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Programmes for running statistical analysis in five experimental designs on minicomputers

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Programmes which run the statistical analysis of experimental designs (simple lattices 5 × 5 with 2 replications, triple lattices 5 × 5 with 3 replications, randomized block, split-plot with 2 and 3 factors) have been processed on minicomputer and written in BASIC language. Each programme has been split in intermediates in order to better combine the computer's hardware characteristics with the mathematical algebraic property of the experimental designs. Each of them is independent, sequential and processes a part of statistical analysis whose results are recorded on external support as the output of this programme and the input for the next intermediate.

1. Introduction

Most problems related to data analysis in small research stations, or when it is difficult the access to the analyzing data center, can be reduced or avoided by developing programmes for better utilizing the top desks or personal minicomputers (Martiniello, 1982). In this way, the versatility to utilize this family of computers, largely widespread in experimental research institutes around the world, increases. The reasons that promote their popularity are explained by Zilli and Pini (1981) and furthermore they have found an imporant use as equipment in some laboratories's instruments (Scott *et al.*, 1978; Klepper and Wilhelmi, 1979; Shenk *et al.*, 1981). The utility to have a large number of programmes able to run on these families of computers can solve or reduce the difficulties in handling and analyzing experimental field data.

The objectives of the paper are: a) to describe five programmes working on minicomputers with emphasis on one of them; b) to provide labor-saving programmes for desk, mini and personal computers able to run without manipulation of the data from the field sheet.

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2. Programme characteristics and method

Programmes which run data analysis of experimental designs are programmed. All programmes have been written in BASIC language and processed on minicomputer with 3K user memory (Olivetti P 6040) whose technical characteristics are pointed out by Martiniello (1982).

The complete programme which runs the stattistical analysis of the experimental designs, edited according to the machine language programme of the computer, has been written in high level language for saving computer memory (Wadsworth, 1977; Heiserman, 1981); and divided in intermediate programmes whose number is related to the experimental designs adopted. They analyze the experimental designs acording to the mathematical procedures reported by Cochran and Cox (1960); Steel and Torrie (1980); Snedecor and Cochran (1980).

Each intermediate programme is independent and sequential. Utilizing the commutative algebraic characteristic of the mathematical model, it processes a part of the statistical analysis whose results are then recorded on an external support (minidisk), which represents the output of this part of the programme. The external support, with data of partial analysis recorded on it, will be the input for the next intermediate programme. This procedure will be continued until the final analysis is achieved.

Generally, the first intermediate step arranges the data for the subsequent part of the programme, and the last one prints the results of the analysis while other intermediate steps develop the mathematical process of the statistical analysis according to the experimental design adopted. The experimental designs programmed are:
1) Partially balanced lattices: a) simple lattices 5 x 5 with 2 replications, recorded on 3 intermediates and utilized for running the analysis in Marocco (1978); b) triple lattices 5 x 5 with 3 replications, recorded on 4 intermediates and utilized for running the analysis in Delogu and Stanca (Coord.) (1980; 1981; 1982).
2) Randomized block recorded on 2 intermediates and utilized for running the analysis in Pezzali and Odoardi (1978).
3) Split-plot (2 factors) recorded on 2 intermediates and utilized for running the analysis in Maggiore *et al.* (1977); Delogu and Martiniello (1978); Delogu *et al.* (1979); Marocco *et al.* (1980).
4) Split-split-plot (3 factors) recorded on 3 intermediates and utilized for running the analysis in Brunetti *et al.* (1982).

The maximum number of experimental plots which can be processed on each programme is: 50, 75, 162, 165 and 147 respectively for simple and triple lattices, randomized block, split-plot and split-split-plot.

These programmes and the flowcharts are available and can be obtained from the author. All of them can be translated in other programme languages and, with small modifications, can be adopted on each kind of computers. Generally, they compute the analysis of variance with the respective degrees of freedom associated to each source of variabily, coefficient of variability, standard error, arrange the mean treatments in a decreasing order and apply Duncan's multiple range test (MRT).

3. How the programmes work

For better understanding how the programmes run the split-split-plot is described. The programme is framed on 3 intermediates named part A, B and C.

[*Part A*]. This intermediate programme has specific subroutines that can be called by keyboard. The subroutine arranges the experimental data, recorded on the field sheet, according to the experimental design adopted. It computes some traits showed in Brunetti *et al.* (1982) and furthermore it can make corrections of the eventual clerical mistakes done during the input of data, calling specific subroutine by keyboard.

This intermediate programme has four series of input data, three pause stages, five subroutines for arrange traits, five subroutines for making remote corrections of the traits and one for corrections of the experimental scheme. The first data input series defines the variables of the experimental design: N is the first factor (Nitrogen rate); T is the second one (Seedling rate); V is the third factor (Variety number); R is the replications number and C is a convenience variable. After the input of those variables, the programme moves to the first pause stage. In this position it is possible to choose the appropriate subroutine for the trait (second input series). After that, the programme reaches the second pause stage, where it is possible to apply corrections to the introduced data, and after each correction the programme goes back to the second pause stage for new correction, or for introducing the data of the experimental scheme (third input series). After this assigment the programme finds the third pause stage where it is possible to make corrections to the experimental scheme and then apply the fourth input series. Former input defines the number of data which must be recorded on the external support and it is related to the hardware of the system. Its value is given by the formula: $X = \dfrac{25 + (N \times R \times T \times V)}{16}$ whose value is drew near for excess to whole number. After this last statement, the programme records the data on minidisk and goes back to the first stage for selecting new subroutine for running new trait.

[*Part B*]. This intermediate programme solves the mathematical steps for computing the sum square of the variation source in the analysis of variance and stores the mean associated to each treatments. Its main structure is formed by one statement equal to the previous input value, one print out whose value is the input for next intermediate, two simple loops and twenty assegnation blocks which, generally, store the sum square components of the analysis whose results are recorded on the external support.

[*Part C*]. This intermediate is the last part of the main programme. It prints out the analysis of variance results with degree of freedom and *F* test associated with each source of variation. It lays out the mean of each treatment in decreasing sequence, and its identification code; furthermore it applies Duncan's multiple range test. Its structure is formed by three input statements: the first is equal to the previous print of the last intermediate, the second is equal to the number of the Duncan coefficient to introduce and the third consists in putting in Duncan's coefficients: first the 5% and after 1% value and so on, until the end of the input. Furthermore the flowchart presents three nested loops with assegnation blocks, conditioned jumps, two of them with a print statement, two simple loops, one with an input, the other with print statement, and four assegnation blocks; at the end of running, the programme goes back to start statement. The other listed programmes follow the same programming philosophy with a small modification connected to the characteristics of the experimental design adopted.

4. Conclusion

All programmes utilize efficiently the user memory and they can be extended to each kind of mini or personal computer. The programmes written on « Olivetti P 6040 » are related to its hardware. As consequence, there is a restriction to utilize the softwares in different computers. This can be avoided utilizing the flowchart of each programme, which can be fit to other computers with the same or different language.

Concluding, all programmes allow the possibilitty to increase user memory, versatility and utility, enhancing the effectiveness of the system. Furthermore, high language programming increase the advantages of the categories of computers described by Zilli and Pini (1981). This provides the possibility to reduce the cost of the data analysis.

Further informations on programmes flowchart and listing in BASIC language described on the text are available on request to the author.

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