

Exercises 8

1. Recall the battery operating conditions example of Chapter 8.

For these data it is easily checked that the sum of the observations and the sum of the squared observations are given by

$$y_{...} = \sum_{i=1}^3 \sum_{j=1}^3 \sum_{k=1}^4 y_{ijk} = 3799 \quad \text{and} \quad \sum_{i=1}^3 \sum_{j=1}^3 \sum_{k=1}^4 y_{ijk}^2 = 478547$$

Using the computational method suggested in the Appendix to Chapter 8, construct ‘by-hand’ the *sums of squares* of the ANOVA Table given in the R output on p7 of the Lecture Notes.

[*Hint* Construct a data table similar to that on p7, replacing the four observed values of each *cell* with their total. From this, calculate the corresponding *row* and *column* totals (which should each sum to the overall total of the observations given above), and hence the required *sums of squares*].

2. A manufacturer of horticultural products is testing a new fertilizer for tomato plants. It is thought that the growth of tomato plant seeds is affected by the amount of sodium and calcium in the fertilizer. A two-factor factorial experiment is performed in which tomato seeds are grown in essentially identical conditions but with fertilizers of different compositions. The data for the growth of the plant stems within a certain period (in mm.) are given below.

		Calcium			
		1%	2%	3%	4%
Sodium	5%	107	101	97	92
		104	103	92	91
		100	92	88	95
	10%	97	92	91	85
		103	101	97	79
		92	88	81	81
	15%	92	75	72	67
		97	81	61	57
		89	85	66	53

- (a) Specify a linear statistical model associated with this experimental design, which incorporates interaction between the effects of sodium and calcium, and define the terms in it with particular reference to the problem under consideration.
- (b) Fit the appropriate model to the data, and determine which effects are either significant, or non-significant, in explaining the variation in the responses.
- (c) Now fit a model which contains no interaction term, and interpret the ANOVA.
- (d) Using a residual analysis, comment on the adequacy of the models fitted. Would you endorse the use of the model of part (c)?