Multiple Comparison Procedures To A Control

For AN(C)OVA Models

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Contents

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Basic Information

Automatic statistics for the file:

File
litter.csv

Your selection for the encoding: UTF-8
Your selection for the decimal character: .
Observations (rows with at least one non-missing value): 74
Variables (columns with at least one non-missing value): 4
Variables considered continuous: 2

Variables considered continuous
weight
number

Variables considered categorical: 2

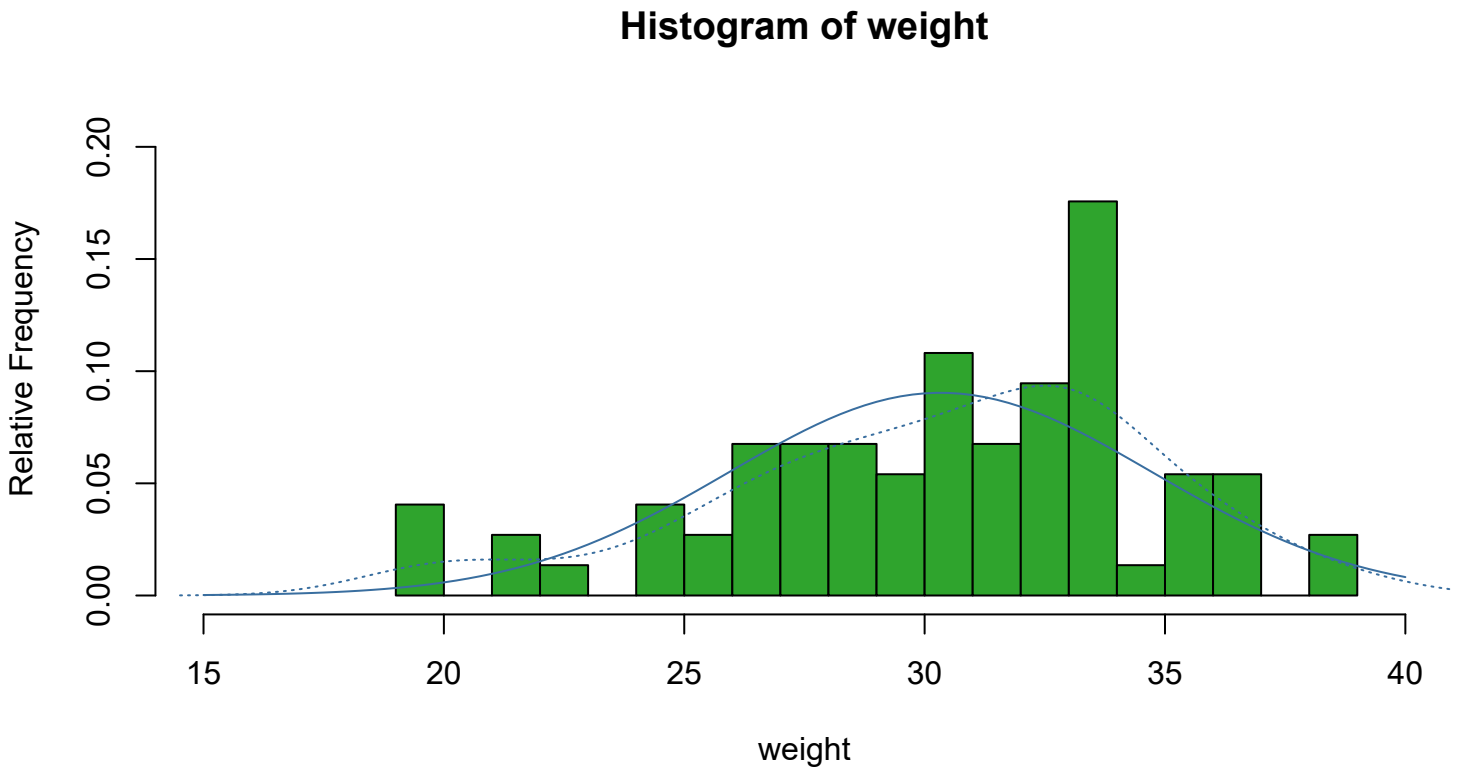
Variables considered categorical
dose
gesttime

