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Interactive Computer Program for Simple Statistical Designs

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Interactive Computer Program for Simple Statistical Designs

By G. H. McKibben, W. A. Dickerson, and E. P. Lloyd¹

ABSTRACT

The program analyzes completely random and randomized complete-block designs and automatically applies Duncan's new multiple-range test to the ranked means. Written in FORTRAN IV, the program requires about 140 K bytes for compilation and 75 K bytes for execution. It is highly machine independent. Index terms: analysis of variance, computer programs, Duncan's new multiple-range test, statistical designs.

DESCRIPTION OF PROGRAM

Interactive processing, that is, working "conversationally" with a computer, is an easy way to enter data for a computer program, inasmuch as a control program commands the operator to enter each piece of information in the correct sequence. While interactive processing may cost somewhat more than normal (batch) processing, the difference is usually negated by a saving in personnel time. Interactive processing may not be possible at some computer installations, but programs designed for interactive use can also be used for batch processing.

The present program provides a convenient way to analyze completely random (one-factor) designs and randomized complete-block (two-factor) designs and to run Duncan's new multiple-range test (Duncan 1957) in the same runstream. The program is designed for ease of data entry; for the most part, only one value per line is entered, thus eliminating the need to skip over columns. Commonly used transformations are provided.

The Duncan portion was originally written by David L. Horton and later revised by M.P. Farrell, both of the Mississippi Agricultural and Forestry Experiment Station. We have further revised it by limiting the number of means handled from 125 to 25, to decrease the amount of computer storage required. Also, we have combined the Duncan program with an analysis of variance program that computes and passes to the Duncan routine the means, error degrees of freedom, and error mean square. The analysis of variance calculations are based on standard procedures (Steel and Torrie 1960). The output has been limited to an 80-column format to prevent overlapping of lines when 80-column terminals are used. The entire program is written in FORTRAN IV and requires about 140 K bytes for compilation and 75 K bytes for execution. It is highly machine independent: only minor changes (primarily input/output device assignments) are necessary to run the program on IBM 370, Univac 1106, and MODCOMP systems.

The completely random and randomized-block designs were chosen because the choice of the error term is automatic in these designs, and so it is a simple matter to pass it and the corresponding error degrees of freedom to a range-test routine. Also, these designs probably constitute more than 75 percent of all statistical designs used by entomol-

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ogists. Likewise, Duncan's test was chosen because of its wide use in entomology. The program is, of course, applicable in other agricultural and biological sciences.

Although Gill (1973) recommended that Duncan's procedure be discontinued because of its relative lack of conservatism in the separation of treatment means (Boardman and Moffitt 1971), Chew (1977) concluded that this objection can be reduced or removed by requiring a significant *F*-value or by using an alpha level of 0.01 or 0.001. A significant *F*-test has not always been considered a prerequisite to the use of this test (Steel and Torrie 1960, p. 107). Chew also advised against using any range test for factorial treatments or for such quantitative factors as application rates of fertilizers and insecticides.

Although the completely random routine will handle equal or unequal numbers of replicates per treatment, the randomized-block routine will handle only one replicate per block. If there is more than one observation per experimental unit, the unit

averages can be analyzed. Duncan's test will handle equal or unequal numbers of replicates.

REFERENCES

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1971. Graphical Monte Carlo type I error rates for multiple comparison procedures. *Biometrics* 27: 738-744.
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1973. Current status of multiple comparisons of means in designed experiments. *J. Dairy Sci.* 56: 973-977.
- Steel, R. G. D., and Torrie, J. H.
1960. Principles and procedures of statistics. 481 pp. McGraw-Hill, New York.

SAMPLE RUN

For illustration, inputs are shown in *italic* type. Program commands and output are roman. Added explanations are given parenthetically. The steps as the program advances are separated by lines.

THIS ANALYSIS OF VARIANCE PROGRAM WILL ANALYZE EITHER A COMPLETELY RANDOM (1-FACTOR) OR RANDOMIZED COMPLETE-BLOCK (2-FACTOR) DESIGN. ENTER C FOR COMPLETELY RANDOM OR R FOR RANDOMIZED BLOCK IN COLUMN 1.

