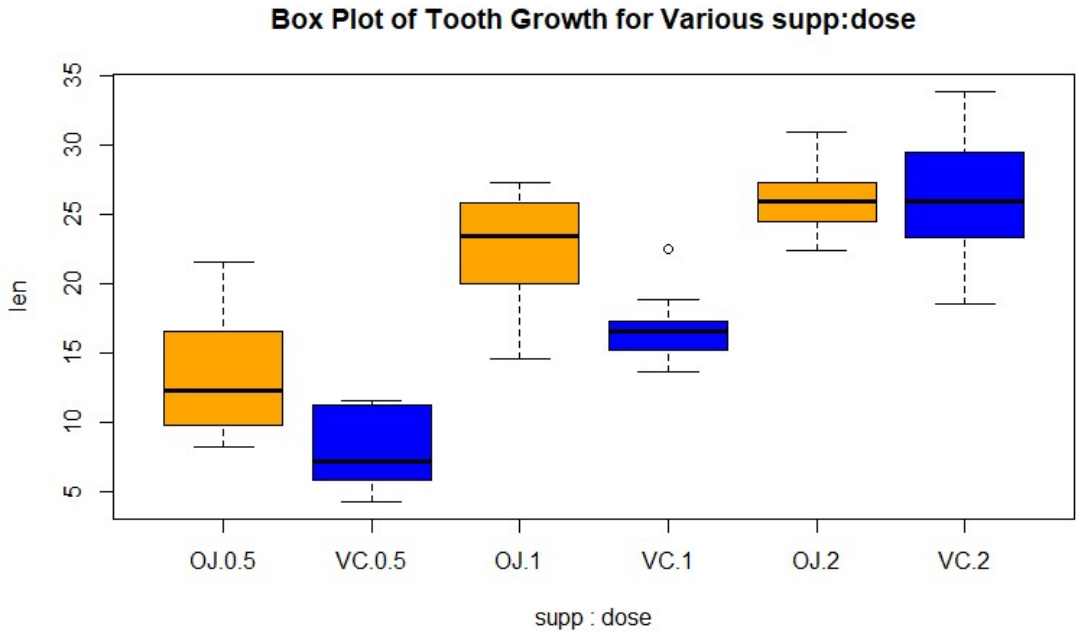
Statistical Report on Tooth Growth Data

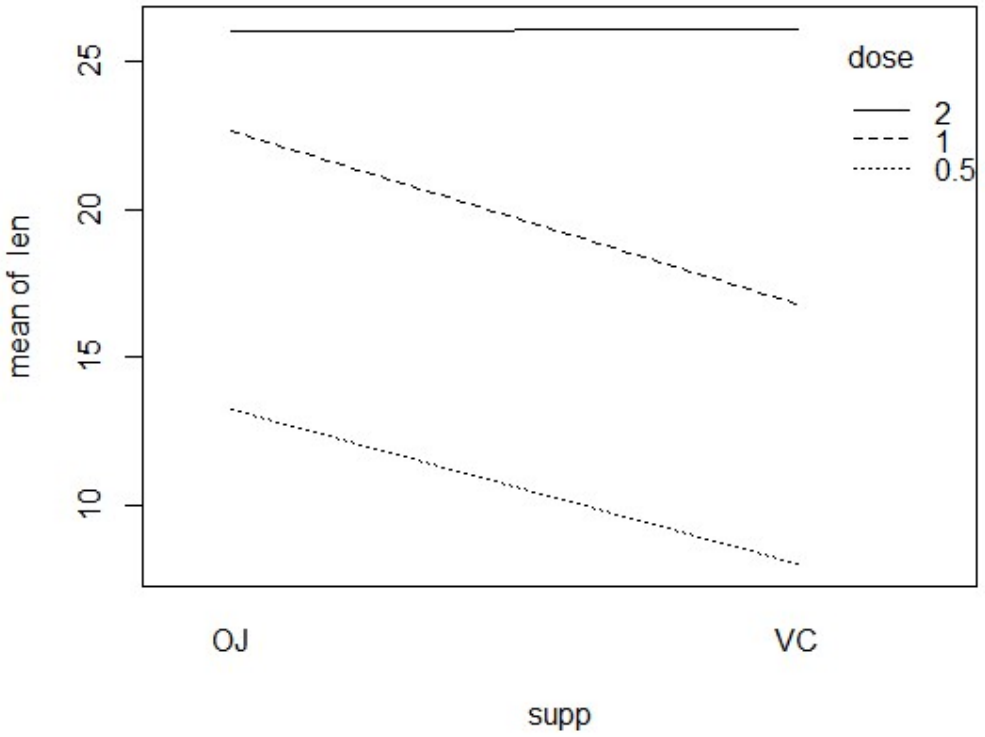
Introduction

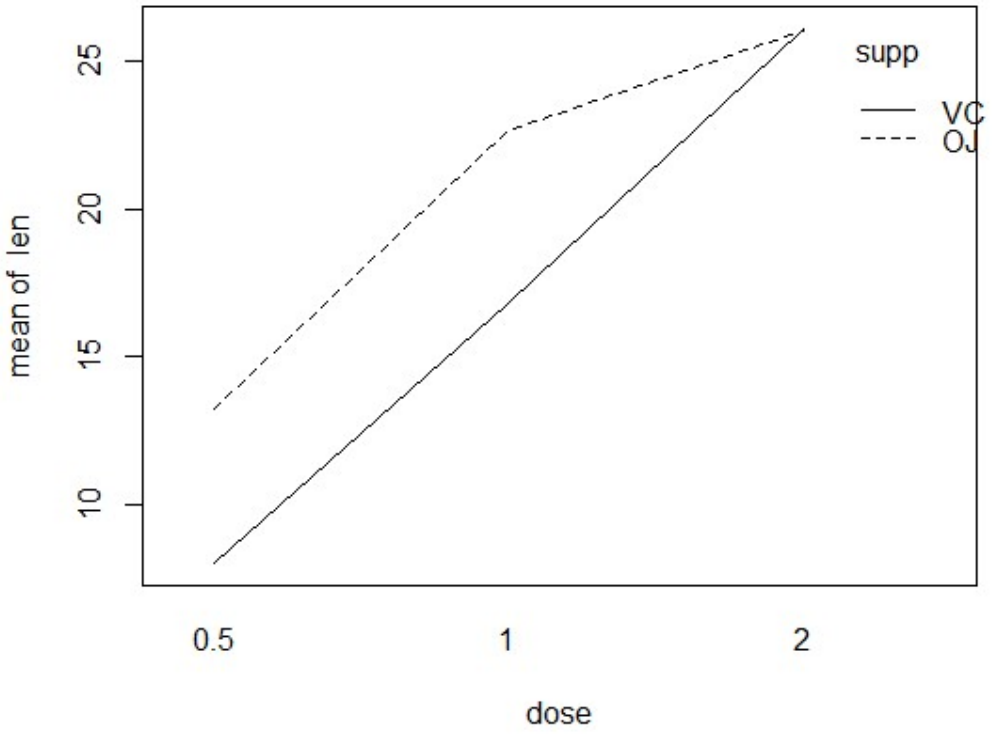
The data represents the effect of Vitamin C on Tooth Growth in Guinea Pigs. The response variable is the length of odontoblasts, which are the cells responsible for tooth growth, of 60 Guinea Pigs. In this experiment each of the Guinea Pigs received one of three doses of Vitamin C (0.5, 1, 2 mg/day) by one of two administrative methods (Orange Juice –OJ, or ascorbic acid VC).

The graphical representation of the data is given in the box plot below. As can be seen in the graph, at the dosages 0.5 and 1 mg/day the median of OJ is greater than that of VC while at the dosa 2 mg/day, the medians of OJ and VC are approximately equal.
There is also an upward trend in the plot which suggests that higher dosages of both treatments result in a larger length of tooth growth as compared to the lower dosages.
Both the minimum and maximum length of the cells responsible for tooth growth recorded can be attributed to VC with minimum growth being 4.20 and the maximum length growth being 33.90



Below are the interaction plots of the data. The plot that appears first suggests that there is no interaction component in the model while the second plot suggest a slight interaction at dose 2mg/day. This report will assume that the model has an interaction component as fitting the data into a model with no interaction while there is an interaction component is detrimental; whereas fitting data without interaction into a model that has an interaction component is not detrimental to a report, but rather conservative.


mean of len
25
20
15
10
dose
2
1
0.5
OJ
VC
supp


mean of len
25
20
15
10
supp
VC
OJ
0.5
1
2
dose

Methodology of Analysis

This data will be analysed by the method of a Two Way Analysis of Variance, which is suitable when testing for the effect of two categorical predictor variables on a continuous response variable. In this case the continuous response variable is the tooth growth of the guinea pigs while the categorical predictor variables are the dose administered and the method of the delivery.

