

# Multiple Comparison Procedures To A Control

## For AN(C)OVA Models

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## Basic Information

Automatic statistics for the file:

File
recovery.csv

Your selection for the encoding: UTF-8

Your selection for the decimal character: .

Observations (rows with at least one non-missing value): 41

Variables (columns with at least one non-missing value): 2

Variables considered continuous: 1

Variables considered continuous
minutes

Variables considered categorical: 1

Variables considered categorical
blanket

## Model Information

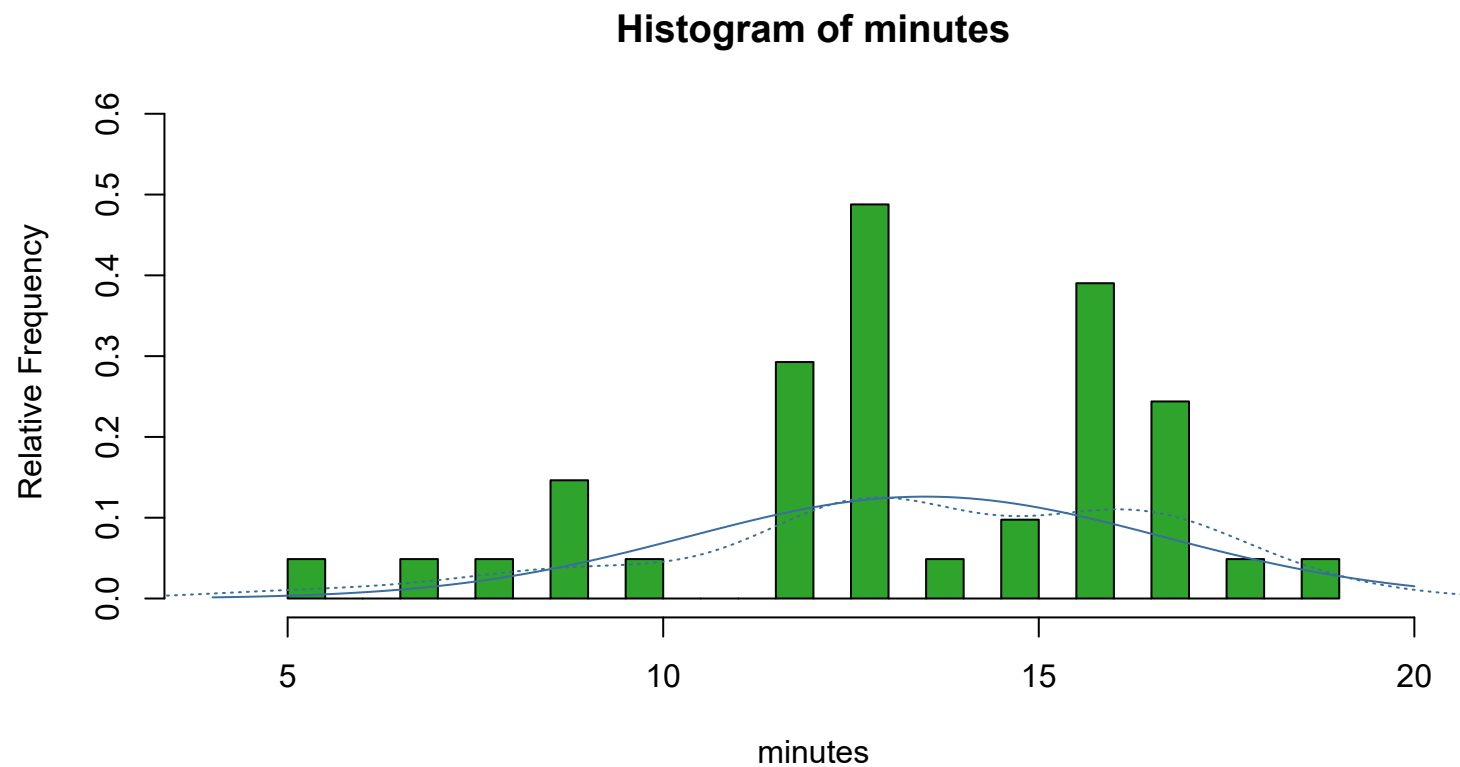
You defined the following linear model: minutes~blanket

