R.W. Payne

Issue No. 10

The GENSTAT Newsletter

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CONTENTS

Published twice yearly by Rothamsted Experimental Station Statistics Department

and the Numerical Algorithms Group Limited

EDITORIAL

The Editors wish to apologise for the late appearance of this issue of the GENSTAT Newsletter; delayed by the pressure of other work. We hope to return approximately to schedule with issue 11, copy for which should be submitted as soon as possible.

Occasionally, minor subscription queries to NAG Central Office cause a disproportionate amount of work. It would be very helpful if anyone with such a query could quote the reference number on the top right hand corner of the address label (or, better still, enclose the label itself). The reference number has a very simple interpretation: for licenced package sites, it is the licence number; for other subscribers the number to the left of the solidus (/) indicates the final issue number of the subscription, that to the right is the number of copies of each issue ordered.

Finally, we regret that the price of the Newsletter has had to be increased to £5.00 per year. When the price was first set at £2.50, it approximately covered printing and postage costs. This is no longer the case, since costs have risen substantially. At the new price, NAG will still be providing most of the editorial and typing effort free of charge.

GENSTAT 4.03 STATUS REPORT

Since the last Newsletter, Genstat has been converted for the Siemens (BS 2000) by Dipl. Math. R Valder of the University of Dusseldorf. Versions for Harris (Stephen Morris, Chelsea College), Honeywell Multics (Doug Clark, University of Bath), Honeywell Sigma 6 (Gordon West, H M Government Communications Centre, Hanslope) and Perkin-Elmer (Graham Jagger and Tony Field, Life Science Research) have also appeared. An interactive version has been produced for DEC-10's by John Byrne of York University.

Ron Baxter of CSIRO is producing a version for the Vax under Unix. This is likely to be the last conversion of 4.03; when it is completed the final tally will be

25 separate conversions completed;
on at least 18 different machine ranges;
from 16 distinct manufacturers.

Orders for Genstat over the last six months have averaged 5 new copies per month. By the time this Newsletter appears, the number of licenced sites should exceed 200.

Lists of all Genstat sites, classified by country and machine range, are given overleaf. Anyone wishing to contact another site should first approach the Genstat Co-ordinator at NAG Central Office.

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GENSTAT 4.04

The new release of Genstat is now in service at Rothamsted. The first versions produced will probably be for IBM and PRIME computers, incorporating amendments to correct errors discovered in the initial test period. The source will then be sent out for conversion to other machines.

Manual updates are available from NAG. We discuss below the main differences between 4.03 and 4.04.

CHANGES.....

In a few respects Genstat 4.04 will not be compatible with earlier releases.

1. The options of the 'REFERENCE' statement have been changed. Only NID, NUNN and RNG remain as before; the LINE option has been removed (and there is now no check on the size of the output file) and the other options have been subsumed into a single PRINT option, with additional facilities for interactive working and debugging macros.

2. In the interests of consistency, all options which in one way or another refer to marginal totals now have the setting TOTAL. In particular:

'JOIN/ and *'PRINT/MARGIN = TOTAL'*	(not *TOT*)
'MARGIN/MODE = TOTAL or *MEAN'*	(not *T* or *M*)
'TABULATE/MARGIN = TOTAL'	(not *TOT*)

3. The backing store directives have been drastically revised. The 'FILE' command has been replaced by FILE options which should be set to an integer (1,2,...). The old concept of a userfile identifier has been discarded (it had no existence outside the job anyway). The ordinals 1,2,... are machine independent (so your Genstat job will run without change on another machine) but the channel numbers corresponding to these integers are machine dependent.

So we may now write

'PUT' or *'GET' subfile $ structure list*

which by default will access the workfile. If FILE = f>0 is set, userfile f will be accessed directly.

'FETCH' or *'SAVE' subfile list*

will, by default, access userfile 1.

The effects of these changes on programs which use backing store are illustrated in the following article in this Newsletter.

4. New directives 'BIN' (binary input) and 'BOUT' (binary output) have been added to transfer unformatted data. The directive name 'SYMAP' has been retained as a synonym of 'BOUT' but to reproduce its previous effect

'SYMAP/FORM = p'

must be used. By default this will write to userfile 1; this may be overridden by a FILE option.

..... AND ENHANCEMENTS

1. Interactive facilities

PRINT options of 'REFERENCE' (or 'INPUT') may be used

a) to produce a copy of the input. If PRINT letter C is set and a secondary output file nominated, all input instructions are copied to this file. It will need editing (before it can be used as an input file for a subsequent job) if incorrect commands have been given or the secondary output channel has been used for other purposes.

b) to control extended fault messages. On all machines except ICL System 4, diagnostic reports will be followed by an extra line of, hopefully, helpful text. These may be suppressed by setting the PRINT option without the letter F. Our thanks are due to John Byrne, of the University of York, for adding this feature to the DEC-10 version of 4.03 and spurring us to make it generally available.

A new directive called 'HELP' has been introduced to provide access to information about Genstat syntax. The directive is described on page 16.

Finally, the contraction R is accepted as a synonym of RUN.

2. Macros

Chasing elusive errors in macros can be difficult and time consuming. PRINT options of 'REFERENCE', 'INPUT' or 'USE' can now be set to force macro instructions to be printed as they are compiled, together with the statement number of the first statement on each line. It should therefore be possible to determine precisely which instruction has failed, even when a nest of macros is used at run time within a loop.

The 'ENDMACRO' statement now has an option LOCALS which, if set to DESTROY, will recover not only the data space but also the directory space occupied by the currect instances of the local identifiers of a macro used at run-time.

3. 'INPUT' and 'OUTPUT' have acquired new options. RECL may be used to change the assumed maximum length of a record, set on entry to the program. For output, RECL will allow interactive users to override the assumption that all output is to a terminal of restricted width.

'OUTPUT' also has an option NLP to reset the number of lines per page assumed by 'GRAPH'.

'BIN' and 'BOUT', which transfer unformatted data records, have been introduced primarily for communication with other Fortran programs. They can also be used to save space and to input data efficiently.

A new option SQUASH for 'PRINT' allows the user to prevent any blank lines being output by 'PRINT' unless explicitly requested in the format of a 'PRINT/C' command.