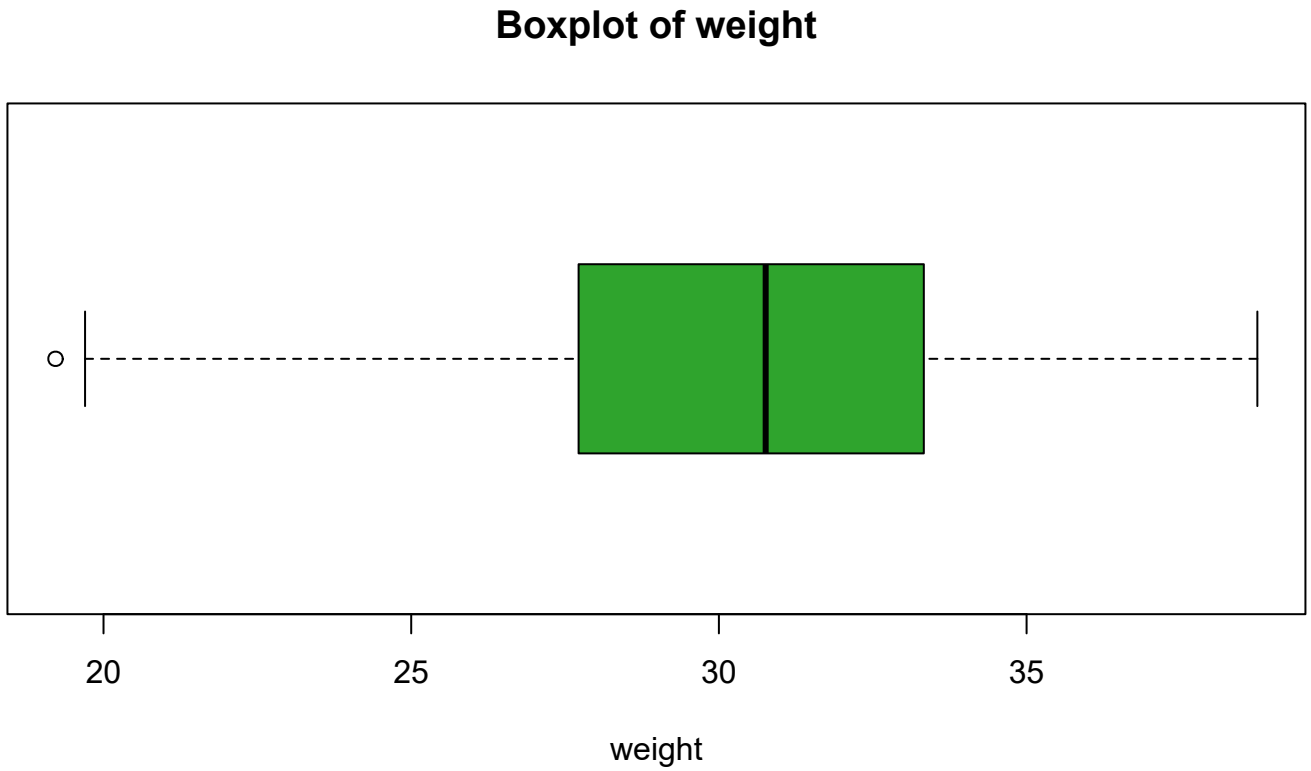
Model Information

You defined the following linear model: weight~dose+gesttime+number+dose*number+gesttime*number
You are interested in the factor: dose
You are interested in pairwise comparisons to the control factor level: 0