You are interested in the factor: blanket

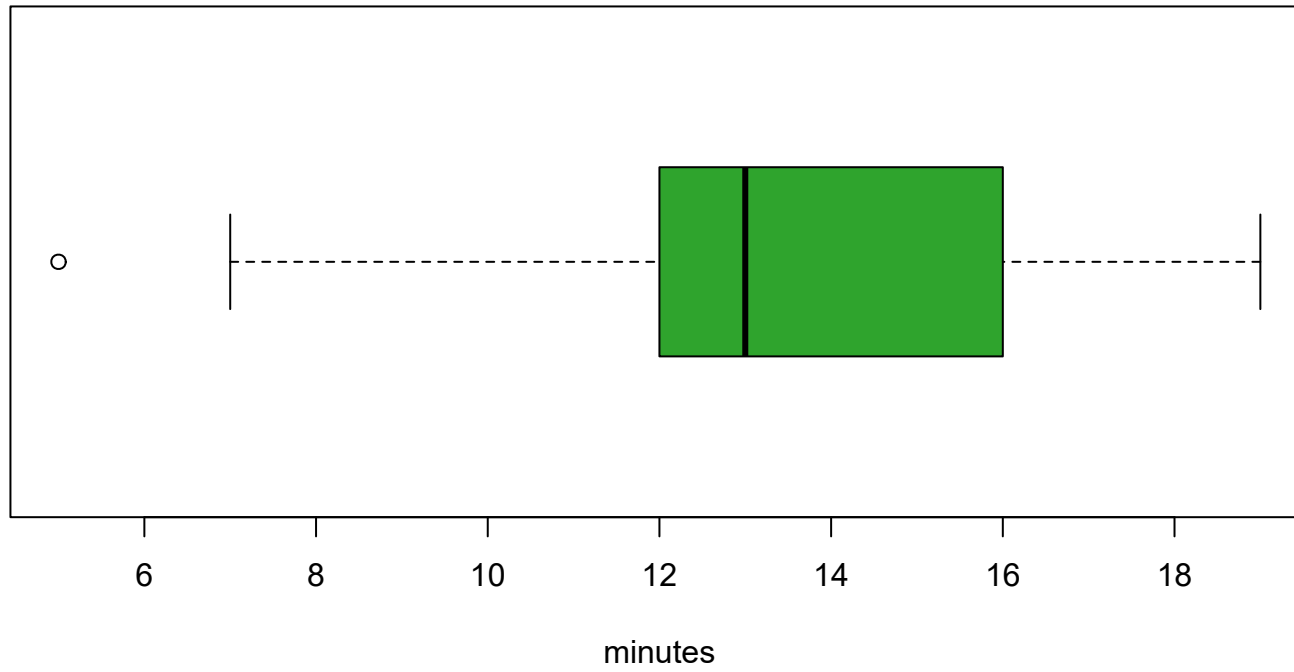
You are interested in pairwise comparisons to the control factor level: b0