4. Graphics

'GRAPH' can now output to graphics devices. However, for a particular device at a particular site, four special routines are needed. We have written (and tested) the routines needed for the Benson plotter connected to the ICL System 4 and the GOC terminal connected to a Prime 550 at Rothamsted. Specifications of the routines, and the source for all versions in use here, will be made available to converters and we will try to coordinate work outside Rothamsted to produce suitable versions for individual sites.

5. Dynamic formats

After a format identifier has been declared by 'SET/F' it may be used in a format list; its contents will be substituted by the compiler.

'SET/F' G1=2,6X : G2=3.6,/

'READ' X $ 2(G1), 3X,G2

has the same effect as

'READ' X $ 2(2,6X), 3X,3.6,/

Although not explicitly proscribed by the manual, this could not be done in 4.03.

'READ' and 'PRINT' have an extra option FMT and 'EQUATE' has two new options LFMT and RFMT, all of which can be set to identifiers declared by 'SET/F'. When one of these statements is executed, if a format option has been set, then any explicit format given with the instruction is ignored and the format identifier used to determine the required format. Be careful: if the identifier is not of the correct type a fatal error will ensue. If it is of the right type, but without values, a null format will be assumed.

These new facilities will allow considerably more flexible use of formats.

6. Calculate and table operations

'CALCULATE' can now operate on integer and factor structures directly. The values of any structure of integer mode on the right hand side of an equation are converted to real values before they are used; if the (real) results of an expression are to be stored as integers they are converted to the nearest integer. Thus 5/3 will be treated as 5.0/3.0 = 1.6 until it has to be stored as an integer when it will be rounded to 2.

The VARFAC function has an optional second argument list to allow factors with non-numeric level names to be handled.

New functions NROW, NCOL, NLEV and TYPE will allow macro writers, in particular, to access attributes of structures.

'TABULATE' can now form tables of within-cell minima, maxima and variances. 'MARGIN' can form minima, maxima, variances and medians from the body of a table (i.e. between-cells).

7. Linear regression

A new directive called 'PREDICT', which provides summaries of a fitted regression model, was described in an article in Newsletter 9. It calculates and displays tables of mean values, optionally with standard errors, classified by factors in the model. The means are adjusted for any variates also in the model and several methods are available for adjusting for effects of some of the factors.

The directives for stagewise regression, 'BEST', 'WORST' and 'MINIMISE', have new options to control their operation. When considering a term for addition to (or deletion from) the current model, the change in the residual mean square may be compared to a partial F statistic, supplied in option FIN (or FOUT). The letter R may now be used in the PRINT option to control printing of the list of residual mean squares - this list is printed by default.

New option settings and keywords have been added to improve control over output from the regression directives. In the 'Y' directive, ERROR=INVERSE specifies the likelihood of the inverse Gaussian distribution. In the ANDEV option of directives like 'FIT' the new setting ANDEV=S prints the summary analysis table using the mean square from the smallest residual sum of squares as the divisor of ratios, rather than the smallest residual mean square, as at present. The keyword DPM is available in these directives to save the diagonal of the projection matrix: this may be used to form standard errors of either fitted values or residuals.

8. Analysis of variance

'ANOVA' has three new options

a) SEED = scalar

The ANOVA dummy analysis currently uses a dummy working variate containing random numbers. The scalar sets a starting value for the random numbers (default 12345). This can be used to check a suspect analysis e.g. if a model term is thought to be incorrectly listed as aliased.

b) TOL = variate

Sets various constants involved in the analysis.

c) PROB = N, Y

If PROB = Y, probabilities are printed for the variance ratios in the AOV table (assuming that they follow F distributions).

Also, a saved 'ANOVA' output segment can be used to print further output from an analysis, without requiring the variate to be analysed again.

E.g. *'ANOVA/PR=10' Y ; OUT=OY*

can be followed later by, for example, *'ANOVA/PR=2' OUT=OY*

'EXTRACT' has a new nameable list COEF.

For a block model term (only) this gives covariate regression coefficients estimated in the stratum for that term, output as a variate of length equal to the number of covariates.

9. Optimisation

A new algorithm has been added, to remove the present constraint on numbers of parameters in a non-linear model. The choice of algorithm is controlled by the option METHOD; the setting GN specifies the new Gauss-Newton algorithm, which has been modified to deal with all the likelihood functions available. (This algorithm is not available for general optimisation with the setting LIK=1.) If there are more than 6 non-linear parameters, the new algorithm is automatically used; there is no longer any limit on the number of linear parameters with the setting LIK=3.

10. Time series

A new directive called 'FOURIER' has been introduced to provide the basic tool for methods of spectral analysis. It uses a fast algorithm to calculate the Fourier transform of a real or complex sequence. The cosine transform of a real sequence is also available.

A PRINT option has been added to the directive 'DERIVE'. The setting PRINT=G will produce a graph of the calculated function, that is, a "correlogram" if the function used is one of the correlation functions ACF, PACF, CCF or THACF.

The LIK option of 'ESTIMATE' has now been implemented; it was described in the manual for release 4.03 but was not available then. The default setting is LIK=EXACT, which gives a more accurate (though more time-consuming) calculation of the likelihood than the only setting available previously, LIK=LS. The setting LIK=MARG may be used to reduce bias in parameter estimates derived for small samples.

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BACKING STORE CHANGES IN GENSTAT 4.04

Facilities for storage and retrieval are being improved in Release 4.04 and the syntax is being revised at the same time. These changes will result in many existing Genstat programs having to be edited. This article explains why this change was made, gives details of the amended syntax (for users not having manual amendments at hand) and gives examples of the old and new syntax.

The major changes are to the 'GET' and 'PUT' directives, where userfiles can now be accessed directly. Most Genstat programs using backing store read structures from one subfile of a userfile (e.g. the macro library) into core. In the past the subfile had to be copied into the workfile and then the requested structures read into core. The stage of copying to or from the workfile is no longer necessary, so there will be savings in disc space and computer time. The ability to create directly a userfile containing one subfile is also provided. This facility will be especially useful to people using interactive Genstat, when they want to stop a job and save the compiled code and structures for future use (using the COMP=DUMP option).