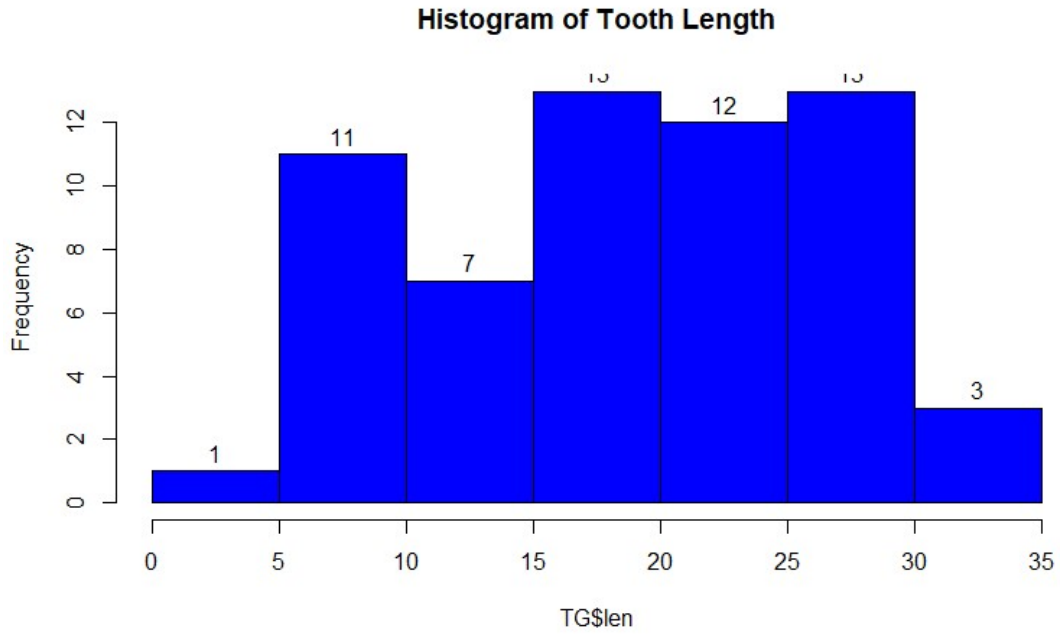
The two way ANOVA assumes that

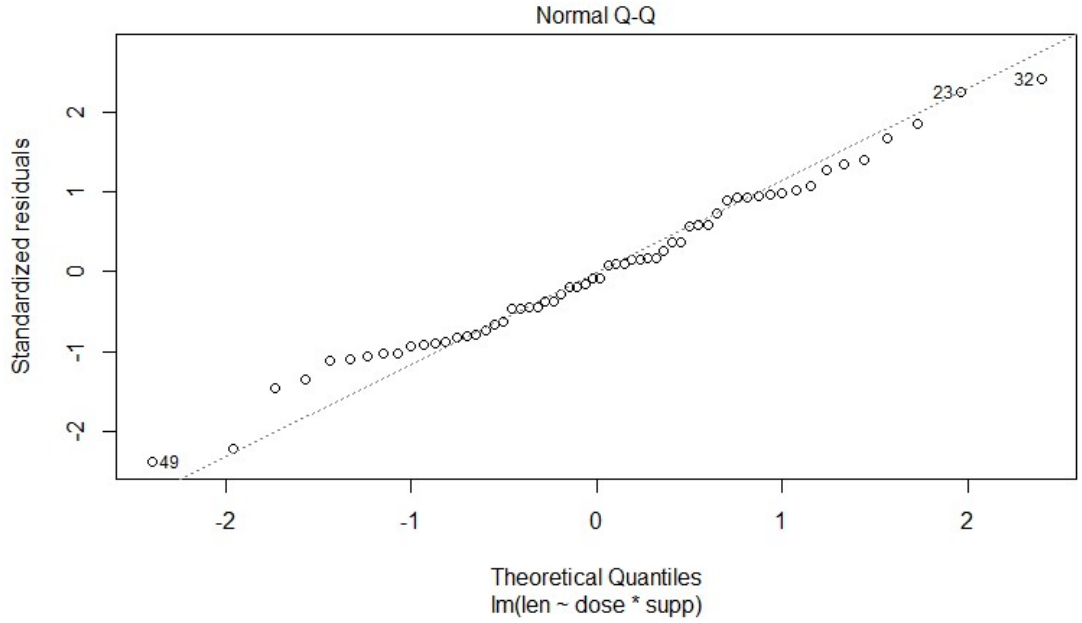
1. The response variable, ie. the length variable of the Tooth Growth data is continuous and approximately normally distributed for every combination of the two categorical predictor variables.
2. Observations should be independent, meaning there shouldn't be a relationship between observations within and between the dose and supplement type groups.
3. There is a constant variance of the dependent variable in every cell of the combination of the two categorical predictor variable.