## Descriptive Plots

### Dependent Variable



**Boxplot of minutes**



## Dependent Against Categorical Factors

**Boxplot of minutes ~ blanket**

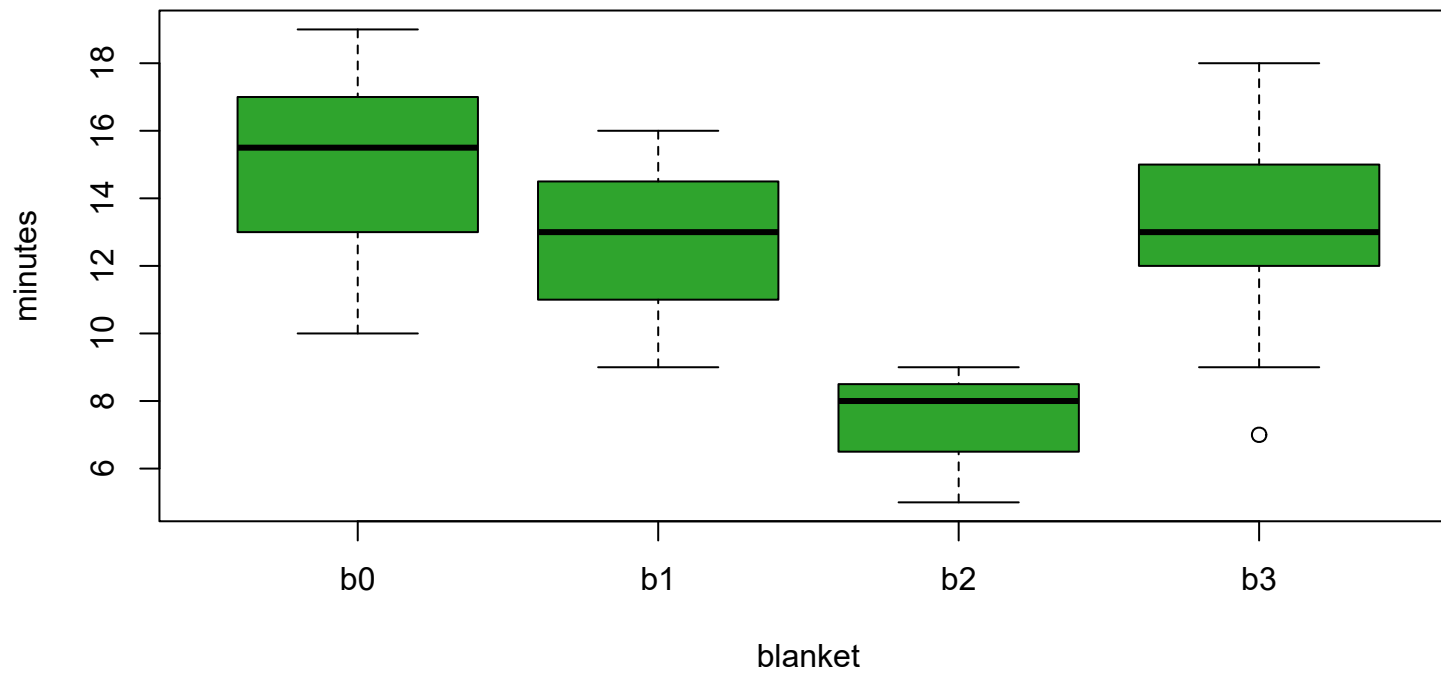


Table 4: Parameter Estimates

Variable	Value	Std.Error	t.value	pvalue	sign. level <sup>1</sup>	Significance at 5 percent error
(Intercept)	11.98	0.57	20.91	<0.001	***	Intercept Significant.
blanket1	2.82	0.70	4.00	<0.001	***	Significant. A Difference between the effect of blanket1 and its reference.
blanket2	0.68	1.20	0.57	0.573		Not Significant. No difference between the effect of blanket2 and its reference.
blanket3	-4.65	1.20	-3.87	<0.001	***	Significant. A Difference between the effect of blanket3 and its reference.

<sup>1</sup> '\*\*\*': sign. to 0.1% error. '\*\*': sign. to 1% error. '\*': sign. to 5% error. ' . ': sign. to 10% error. ' ': not sign. ' - ': no statement.