It has always been possible to specify a userfile in the 'PUT' and 'GET' directives but unexpected problems could arise. For example, the 'GET' directive could be used to copy structures from a userfile. Formerly, the 'GET' directive copied all the subfiles in the userfile into the workfile and the requested structures were then copied into core. However, if subfiles of the same name existed in the userfile and workfile, the job failed. In 4.04, the requested structures will be copied directly into core from the subfile in the userfile so that it does not matter if subfiles in the workfile and the userfile have the same name.

At the same time as implementing the important changes described above, it was felt necessary to simplify the syntax. In the past, the number of the channel to which a userfile had been assigned was specified by the 'FILE' directive. The 'FILE' directive has been removed and replaced by a FILE option with a scalar setting. The setting *0* corresponds to the workfile and setting *1* to the userfile assigned to the first available channel. The default value is the lowest possible for each directive, i.e. *0* for 'DISPLAY', 'PUT' and 'GET', *1* for 'SAVE' and 'FETCH'.

In the revised syntax for the backing store directives given below, only changes from 4.03 Genstat are given in detail.

'PUT or GET/<u>option list</u>' subfile ($ <u>sequence</u> of <u>renaming segments</u> of <u>core structures</u>)

where option list is

FILE=<u>scalar</u>,PRINT=<u>name</u>,LIST=<u>name</u>,COMP=<u>name</u>

The values for the FILE option are

0 = workfile (default)
1 = userfile assigned to first channel
2 = userfile assigned to second channel
etc

(the number of channels varies according to installation).

The settings for the PRINT option are now

Z = no printing of changed catalogues (default) (formerly N)
C = printing of changed catalogues (formerly Y)

'SAVE or FETCH/option list' (sequence of renaming segments of subfiles of the workfile)

'DISPLAY/option list' (list of subfiles)

where option list for 'SAVE', 'FETCH' and 'DISPLAY' is

FILE=scalar,PRINT=name,LIST=name.

The values of the option FILE are the same as in 'PUT' except that *0* is not permitted for SAVE or fetch where the default will be *1*. The PRINT option is the same as in 'PUT', except for DISPLAY where the default is C.

'CLEAR/option list' (list of subfiles)

where option list is

PRINT=name,LIST=name.

The PRINT option is the same as in 'PUT'.

The examples below illustrate how programs need to be modified.

A) STORING SOME STRUCTURES PERMANENTLY

4.03	*4.04*
'PUT' SUB $ DATA(1...10)	'PUT' SUB $ DATA(1...10)
'FILE' PERM=48	'SAVE/FILE=2' SUB
''FILE ATTACHED TO CHANNEL 48:- 47 RESERVED FOR MACRO LIBRARY AT ROTHAMSTED''	''FILE ATTACHED TO SECOND AVAILABLE BACKING STORE CHANNEL:- 48 AT ROTHAMSTED''
'SAVE' PERM $ SUB	
alternative	alternative
'FILE' PERM=48	'PUT/FILE=2' SUB $ DATA(1...10)
'PUT' PERM,SUB $ DATA(1...10)	

Similar changes apply to 'GET' and 'FETCH' for retrieval.

B) STORING STRUCTURES PERMANENTLY IN GROUPS IN ONE FILE

4.03	*4.04*
'PUT' SUB(1) $ DATA(1...5)	'PUT' SUB(1) $ DATA(1...5)
: SUB(2) $ DATA(6...10)	: SUB(2) $ DATA(6...10)
'FILE' PERM=48	'SAVE/FILE=2' SUB(1,2)
'SAVE' PERM $ SUB(1,2)	

C) STORING STRUCTURES PERMANENTLY IN MORE THAN ONE FILE

4.03

```
'PUT'     SUB(1) $ DATA(1...5)
  :       SUB(2) $ DATA(6...10)
'FILE'    PERM(1)=48
  :       PERM(2)=49
''2ND FILE ATTACHED TO CHANNEL 49''

'SAVE'    PERM(1) $ SUB(1)
  :       PERM(2) $ SUB(2)
```

4.04

```
'PUT'     SUB(1) $ DATA(1...5)
  :       SUB(2) $ DATA(6...10)
'SAVE/FILE=2'     SUB(1)
'SAVE/FILE=3'     SUB(2)
''2ND FILE ATTACHED TO THIRD AVAILABLE
BACKING STORE CHANNEL:- 49 AT
ROTHAMSTED''
```

D) REPLACING ONE SUBFILE IN A FILE, LEAVING OTHERS UNCHANGED

4.03

```
'FILE'     PERM = 48
'FETCH/LIST=ALL'     PERM
'GET/LIST=ALL'     SUB(1)
'CALC'     DATA(1) = NEW*DATA(1)
'CLEAR'     SUB(1)
'PUT'     SUB(1) $ DATA(1...5)
'SAVE/LIST=ALL'     PERM
```

4.04

```
'FETCH/LIST=ALL,FILE=2'
'GET/LIST=ALL'     SUB(1)
'CALC'     DATA(1)=NEW*DATA(1)
'CLEAR'     SUB(1)
'PUT'     SUB(1) $ DATA(1...5)
'SAVE/LIST=ALL,FILE=2'
```

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THE HELP DIRECTIVE

A new directive has been introduced in Release 4.04 to make information available to people using Genstat interactively. It may also be used in batch, to print the information for reference; however, we also hope to make all the information available on a reference card.

The directive may be used as follows:

(1) Index: Type 'HELP' followed by 'RUN' (or by the new synonym for 'RUN' - 'R'). This lists 16 section headings, e.g. data input, linear regression analysis, and gives a section number for each.

(2) Index of section: Type 'HELP' *section number* 'R'. This gives general information about the section and a list of directive names.

(3) Syntax of a directive: Type 'HELP' *directive name* 'R'. This gives the form of the directive, a one-line description of its purpose and a list of all options, option settings and keywords, with brief descriptions.

(4) Further information: The information for some directives takes more than 20 lines, the maximum to be presentable on a video-terminal. To get more, the directive name can be given again with a suffix: possible suffices are listed at the end of the first section of output. For example, 'HELP' CALC(2) 'R' lists functions which summarise structure values.