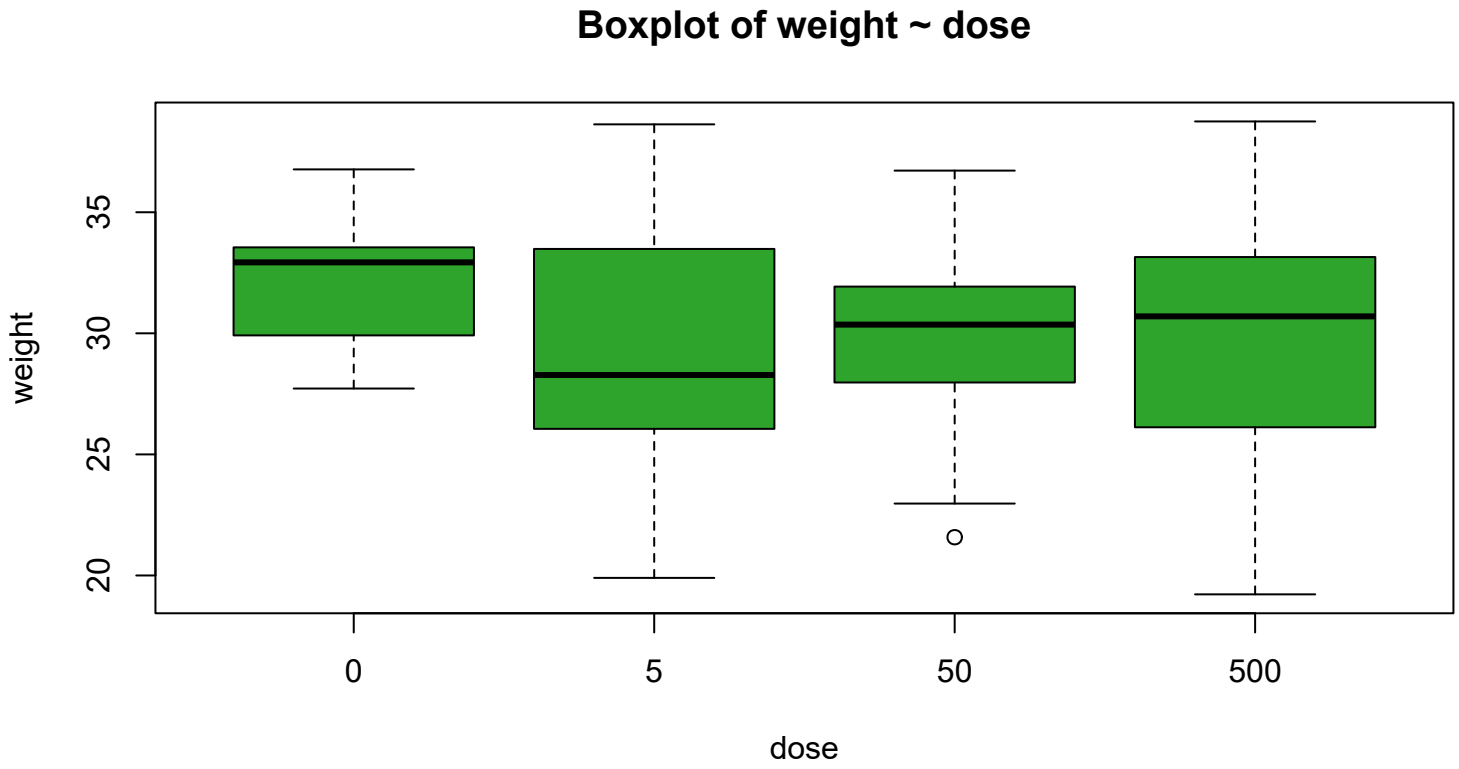
Descriptive Plots

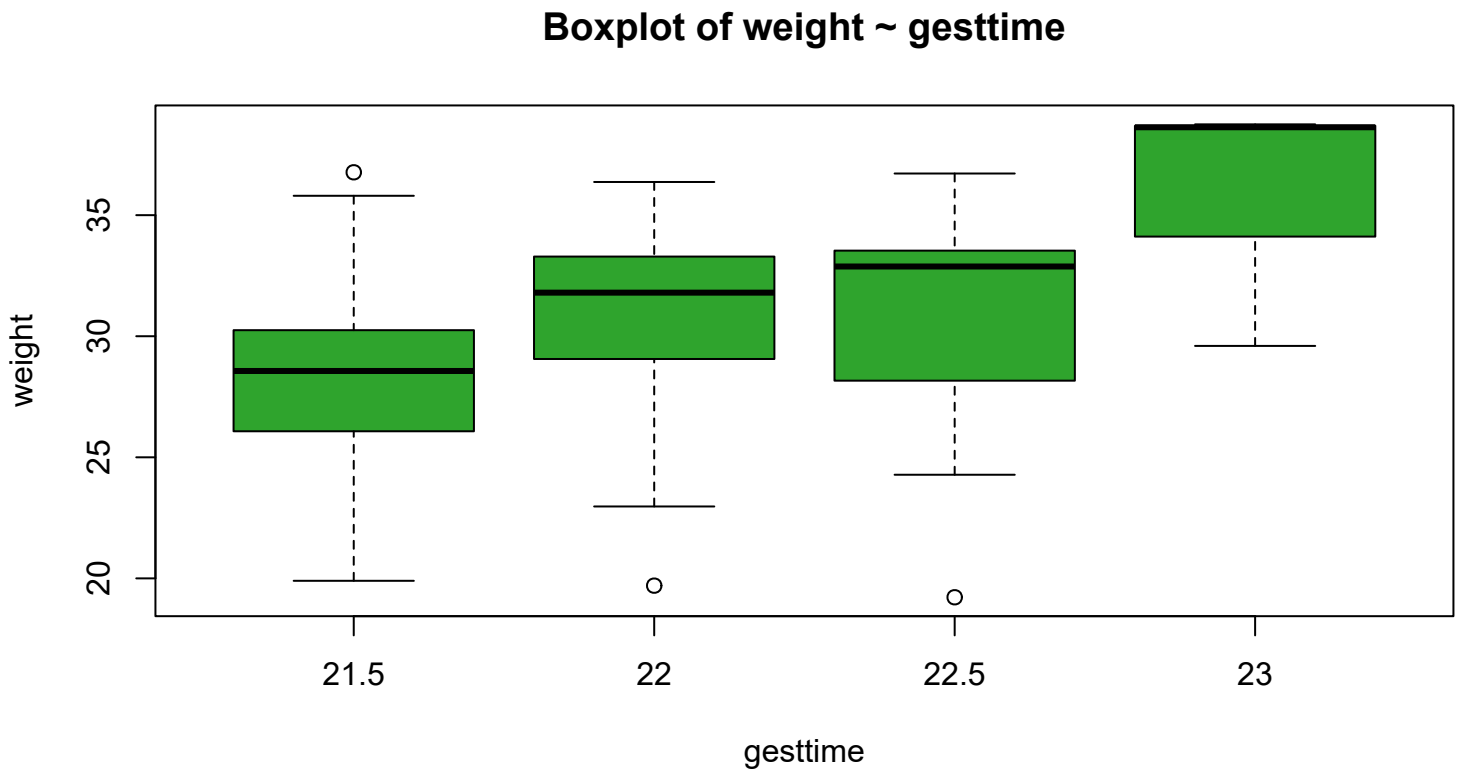
Dependent Variable



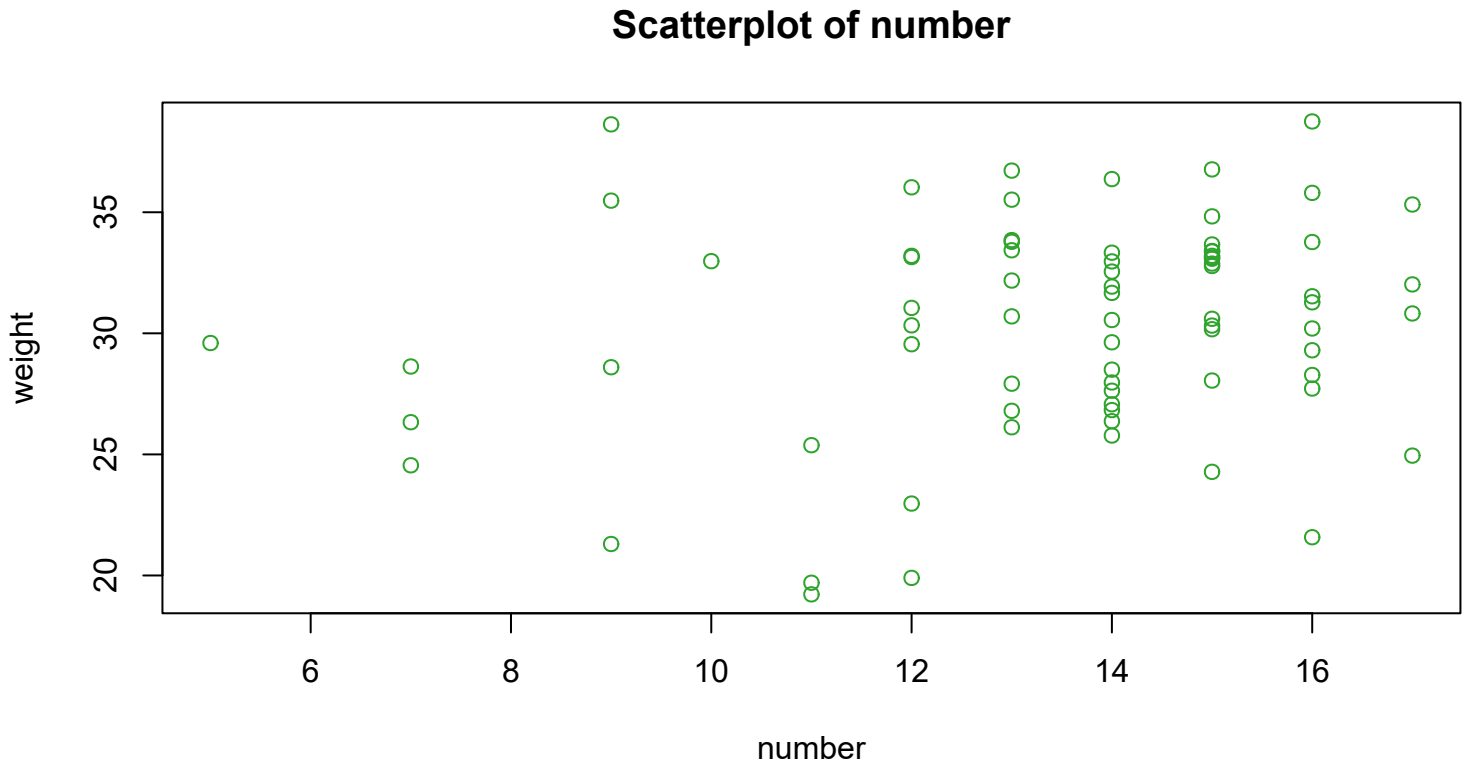

Boxplot of weight
20
25
30
35
weight

Dependent Against Categorical Factors




Boxplot of weight ~ gesttime
weight
20
25
30
35
21.5
22
22.5
23
gesttime

Dependent against Covariates



Interaction Plot

Note: The more parallel the lines, the less likely is the significance of the interaction.