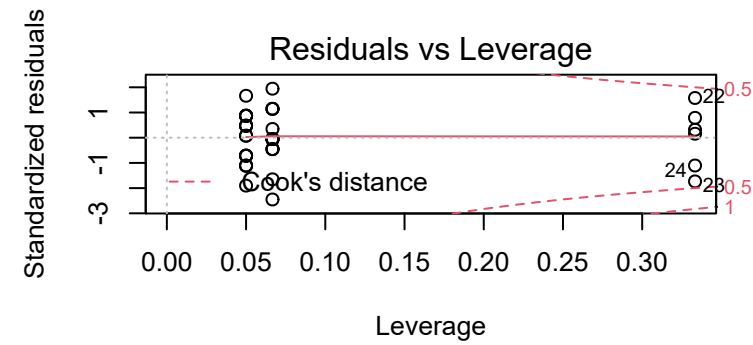
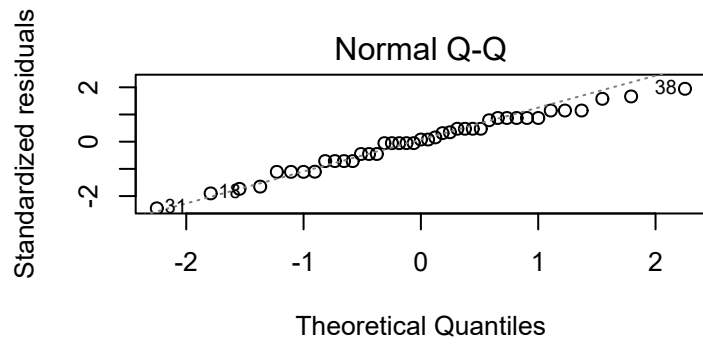
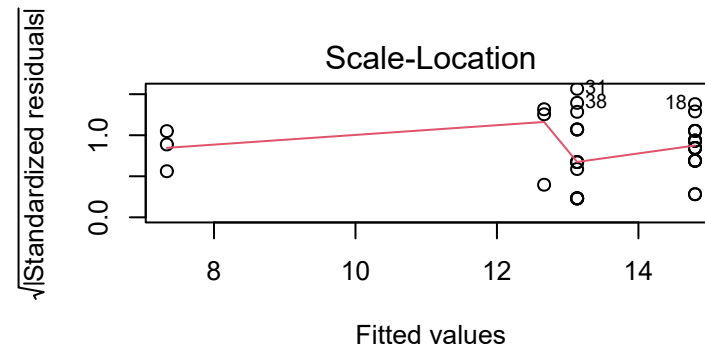
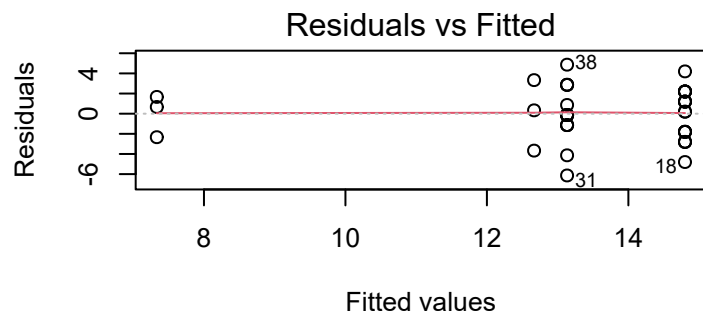
## Anova Table (Type III tests)

Response: minutes

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	2933.11	1	437.1314	< 2.2e-16 ***
blanket	151.98	3	7.5499	0.0004619 ***
Residuals	248.27	37		

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1



## 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

#### Multiple Comparison: Dunnet Contrasts

Test whether the factor level b0 of the factor blanket is different from the other levels. The Null Hypothesis is for example  $b1 - b0 = 0$ .

Null Hypothesis	Value	Std.Error	T.value	adjusted P.value	Sign. level <sup>1</sup>	Significance at 5 percent Type I error
$b1 - b0 = 0$	-2.13	1.60	-1.33	0.456	***	Not Significant. Level b0 of factor blanket is not different than b1 <sup>2</sup>
$b2 - b0 = 0$	-7.47	1.60	-4.66	<0.001		Significant. Level b2 of factor blanket is significantly different than b0 <sup>3</sup>
$b3 - b0 = 0$	-1.67	0.88	-1.88	0.182		Not Significant. Level b0 of factor blanket is not different than b3 <sup>2</sup>

<sup>1</sup> '\*\*\*': sign. to 0.1% error. '\*\*': sign. to 1% error. '\*': sign. to 5% error. ' . ': sign. to 10% error. ' ': not sign. ' - ': no statement.

<sup>2</sup> H1 does not hold significantly.

<sup>3</sup> H1 holds significantly.

#### Simoultaneous Confidence Intervals: Dunnet Contrasts

Simultaneous Confidence Intervals which includes the true value of the difference between the reference level b0 and the other levels of blanket

Null Hypothesis	Value	Lower bound	Upper bound	Interpretation
$b1 - b0 = 0$	-2.13	-6.12	1.86	The interval (-6.12, 1.86) traps the true difference b1-b0 with probability 95 percent. <sup>2</sup>
$b2 - b0 = 0$	-7.47	-11.46	-3.48	The interval (-11.46, -3.48) traps the true difference b2-b0 with probability 95 percent. <sup>1</sup>
$b3 - b0 = 0$	-1.67	-3.87	0.54	The interval (-3.87, 0.54) traps the true difference b3-b0 with probability 95 percent. <sup>2</sup>

<sup>1</sup> Remark: Zero is not in the confidence interval.

<sup>2</sup> 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/>.



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