With some versions of Genstat, the information will not be available because of limitation of storage. The text is presented in lines of 64 characters to ensure it fits on most terminals; there are about 1250 lines available, which take 80K bytes of storage. By contrast, it is hoped to print all the information, legibly, on a reference card measuring 21 x 60 cm, concertina-folded to give 12 pages.

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DIALLEL CROSSES, PARTIALLY BALANCED INCOMPLETE BLOCK DESIGNS WITH TRIANGULAR ASSOCIATION SCHEMES AND RECTANGULAR LATTICES

INTRODUCTION

What have these designs in common? Apart from esoteric names, all three have a high degree of symmetry and yet cannot be completely analysed by the Genstat 'ANOVA' directive. The treatment structure for the first design cannot be specified, the 'ANOVA' algorithm finds the second design unbalanced and treatment means for the third are only 'approximate'. Of course, other methods of analysis are possible and macros are available to analyse (i) diallel crosses using regression procedures (N.G. Alvey and O. Mayo, personal communications) and (ii) rectangular lattices using 'ANOVA' on the dual of the design (E.R. Williams and D. Ratcliff, CSIRO Macro).

I suggest instead a technique which aids in the analysis and, I think, the understanding of all three designs (and no doubt others). It is based on the idea of repeating the data several times and generating treatment and block factors with each copy of the data. The treatment and block factors are chosen so that the repeated data has a 'balanced' structure and that the required analysis is a meaningful subset (usually the only one) of the analysis of the extended data. Thompson and Baker (1981) found a similar idea useful in embedding several types of data into a generalised linear model framework.

I will demonstrate the technique for each design in turn and then discuss the disadvantages of the method and point out how the Genstat 'ANOVA' algorithm might be improved.

DIALLEL CROSSES

In plant breeding work on p different parental lines, often, all reciprocal crosses can be made and the p^2 progeny used for the comparison of parental lines. Various models and analyses have been suggested (Yates (1947), Hayman (1954), Griffing (1956), Jinks and Mather (1971)). I first consider a simple model that exhibits the difficulty in fitting these classes of models. I take the case where the progeny mean, when a male of line i is crossed with a female of line j, is y_{ij}. One might think of fitting a factorial model

$$y_{ij} = mean + male\ line\ (i)\ effect + female\ line\ (j)\ effect$$

and this can be easily done in 'ANOVA'. However it might be reasonable to assume the male and female effects of line i to be similar and so want to fit a model

$$y_{ij} = mean + line\ (i)\ effect + line\ (j)\ effect. \qquad (1)$$

However, each observation has 2 contributions from the line factor and so it is difficult to specify the treatment structure. Suppose, however, that we have two observations yt_{ij1} and yt_{ij2} with expectations

$$yt_{ij1} = mean + line\ (i)\ effect\ , \quad yt_{ij2} = mean + line\ (j)\ effect.$$

Each such pair yt_{ij1} and yt_{ij2} can be put in a different level of a factor DUMMY (for example put yt_{ij1} and yt_{ij2} into level $(i+(j-1)xp)$. For $p=3$ the data, treatment and block factors will be

$$
\begin{array}{rlllllllll}
Y = & (y_{11} & y_{12} & y_{13} & y_{21} & y_{22} & y_{23} & y_{31} & y_{32} & y_{33}) \\
YT = & (yt_{111} & yt_{121} & yt_{131} & yt_{211} & yt_{221} & yt_{231} & yt_{311} & yt_{321} & yt_{331} \\
 & yt_{112} & yt_{122} & yt_{132} & yt_{212} & yt_{222} & yt_{232} & yt_{312} & yt_{322} & yt_{332}) \\
= & (y_{11} & y_{12} & y_{13} & y_{21} & y_{22} & y_{23} & y_{31} & y_{32} & y_{33} \\
 & y_{11} & y_{12} & y_{13} & y_{21} & y_{22} & y_{23} & y_{31} & y_{32} & y_{33}) \\
LINE = & (1 & 1 & 1 & 2 & 2 & 2 & 3 & 3 & 3 \\
 & 1 & 2 & 3 & 1 & 2 & 3 & 1 & 2 & 3) \\
DUMMY = & (1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\
 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9).
\end{array}
$$

Then an analysis of the $p^2 \times 2$ values yt_{ijk} with LINE as treatment factor and DUMMY as a blocking factor will use 1 in the DUMMY stratum and, hence, give the required analysis in the DUMMY stratum. As noted by Wilkinson (1971) the resulting line effects have efficiency $(p-2)/(p-1)$.

Other more complicated models might be fitted. In Appendix 1 the code is given for Hayman's (1954) analysis using data in Mather and Jinks (1971, p. 256). This analysis includes comparisons of mean parental performance with mean progeny performance (i.e. y_{ii} versus y_{ij} $(j=i)$ or 'pure' versus 'cross') and of line parental performance with line cross performance and fits a model similar to (1) to the reciprocal difference $(y_{ij}-y_{ji})$.

PARTIALLY BALANCED INCOMPLETE BLOCKS WITH TRIANGULAR ASSOCIATION SCHEMES (P.B.I.B.T.)

These designs (for example Clatworthy, 1973) have $t = n(n-1)/2$ treatments. The association scheme can be obtained from a symmetric $n \times n$ array A with the diagonal blank and each treatment occurring twice - once above and once below the diagonal. Treatments in the same row or column are first associates. For example, the design with $t=10$, $b=6$, $k=5$, $r=3$, with treatments

$1, 3, 7, 8, 9$	in the first block
$1, 2, 6, 9, 10$	in the second block
$1, 4, 5, 8, 10$	in the third block
$2, 4, 6, 7, 8$	in the fourth block
$2, 3, 5, 7, 10$	in the fifth block and
$3, 4, 5, 6, 9$	in the sixth block

is a P.B.I.B.T..