Analysis of Results

The assumptions made for this model where that of normality, constant variance and independence. Below is an examination of each assumption:

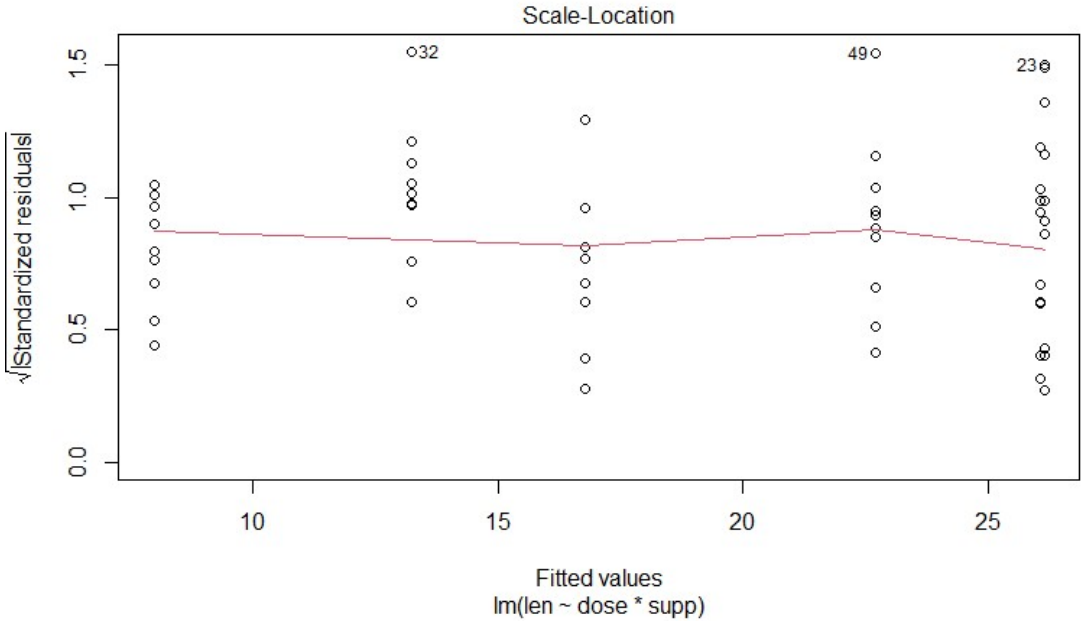
I. Normality: The response variable appears to be approximately normally distributed, while the Shapiro test confirms this at 5% significance level, as the p-value for this test is 0.1091 > 0.05 (See Part Two of appendix).