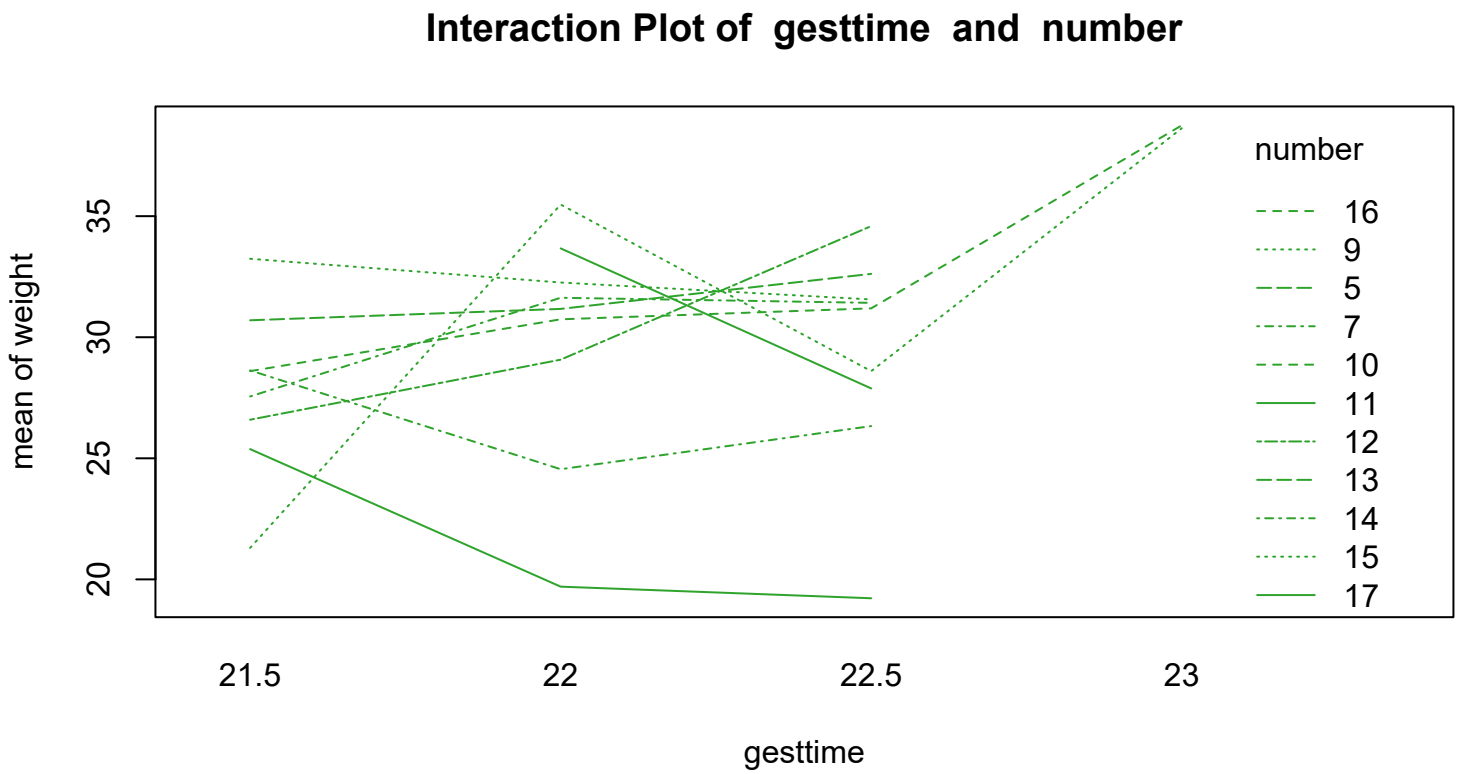

Interaction Plot of gesttime and number
mean of weight
20
25
30
35
21.5
22
22.5
23
gesttime
number
16
9
5
7
10
11
12
13
14
15
17