The design has array A

*	1	2	3	4
1	*	5	6	7
2	5	*	8	9
3	6	8	*	10
4	7	9	10	*

and this indicates that $2, 3, 4, 5, 6$ and 7 are the first associates of 1 and $3, 6, 8, 4, 7$ and 9 are first associates of 10. As A is symmetric, the information on the association scheme can be found from the triangular array above (or below) the diagonal and hence the designs are said to have a triangular association scheme. The designs cannot be analysed directly by 'ANOVA' but they can be made balanced by imposing a pseudo-treatment structure. Because of the association scheme it is natural to use the rows and columns of A to generate some pseudo-treatment structure. Suppose that treatment i (in the lower triangle of A) is in row r_i and column c_i. Then T.P. Speed has shown that P.B.I.B.T. designs have general balance with respect to the pseudo-treatment scheme

$$\begin{aligned} i\text{-th treatment effect} &= r_i\text{-th pseudo-treatment effect} \\ &+ c_i\text{-th pseudo-treatment effect} \\ &+ r_i, c_i \text{ pseudo-treatment interaction effect} \end{aligned}$$

with $(n-1)$ degrees of freedom for the pseudo-treatment effects and $(n-2)(n-1)/2$ degrees of freedom for the interaction effects.

This model is similar to the diallel model and can be fitted in a similar way. We make 2 copies of the data and use the rows of A to give the levels of the pseudofactor for the first copy and the columns of A to give the levels of the pseudofactor for the second. For example, the treatments

1 2 3 4 5 6 7 8 9 10

can be replaced by

2 3 4 5 3 4 5 4 5 5

with the first copy of the data and by

1 1 1 1 2 2 2 3 3 4

with the second copy of the data. Appendix 2 gives the Genstat code for the analysis of variance for this design, with some artificial data.

One problem is that Genstat does not know that each treatment is associated with 2 levels of the pseudofactor and it is not clear how the levels are calculated when deriving tables of means. For instance with the example above, Genstat associates levels *2, 2, 3, 3, 3, 3, 4, 4, 4, 5* with the treatments *1-10*. The level for treatment i is the integer part of $[(r_i+c_i+1)/2]$. In most other circumstances, the association of two levels of a pseudofactor with one treatment combination will only occur by mistake and it is intended to trap this in future releases of Genstat! However, correct tables of means and standard errors can easily be constructed using 'EXTRACT'.

A macro is available from the author to generate the levels of the pseudo-factors from treatment and block-factors for P.B.I.B.T. designs when A is not known, for example, if the treatments are randomised and no note is kept of the original order.

RECTANGULAR LATTICES

These designs, introduced by Harshbarger (1950) for $p(p-q)$ treatments in blocks of $(p-q)$, are a development of square lattices (Yates, 1936). Macros exist to analyse rectangular lattices but it is interesting to show how the method of the previous sections can also be used with these designs.

Consider a design for *12 = 4* x *3* treatments in 3 replications and block size of 3. A rectangular lattice design with these dimensions can be constructed from the following Graeco-Latin square

TP 2

TP 1	*1*	*2*	*3*	*4*
1	*13* *A* δ	*1* *D* α	*2* *B* β	*3* *C* γ
2	*4* *C* α	*14* *B* δ	*5* *D* γ	*6* *A* β
3	*7* *D* β	*8* *A* γ	*15* *C* δ	*9* *B* α
4	*10* *B* γ	*11* *C* β	*12* *A* α	*16* *D* δ

where the levels of *TP3* are the Latin letters *A, B, C, D* and of *TP4* are the Greek Letters α§ β§ γ§ δ. We associate with each cell a treatment, the off-diagonal cells are numbered from *1* to *12*, the diagonal from *13* to *16*. Then, using rows, columns and treatments to generate blocks, a 3-replicate rectangular lattice design can be derived by ignoring the diagonal elements of the square. (It will become apparent later why we have bothered to label the diagonal treatments as *13* to *16*.)

This is

Rep I	*1*	*2*	*3*	*Rep II*	*4*	*7*	*10*	*Rep III*	*6*	*8*	*12*
	4	*5*	*6*		*1*	*8*	*11*		*2*	*9*	*10*
	7	*8*	*9*		*2*	*5*	*12*		*3*	*4*	*11*
	10	*11*	*12*		*3*	*6*	*9*		*1*	*5*	*7*

This suggests using *TP1 + TP2 + TP3 + TP4* as a pseudofactor structure for *T* and, although this allows Genstat to produce the correct analysis of variance, the treatment effects are only 'approximate'. This is because *TP1, TP2* and *TP3* are not mutually orthogonal.

T.P. Speed has suggested an alternative subdivision of the pseudofactor space which allows an orthogonal subdivision. In our case, rather than think of *TP1, TP2, TP3* as representing 3 sets of 4 effects, we think of them as a two-way table indexed by *COPY* with 3 levels and *TP* with 4 levels, i.e.

		TP1	*TP2*	*TP3*
COPY		*1*	*2*	*3*
	1	*1*	*1*	*A*
TP	*2*	*2*	*2*	*B*
	3	*3*	*3*	*C*
	4	*4*	*4*	*D*

Speed has shown that *TP* and *TP.COPY* generate orthogonal subspaces (with 3 degrees of freedom and 6 degrees of freedom in our case). Note that the combinations of the pseudofactors *TP1*, *TP2*, *TP3* at level i of *TP* relate to the i-th diagonal of the Graeco-Latin square, so that the average effects of *TP* would give estimates to compare treatments *13* to *16* if the pseudo-factorial model was appropriate.

Hence, each treatment is now associated with 3 levels of *TP* and *TP.COPY*. As before, we can specify this model using 3 copies of the data and using *TPi* to give the level of *TP* with the ith copy of the data. Appendix 3 gives the Genstat code for a rectangular lattice taken from Kempthorne (1952, p.522). Again, there is a problem linking up treatment estimates with the 3 levels of TP and COPY.

DIFFICULTIES

There are three disadvantages of this method (i) multiple copies of, for instance, the yield variate are needed, (ii) effects and sums of squares in the dummy stratum are calculated, (iii) the linkage between treatments and pseudofactors is not complete.

G.N. Wilkinson has suggested that a simple modification of the algorithm should avoid at least the first two of the difficulties. He would allow the treatment factor length to be a multiple, say c, of the length of the analysed variate. When treatment totals are calculated, the program would go through the data c times and when sweeps are made, c terms would be taken from each data value. A similar technique could be used for deriving treatment estimates from pseudofactors.