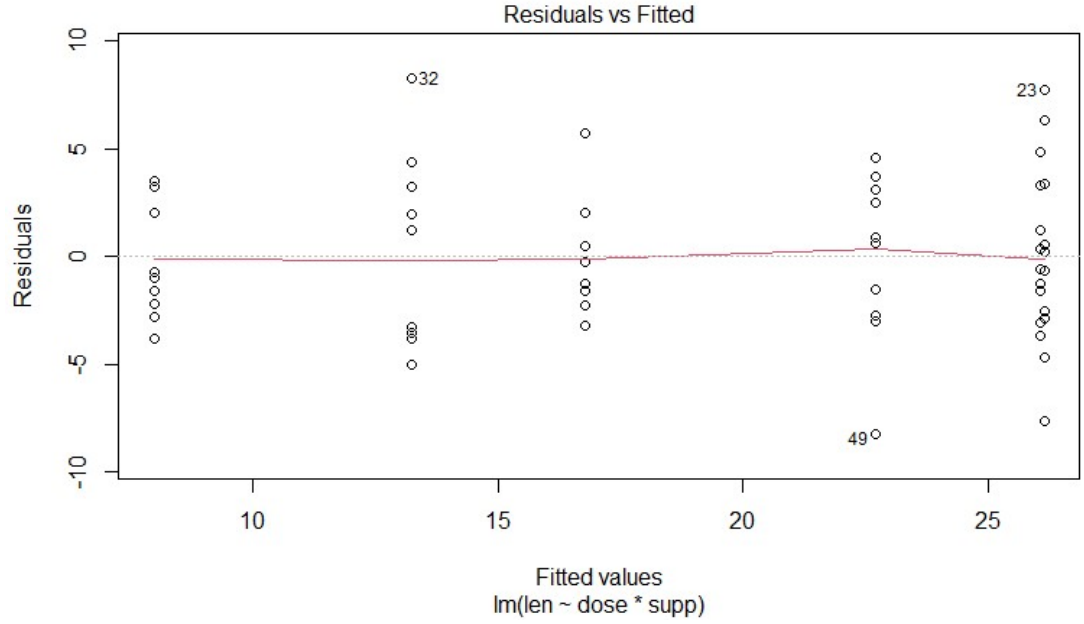




Most points in the Normal Q-Q plot lie on the diagonal line or very close to the diagonal line which further suggests that the data is normally distributed. The three points which have been identified as outliers lie within 3 standard deviations of the mean and may not be influential.

I. Constant variance and independence:





The above plots show that the constant variance assumption has been met as the residual points do not fan out or funnel in. The assumption of independence is violated; the residual

points do not follow a random pattern, instead there is a pattern of stacking of points along the x-axis.

Hypothesis Testing:

Interaction component:

- Hypotheses: H_0: $\sigma_{ab}^2 = 0$ against H_1 : $\sigma_{ab}^2 > 0$
- Rejection Criteria: Reject H_0 if F > $F_{0.05,(2,54)}$ = 3.1682
- Test Statistic: F = $\frac{MS_{supp:dose}}{MSE}$
  = $\frac{54.16}{13.19}$
  =4.107
- Decision: Since F = 4.107 > 3.1682, we reject the null hypothesis and conclude that the variation of the interaction of supplements and dose contributes highly to the variation of the strength measurements

Supp Component

- Hypotheses: H_0: $\sigma_a^2 = 0$ against H_1 : $\sigma_a^2 > 0$
- Rejection Criteria: Reject H_0 if F > $F_{0.05,(1,2)}$ = 18.51282
- Test Statistic: F = $\frac{MS_{supp}}{MS_{ab}}$
  = $\frac{205.35}{54.16}$
  =3.792
- Decision: Since F = 3.792< 18.51282, we do not reject the null hypothesis and conclude that the variation of the supplement component does not contribute highly to the variation of the strength measurements

Dose Component

- Hypotheses: H_0: $\sigma_b^2 = 0$ against H_1 : $\sigma_b^2 > 0$
- Rejection Criteria: Reject H_0 if F > $F_{0.05,(2,2)}$ = 19
- Test Statistic: F = $\frac{MS_{dose}}{MS_{ab}}$
  = $\frac{1213.22}{54.16}$
  =22.4
- Decision: Since F = 22.4 > 19, we reject the null hypothesis and conclude that the variation of the dose component contributes highly to the variation of the strength measurements

Dose and the interaction of dose and supp have a statistically significant effect on tooth length while supplement type has no statistical significance on tooth length.