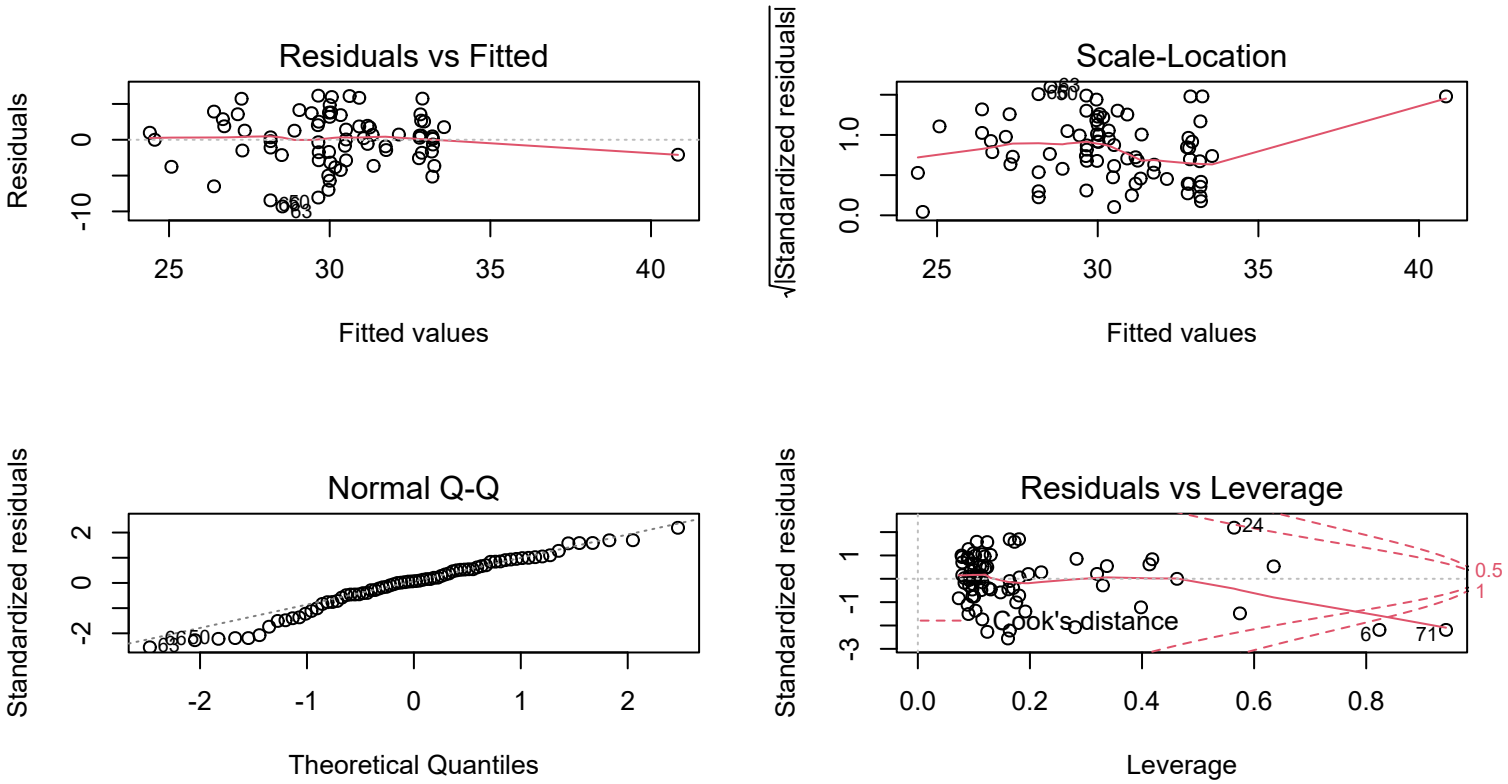
Table 4: Parameter Estimates

Variable	Value	Std.Error	t.value	pvalue	sign. level[1]	Significance at 5 percent error
(Intercept)	24.02	3.22	7.47	<0.001	***	Intercept Significant.
dose1	6.13	4.93	1.24	0.219		Not Significant. No difference between the effect of dose1 and its reference.
dose2	2.99	5.41	0.55	0.582		Not Significant. No difference between the effect of dose2 and its reference.
dose3	-0.35	7.52	-0.05	0.963		Not Significant. No difference between the effect of dose3 and its reference.
gesttime1	-5.91	4.73	-1.25	0.216		Not Significant. No difference between the effect of gesttime1 and its reference.
gesttime2	2.99	4.88	0.61	0.542		Not Significant. No difference between the effect of gesttime2 and its reference.
gesttime3	3.31	5.10	0.65	0.519		Not Significant. No difference between the effect of gesttime3 and its reference.
number	0.58	0.24	2.42	0.019	*	Significant. A Difference between the effect of number and its reference.
dose1:number	-0.30	0.35	-0.86	0.392		Interaction not Significant. Effect dose1 vs. reference don't depends on number.
dose2:number	-0.31	0.40	-0.76	0.448		Interaction not Significant. Effect dose2 vs. reference don't depends on number.
dose3:number	-0.01	0.52	-0.01	0.99		Interaction not Significant. Effect dose3 vs. reference don't depends on number.
gesttime1:number	0.17	0.36	0.47	0.641		Interaction not Significant. Effect gesttime1 vs. reference don't depends on number.
gesttime2:number	-0.30	0.36	-0.84	0.406		Interaction not Significant. Effect gesttime2 vs. reference don't depends on number.
gesttime3:number	-0.29	0.38	-0.77	0.446		Interaction not Significant. Effect gesttime3 vs. reference don't depends on number.