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APPENDIX 1

```
 'REFERENCE' DIALLEL
'CAPTION'   ''
   P is the number of parental lines
   Sets up size parameters
   I is the index for male parent,
   J is the index for female parent,
   D is the index for copies of data,
     variates,factors,and calculations
     for PARents,Pure Versus Crosses,
     RECIPricals,DUMMY.
   Crosses (i,j) and (j,i) are at level
        ix(i-1)/2+j of RECIP.
''
 'SET' P=9    'SCALAR' N,N1,N2
 'CALC' N=2*P*P  : N1=P*P  : N2=P*(P-1)/2
 'RUN'
 'UNITS' UN$N=1...N
 'VARIATE' I=(P!(1...P))2 : J=((1...P)P)2 : D=N1!(1,2)
 'VARIATE' PARV,PVCV,RECIPV,DUMV
 'FACTOR' PARENTS$P : PVC$2  : RECIP$N2 : DUMMY$N1 : COPY$2
 'CALC' PARV=I*(D.EQ.1) + J*(D.EQ.2)
 'CALC' PVCV=(I.EQ.J) + 2*(I.NE.J)
 'CALC' RECIPV=(I.GE.J)*(I*(I-1)/2 + J) + (I.LT.J)*(J*(J-1)/2 + I)
 'CALC' DUMV=(I-1)*P + J
 'GROUP' PARENTS,PVC,RECIP,DUMMY,COPY=INTPT(PARV,PVCV,RECIPV,DUMV,D)
 'HEADING'  H = ''
  THIS GIVES FOUR TIMES THE NUMBERS IN JINKS AND MATHER (page 256) ''
 'DESCRIBE'    YT $ ; H

 'BLOCKS' RECIP/DUMMY
 'TREATMENTS' PARENTS*PVC + PARENTS*COPY
 'VARIATE' Y$N1  'VARIATE' YT
 'READ/PRIN=DEM' Y  'EQUATE' YT=Y
 'DESCIBE' YT$5
 'ANOVA/PR=00010' YT
 'RUN'
```

```
77.8 53.4 79.6 69.6 50.2 59.6 71.4 67.6 50.6
47.8 54.1 50.0 46.2 43.0 52.4 46.8 41.2 40.4
68.8 53.2 97.6 59.1 50.0 63.0 72.2 48.8 52.0
72.2 47.0 62.4 68.2 46.8 58.7 54.4 44.6 50.0
53.0 46.4 52.0 51.0 53.2 55.0 54.4 40.4 48.4
56.8 48.2 60.6 63.8 48.3 54.0 55.4 44.8 49.6
73.8 49.4 83.6 67.8 60.2 59.6 74.0 48.8 58.2
53.6 38.6 55.6 44.2 38.4 37.6 45.4 30.6 43.6
50.6 46.6 49.8 48.0 45.0 42.6 54.8 38.0 50.8
'EOD'
Y     MNMINMAX       54.2616      30.6000      97.6000    81  VALUES    0 MISSING

1
 ***** ANALYSIS OF VARIANCE *****

 VARIATE: YT
   THIS GIVES FOUR TIMES THE NUMBERS IN JINKS AND MATHER (page 256)

 SOURCE OF VARIATION                DF         SS        SS%          MS        VR

 RECIP STRATUM
   PARENTS                           8   1.582E 4     72.85   1.978E 3    23.238
   PVC                               1   1.294E 3      5.96   1.294E 3    15.203
   PARENTS.PVC                       8   1.146E 3      5.27   1.432E 2     1.683
   RESIDUAL                         27   2.298E 3     10.58   8.511E 1
 TOTAL                              44   2.056E 4     94.66   4.673E 2

 RECIP.DUMMY STRATUM
   PARENTS.COPY                      8   5.420E 2      2.50   6.775E 1     3.068
   RESIDUAL                         28   6.183E 2      2.85   2.208E 1
 TOTAL                              36   1.160E 3      5.34   3.223E 1

 RECIP.DUMMY.*UNITS* STRATUM
   PARENTS                           8   0.000E 0      0.00   0.000E 0
   COPY                              1   0.000E 0      0.00   0.000E 0
   PARENTS.COPY                      8   0.000E 0      0.00   0.000E 0
   RESIDUAL                         64   0.000E 0      0.00   0.000E 0
 TOTAL                              81   0.000E 0      0.00   0.000E 0

 GRAND TOTAL                       161   2.172E 4    100.00

 GRAND MEAN                      54.26172
 TOTAL NUMBER OF OBSERVATIONS         162

 ***** INFORMATION SUMMARY *****

 MODEL TERM                         EF  NON-ORTHOGONAL TERMS

 RECIP STRATUM
   PARENTS                       0.500
   PARENTS.PVC                   0.875  PARENTS

 RECIP.DUMMY STRATUM
   PARENTS.COPY                  0.500

 RECIP.DUMMY.*UNITS* STRATUM
   PARENTS                       0.500  RECIP
   PARENTS.COPY                  0.500  RECIP.DUMMY

 'CLOSE'
```

APPENDIX 2

```
 'REFERENCE'          ROW_COLUMN_ASSOCIATION
 ''
  This file is RCA
 ''
 'CAPTION'            ''
  The row and column associations are now calculated by grouping the levels
  of factor T ''
 'UNITS'              $ 60
 'INTEGER'            INT1 = -11,-1,2,-5,3,6,-8,4,7,9,-10
     :                INT2 = 1,2,3,-4,5,6,-7,8,-9,-10,-11
```

```
'FACTOR'            R $ 5
    :               C $ 5
    :               T $ 10 = 3(1),2(2),2(3),2,2(4),3,4,7,(6,5)2,
                    5,8,9,8,2(7),6,9,2(10),8,10,9
    :               DUMMY $ 30 = (1...30)2
    :               BLOCK $ 6 = (1...6)10
'RUN'

'GROUP'             R = GROUP(T ; INT1)
    :               C = GROUP(T ; INT2)
'RUN'


'FACTOR'            TREAT $ 10 = T,T
    :               PF1 $ 5 = R,C
'VARIATE'           Y = (3(-3),2(-2,-1),-2,2(0),-1,0,1,0,-1,0,2(-1),
                    1,2,3(1),0,2,2(3),1,3,2)2
    :               BLCKT = (-5,-3,-1,1,3,5)10
    :               INTERACT = (5(0),2(2),0,2(-2),(2,-2)2,0,-2,
                    5(0),2(2),-2,6(0))2
'PRINT/P'           DUMMY,BLOCK,TREAT,PF1,Y,BLCKT,INTERACT $ 10
'RUN'
```

