7.10. Factorial three-way parametric analysis of variance

EXAMPLE 7.7. Lead levels in soil samples taken at various depths, distances, and bearings from a smelter

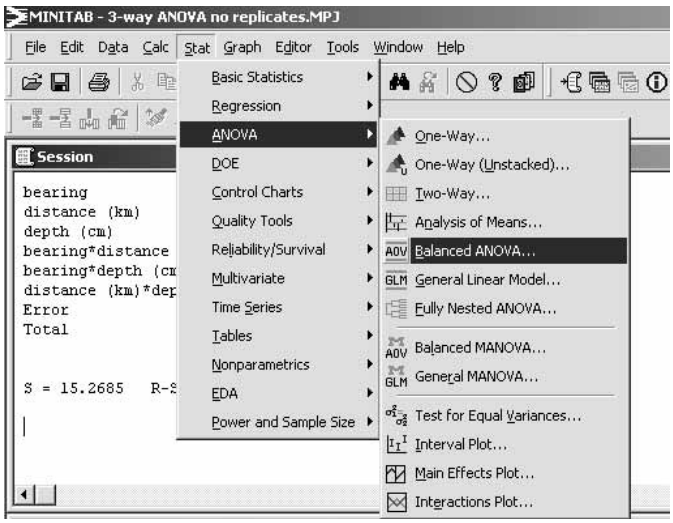
BOX 7.10. How to carry out a three-way factorial parametric anova without replicates

Step 1. Enter the data into the worksheet section of the Minitab display. Obviously there will be a lot of repeated entries in the 'forest' column: you can copy an entry down a column by hovering the cursor over the bottom right-hand corner of a cell until it changes from an open horizontal–vertical cross into an addition sign; when this happens, hold down the left mouse button, and drag the cursor down as far as you need.

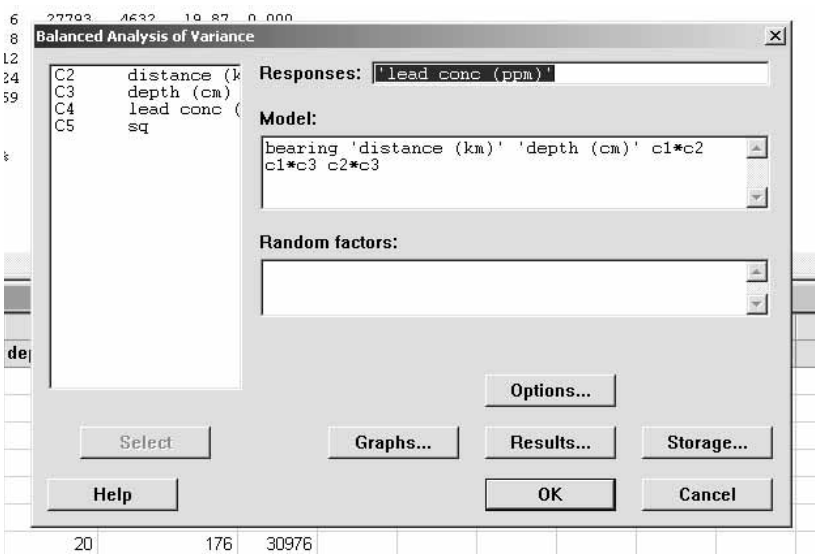
Worksheet 1 ***

↓	C1-T	C2	C3	C4	C5
	bearing	distance (km)	depth (cm)	lead conc (ppm)	
1	south	0.25	5	155	
2	south	0.25	10	102	
3	south	0.25	15	77	
4	south	0.25	20	65	
5	south	0.25	30	26	
6	south	0.50	5	98	
7	south	0.50	10	65	
8	south	0.50	15	45	
9	south	0.50	20	23	
10	south	0.50	30	9	

Step 2. Perform the test. Go to 'Stat', 'ANOVA', 'Balanced ANOVA'.



Transfer 'concentration' into the 'Response' window by highlighting 'concentration' and clicking on 'Select'. Transfer 'bearing', 'distance', and 'depth' into the 'Model' window using the same method. We also want to test for interactions between the three factors, so in the 'model' window, add 'c2*c3 c1*c3 c1*c2', where the '*' tells the system to model the interaction between factors in the appropriate columns. (We could have transferred the factors across, but that would have been tedious.)



Click on 'OK'. The output will appear in the session window.

ANOVA: lead conc (μg/g) versus bearing, distance (km), depth (cm)

Factor	Type	Levels	Values
bearing	fixed	3	south, south-east, south-west
distance (km)	fixed	4	0.25, 0.50, 1.00, 2.00
depth (cm)	fixed	5	5, 10, 15, 20, 30

Analysis of Variance for lead conc (μg/g)

Source	DF	SS	MS	F	P
bearing	2	188872	94436	405.09	0.000
distance (km)	3	67477	22492	96.48	0.000
depth (cm)	4	103956	25989	111.48	0.000
bearing*distance (km)	6	27793	4632	19.87	0.000
bearing*depth (cm)	8	57021	7128	30.57	0.000
distance (km)*depth (cm)	12	12921	1077	4.62	0.001
Error	24	5595	233		
Total	59	463636			

S = 15.2685 R-Sq = 98.79% R-Sq(adj) = 97.03%

Step 3. Decide what the results mean.
In this analysis, we first look at the interactions. In all three cases (bearing–distance, bearing–depth and distance–depth) we have large values of F (19.9, 30.6 and 4.6), and p values that are all well under 0.01. Because of these interactions, it is not meaningful to look at the individual responses, even though the software generates the figures.