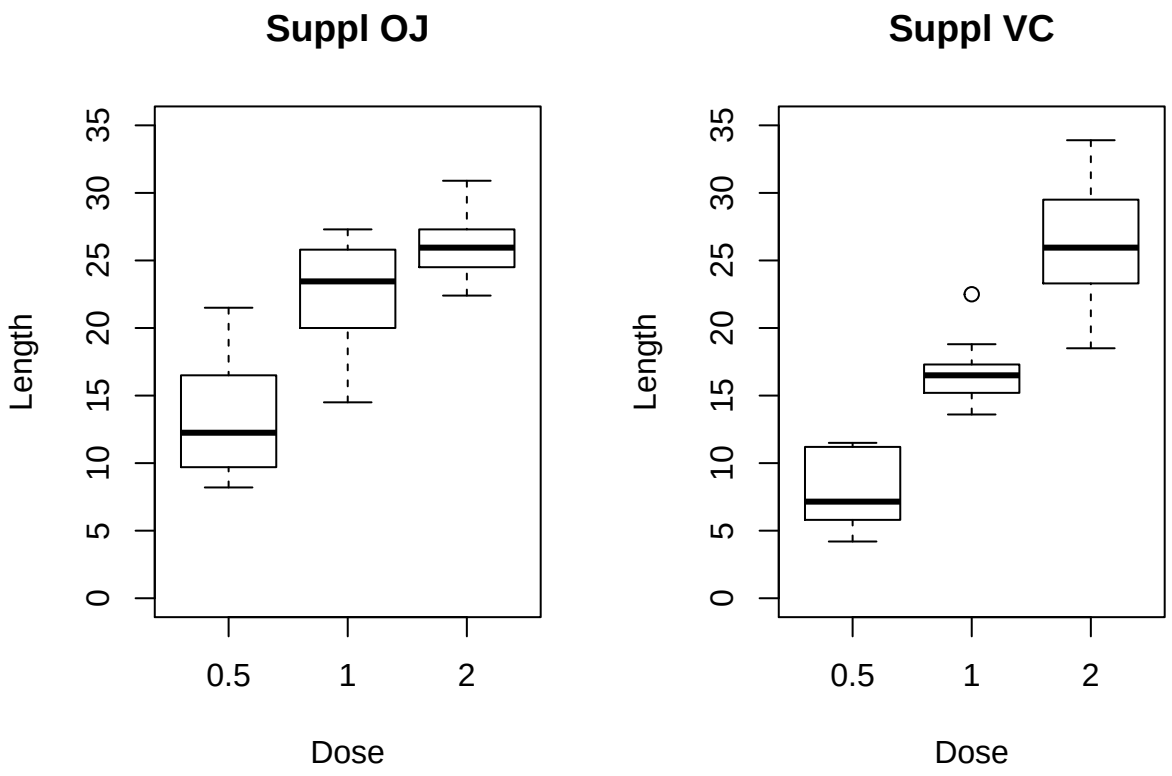
(The lower and upper ends of the box-and-whisker plot boxes represent the 25th and 75th quartiles of the data. The dashed lines represent the extent to the minimum and maximum values of the data, and the midline across the box represents the *median* of the data.)

There seems to be a clear dose response relationship between the supplements and toothgrowth, but no *clear* difference between the supplement types.

Subsetting Growth by Dose and Supplement Type

Breaking the dose response relationship out *by* supplement type highlights some differences between the supplement types at different doses.

Although there does not seem to be a significant difference in growth between the supplements at the *highest* dose level, at the low and middle dose levels, the `OJ` supplement demonstrates more growth. I will present the statistical test results below.



Hypothesis Tests of growth vs. supplement *Type*

The underlying assumption to this analysis is that the growth measurements at given dose and supplement type are iid random variables. With small sample sizes of 10, this makes the *t-test* appropriate. The sample groups are not paired (different animals). Based on the wide variation in the boxplot box sizes above, it seems prudent to use the default assumption of *unequal* variances between the groups.

Overall Over the data for *all* dose levels, we cannot reject the hypothesis that the difference in tooth growth between the supplement types is zero, because the 95% CI includes zero.

```
t.test( len ~ supp, 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
```

Comparing at the Same Dose Levels Tooth growth between supplements at the *same* dose levels does show some significant differences though.

The table below summarizes *t*-test hypothesis testing results for the null hypothesis that the *mean difference in tooth growth between supplement types* is zero at different dose levels.

```
##    Dose t.stat     df 95CI.lo 95CI.hi  pval mean.OJ mean.VC
## t   0.5  3.170 14.969   1.719   8.781 0.006   13.23    7.98
## t1  1.0  4.033 15.358   2.802   9.058 0.001   22.70   16.77
## t2  2.0 -0.046 14.040  -3.798   3.638 0.964   26.06   26.14
```

As the boxplots above suggest, the hypothesis testing results support the conclusions that:

1. Tooth growth is significantly greater at the 0.5 and 1.0 doses with `OJ`. The 95% CI does not include zero. (p-values = 0.006, 0.001, respectively).
2. At the highest dose level, 2.0, there is no significant difference in tooth growth. The 95% CI includes zero.