DUMMY	BLOCK	TREAT	PF1	Y	BLCKT	INTERACT
1	1	1	2	-3	-5	0
2	2	1	2	-3	-3	0
3	3	1	2	-3	-1	0
4	4	2	3	-2	1	0
5	5	2	3	-2	3	0
6	6	3	4	-1	5	2
7	1	3	4	-1	-5	2
8	2	2	3	-2	-3	0
9	3	4	5	0	-1	-2
10	4	4	5	0	1	-2
11	5	3	4	-1	3	2
12	6	4	5	0	5	-2
13	1	7	5	1	-5	2
14	2	6	4	0	-3	-2
15	3	5	3	-1	-1	0
16	4	6	4	0	1	-2
17	5	5	3	-1	3	0
18	6	5	3	-1	5	0
19	1	8	4	1	-5	0
20	2	9	5	2	-3	0
21	3	8	4	1	-1	0
22	4	7	5	1	1	2
23	5	7	5	1	3	2
24	6	6	4	0	5	-2
25	1	9	5	2	-5	0
26	2	10	5	3	-3	0
27	3	10	5	3	-1	0
28	4	8	4	1	1	0
29	5	10	5	3	3	0
30	6	9	5	2	5	0
1	1	1	1	-3	-5	0
2	2	1	1	-3	-3	0
3	3	1	1	-3	-1	0
4	4	2	1	-2	1	0
5	5	2	1	-2	3	0
6	6	3	1	-1	5	2
7	1	3	1	-1	-5	2
8	2	2	1	-2	-3	0
9	3	4	1	0	-1	-2
10	4	4	1	0	1	-2

11	5	3	1	-1	3	2
12	6	4	1	0	5	-2
13	1	7	2	1	-5	2
14	2	6	2	0	-3	-2
15	3	5	2	-1	-1	0
16	4	6	2	0	1	-2
17	5	5	2	-1	3	0
18	6	5	2	-1	5	0
19	1	8	3	1	-5	0
20	2	9	3	2	-3	0
21	3	8	3	1	-1	0
22	4	7	2	1	1	2
23	5	7	2	1	3	2
24	6	6	2	0	5	-2
25	1	9	3	2	-5	0
26	2	10	4	3	-3	0
27	3	10	4	3	-1	0
28	4	8	3	1	1	0
29	5	10	4	3	3	0
30	6	9	3	2	5	0

```
'BLOCKS'            BLOCK/DUMMY
'TREATMENT'         TREAT//PF1
'CALCULATE'         Y = Y + BLCKT
    :               Y = Y + INTERACT
'ANOVA/PR=03013'    Y
'RUN'
```

1

***** ANALYSIS OF VARIANCE *****

VARIATE: Y

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
BLOCK STRATUM					
TREAT	5	6.712E 2	72.33	1.342E 2	
TOTAL	5	6.712E 2	72.33	1.342E 2	
BLOCK.DUMMY STRATUM					
TREAT	9	2.568E 2	27.67	2.853E 1	
RESIDUAL	15	0.000E 0	0.00	0.000E 0	
TOTAL	24	2.568E 2	27.67	1.070E 1	
BLOCK.DUMMY.*UNITS* STRATUM					
TREAT	4	0.000E 0	0.00	0.000E 0	
RESIDUAL	26	0.000E 0	0.00	0.000E 0	
TOTAL	30	0.000E 0	0.00	0.000E 0	
GRAND TOTAL	59	9.280E 2	100.00		

GRAND MEAN 0.00
TOTAL NUMBER OF OBSERVATIONS 60

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
BLOCK STRATUM		
TREAT	0.200	
BLOCK.DUMMY STRATUM		
PF1	0.375	
TREAT	0.800	BLOCK
BLOCK.DUMMY.*UNITS* STRATUM		
PF1	0.625	BLOCK.DUMMY

***** TABLES OF EFFECTS *****

VARIATE: Y

*** BLOCK STRATUM ***

TREAT EFFECTS: REP 6 ESE *

TREAT	1	2	3	4	5	6	7	8	9	10
	-15.00	1.67	7.00	6.33	11.67	3.00	0.33	-8.33	-5.00	-1.67

*** BLOCK.DUMMY STRATUM ***

PF1 EFFECTS: REP 12 ESE 0.000

PF1	1	2	3	4	5
	-4.00	-2.00	0.00	2.00	4.00

TREAT EFFECTS: REP 6 ESE 0.000

TREAT	1	2	3	4	5	6	7	8	9	10
	0.00	0.00	2.00	-2.00	-0.00	-2.00	2.00	-0.00	-0.00	-0.00

*** BLOCK.DUMMY.*UNITS* STRATUM ***

PF1 EFFECTS: REP 12 ESE 0.000

PF1	1	2	3	4	5
	0.00	0.00	0.00	0.00	0.00

***** TABLES OF MEANS *****

VARIATE: Y

GRAND MEAN 0.00

TREAT	1	2	3	4	5	6	7	8	9	10
PF1	2	2	3	3	3	3	4	4	4	5
	0.00	0.00	2.00	-2.00	-0.00	-2.00	2.00	-0.00	-0.00	-0.00

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	TREAT
REP	6
SED	0.000

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
BLOCK	0	*	*
BLOCK.DUMMY	15	0.000	*
BLOCK.DUMMY.*UNITS*	26	0.000	*

'CLOSE'