[1] '***': sign. to 0.1% error. '**': sign. to 1% error. '*': sign. to 5% error. ' . ': sign. to 10% error. ' ': not sign. ' - ': no statement.

```
Anova Table (Type III tests)

Response: weight
               Sum Sq Df F value    Pr(>F)
(Intercept)    882.00  1 55.7909 3.951e-10 ***
dose            57.13  3  1.2045   0.31590
gesttime        27.72  3  0.5845   0.62750
number          92.43  1  5.8466   0.01866 *
dose:number     42.22  3  0.8901   0.45152
gesttime:number 26.03  3  0.5489   0.65082
Residuals      948.55 60
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```


Residuals vs Fitted
Residuals
Fitted values
Scale-Location
√|Standardized residuals|
Fitted values
Normal Q-Q
Standardized residuals
Theoretical Quantiles
Residuals vs Leverage
Standardized residuals
Cook's distance
Leverage

Multiple Comparisons of Means to a Control

Theoretical background: Testing multiple hypotheses simultaneously and each at the same pre-specified significance level, increases the probability of false positive effects. The probability to commit at least one false positive decision increases with the number of hypotheses. A solution to overcome this problem is given by multiple comparisons procedures. Here, we do not control the per-hypothesis Type I error but the probability of committing at least one Type I error over all hypotheses. Using p-values adjusted for multiplicity, individual hypotheses can be finally compared with the pre-specified significance level.

Dunnet

Test whether the factor level 0 of the factor dose is different from the other levels. The Null Hypothesis is for example 5 - 0 =0.

Multiple Comparison: Dunnet Contrasts

Null Hypothesis	Value	Std.Error	T.value	adjusted P.value	Sign. level[1]	Significance at 5 percent Type I error
5 - 0 = 0	-3.13	7.53	-0.42	0.96		Not Significant. Level 0 of factor dose is not different than 5[2]
50 - 0 = 0	-6.48	10.87	-0.60	0.90		Not Significant. Level 0 of factor dose is not different than 50[2]
500 - 0 = 0	-14.89	7.93	-1.88	0.17		Not Significant. Level 0 of factor dose is not different than 500[2]

[1] '***': sign. to 0.1% error. '**': sign. to 1% error. '*': sign. to 5% error. ' . ': sign. to 10% error. ' ': not sign. ' - ': no statement.

[2] H1 does not hold significantly.

[3] H1 holds significantly.

Simultaneous Confidence Intervals which includes the true value of the difference between the reference level 0 and the other levels of dose

Simoultaneous Confidence Intervals: Dunnet Contrasts

Null Hypothesis	Value	Lower bound	Upper bound	Interpretation
5 - 0 = 0	-3.13	-21.46	15.19	The interval (-21.46, 15.19) traps the true difference 5-0 with probability 95 percent.[2]
50 - 0 = 0	-6.48	-32.94	19.99	The interval (-32.94, 19.99) traps the true difference 50-0 with probability 95 percent.[2]
500 - 0 = 0	-14.89	-34.19	4.41	The interval (-34.19, 4.41) traps the true difference 500-0 with probability 95 percent.[2]

[1] Remark: Zero is not in the conidence interval.

[2] Remark: Zero is in the confidence interval.

References

Fox, John, and Sanford Weisberg. 2019. *An R Companion to Applied Regression*. Third. Thousand Oaks CA: Sage. https://socialsciences.mcmaster.ca/jfox/Books/Companion/.

Gross, Juergen, and Uwe Ligges. 2015. *Nortest: Tests for Normality*. https://CRAN.R-project.org/package=nortest.

Madsen, Jacob H. 2018. *DDoutlier: Distance & Density-Based Outlier Detection*. https://CRAN.R-project.org/package=DDoutlier.

R Core Team. 2019. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Zeileis, Achim, and Torsten Hothorn. 2002. "Diagnostic Checking in Regression Relationships." *R News* 2 (3): 7–10. https://CRAN.R-project.org/doc/Rnews/.