R

THIS IS AN ANALYSIS OF VARIANCE PROGRAM FOR A RANDOMIZED COMPLETE-BLOCK DESIGN (STEEL & TORRIE, PP. 132-142), WITH DUNCAN'S NEW MULTIPLE-RANGE TEST. ONLY 1 REPLICATE ALLOWED PER BLOCK.

ENTER NUMBER OF TREATMENTS IN COLUMNS 1 & 2, NUMBER OF BLOCKS IN COLUMNS 3 & 4, & TITLE (OPTIONAL) IN COLUMNS 5-73.

0405SAMPLE RUN

NO. TREATMENTS = 4
NO. BLOCKS = 5

(Program confirms information entered above.)

ENTER TRANSFORMATION CODE IN COLUMN 1. 0 = NO TRANSFORMATION. 1 = ARCSIN (\sqrt{X}).
2 = $\sqrt{X + 1}$. 3 = $X/1000$. 4 = $X + 1$. 5 = LOG ($X + 1$). ONLY 1 TRANSFORMATION
ALLOWED.

0

ENTER 20 OBSERVATIONS, ONE PER LINE, WITH DECIMAL POINT. (Decimal point is
required even when datum is a whole number.) KEEP TREATMENTS IN THE SAME ORDER
THROUGHOUT ALL BLOCKS. IF AN INCORRECT ENTRY IS MADE, ENTER 9 IN COLUMN 1 TO
START OVER. (Program returns to transformation code when 9 is entered.)

ENTER OBSERVATIONS FOR TREATMENTS 1-4 FOR BLOCK 1

10.
15.
12.
25.

ENTER OBSERVATIONS FOR TREATMENTS 1-4 FOR BLOCK 2

22.
38.
20.
45.

ENTER OBSERVATIONS FOR TREATMENTS 1-4 FOR BLOCK 3

40.
70.
36.
105.

ENTER OBSERVATIONS FOR TREATMENTS 1-4 FOR BLOCK 4

12.
11.
13.
20.

ENTER OBSERVATIONS FOR TREATMENTS 1-4 FOR BLOCK 5

8.
9.
8.
15.

TITLE: SAMPLE RUN (Program tabulates data entered above.)

BLOCK 1	10.00000	15.00000	12.00000	25.00000
BLOCK 2	22.00000	38.00000	20.00000	45.00000
BLOCK 3	40.00000	70.00000	36.00000	105.00000

BLOCK 4	12.00000	11.00000	13.00000	20.00000
BLOCK 5	8.00000	9.00000	8.00000	15.00000

(Analysis of variance. DF, degrees of freedom. SS, sum of squares. MS, mean square. F, variance ratio. PR, probability.)

SOURCE	DF	SS	MS	F	PR>F
BLOCKS	4	7543.70000	1885.92500	12.53	0.000303
TREATMENTS	3	1929.00000	643.00000	4.27	0.028638
ERROR	12	1805.50000	150.45833	-----	-----
TOTAL	19	11278.20000	-----	-----	-----

TREATMENT NO.	MEAN	(Program outputs and passes treatment means to Duncan routine.)
1	18.40000	
2	28.60000	
3	17.80000	
4	42.00000	

DUNCAN'S NEW MULTIPLE-RANGE TEST

TITLE: SAMPLE RUN

TREAT- MENT NO.	YOUR ID	RANKED MEANS	N	ALPHA = 0.05	ALPHA = 0.01
4		42.00000	5	A	A
2		28.60000	5	AB	A
1		18.40000	5	B	A
3		17.80000	5	B	A

MEANS NOT FOLLOWED BY A COMMON LETTER DIFFER SIGNIFICANTLY FROM ONE ANOTHER. IF THERE ARE NO SIGNIFICANCE INDICATORS FOLLOWING A MEAN, THERE IS ONLY 1 MEAN IN THE SUBSET. ("Your ID" column provided for penciled-in notations.)

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This publication is available from the Science and Education Administration, 4116 Reedy Creek Rd., Raleigh, N.C. 27607.

A copy of the computer program described herein is available from the authors at the address above. Send a reel of magnetic tape and formatting instructions when making your request.

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