APPENDIX 3

```
'REFERENCE/NID=100,NUNN=100'        TRIPLE_RL
'CAPTION'               ''
This program uses an example of a triple rectangular lattice taken from
 'The Design and Analysis of Experiments' by Kempthorne (page 522).
''
'LINES'                 10
'UNITS'                 $ 36
'FACTOR'                R $ 3 = 12(1...3)
    :                   T4 $ 3
    :                   B,T1,T2,T3 $ 4
    :                   T $ 12
'READ/PRIN=DE,FORM=P'   Y,T,T1,T2,T3,B,T4
'RUN'
  8.9   2  1  3  2  1  2
 10.0   3  1  4  3  1  3
 11.6   1  1  2  4  1  1
  9.4   7  3  1  4  3  2
  9.3   9  3  4  2  3  1
 10.2   8  3  2  1  3  3
  9.6   4  2  1  3  2  1
 11.4   5  2  3  4  2  3
 10.0   6  2  4  1  2  2
 11.8  10  4  1  2  4  3
 11.7  12  4  3  1  4  1
 13.1  11  4  2  3  4  2
 11.6   2  1  3  2  3  2
 12.4  12  4  3  1  3  1
 10.0   5  2  3  4  3  3
  9.6   7  3  1  4  1  2
 10.0  10  4  1  2  1  3
  8.4   4  2  1  3  1  1
 10.5   1  1  2  4  2  1
 11.0   8  3  2  1  2  3
 10.0  11  4  2  3  2  2
 11.5   3  1  4  3  4  3
 12.6   9  3  4  2  4  1
 11.8   6  2  4  1  4  2
 11.2   2  1  3  2  2  2
 12.1   9  3  4  2  2  1
  9.7  10  4  1  2  2  3
  7.8   3  1  4  3  3  3
  9.6  11  4  2  3  3  2
 10.6   4  2  1  3  3  1
  8.7  12  4  3  1  1  1
  9.1   8  3  2  1  1  3
  8.0   6  2  4  1  1  2
  8.7   1  1  2  4  4  1
  7.5   7  3  1  4  4  2
  8.3   5  2  3  4  4  3
'EOD'
'PRINT/P'               Y,R,B,T,T1,T2,T3,T4 $ 10.2,7(10)
'LINES'                 10
'BLOCKS'                R/B
'TREATMENTS'            T//(T1+T2+T3+T4)
'CAPTION'               ''
This analysis uses the data and gives an approximate table of means ''
'ANOVA'                 Y
'RUN'
```

Y	R	B	T	T1	T2	T3	T4
8.90	1	1	2	1	3	2	2
10.00	1	1	3	1	4	3	3
11.60	1	1	1	1	2	4	1
9.40	1	3	7	3	1	4	2
9.30	1	3	9	3	4	2	1
10.20	1	3	8	3	2	1	3
9.60	1	2	4	2	1	3	1
11.40	1	2	5	2	3	4	3
10.00	1	2	6	2	4	1	2
11.80	1	4	10	4	1	2	3
11.70	1	4	12	4	3	1	1
13.10	1	4	11	4	2	3	2
11.60	2	3	2	1	3	2	2
12.40	2	3	12	4	3	1	1
10.00	2	3	5	2	3	4	3
9.60	2	1	7	3	1	4	2
10.00	2	1	10	4	1	2	3
8.40	2	1	4	2	1	3	1
10.50	2	2	1	1	2	4	1
11.00	2	2	8	3	2	1	3
10.00	2	2	11	4	2	3	2
11.50	2	4	3	1	4	3	3
12.60	2	4	9	3	4	2	1
11.80	2	4	6	2	4	1	2
11.20	3	2	2	1	3	2	2
12.10	3	2	9	3	4	2	1
9.70	3	2	10	4	1	2	3
7.80	3	3	3	1	4	3	3
9.60	3	3	11	4	2	3	2
10.60	3	3	4	2	1	3	1
8.70	3	1	12	4	3	1	1
9.10	3	1	8	3	2	1	3
8.00	3	1	6	2	4	1	2
8.70	3	4	1	1	2	4	1
7.50	3	4	7	3	1	4	2
8.30	3	4	5	2	3	4	3

'his analysis uses the data and gives an approximate table of means

**** ANALYSIS OF VARIANCE *****

'ARIATE: Y

OURCE OF VARIATION	DF	SS	SS%	MS	VR
STRATUM	2	16.1072	21.75	8.0536	8.329
.B STRATUM					
T	9	36.9025	49.84	4.1003	
OTAL	9	36.9025	49.84	4.1003	4.240
.B.*UNITS* STRATUM					
T	11	8.4630	11.43	0.7694	0.796
RESIDUAL	13	12.5703	16.98	0.9669	
OTAL	24	21.0333	28.41	0.8764	
RAND TOTAL	35	74.0430	100.00		

RAND MEAN 10.21

OTAL NUMBER OF OBSERVATIONS 36

**** INFORMATION SUMMARY *****

ODEL TERM	EF	NON-ORTHOGONAL TERMS
.B STRATUM		
T1	0.407	
T2	0.323	T1
T3	0.099	T1 T2

```
R.B.*UNITS* STRATUM
  T1                                0.593  R.B
  T2                                0.556  R.B  T1
  T3                                0.494  R.B  T1  T2

ALIASED MODEL TERMS
T


***** TABLES OF MEANS *****

VARIATE: Y


    GRAND MEAN     10.21

*** FOLLOWING TABLE OF MEANS IS ONLY APPROXIMATE ***
```

T	1	2	3	4	5	6	7	8	9	10	11
T1	1	1	1	2	2	2	3	3	3	4	4
T2	2	3	4	1	3	4	1	2	4	1	2
T3	4	2	3	3	4	1	4	1	2	2	3
T4	1	2	3	1	3	2	2	3	1	3	2
	11.24	10.03	9.25	9.47	9.98	9.42	10.18	11.29	10.69	9.75	10.60

T	12
T1	4
T2	3
T3	1
T4	1
	10.66

```
***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE                      T
---------------------------
REP                        3
SED                    1.160
EXCEPT WHEN COMPARING MEANS WITH SAME LEVEL(S) OF:
  T1                   0.991
  T2                   0.979
  T3                   0.954
  T4                   1.088


***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM                    DF          SE         CV%

R                           2       0.819         8.0
R.B                         0           *           *
R.B.*UNITS*                13       0.983         9.6

'UNITS'            UNIT $ 108 = 1...108
'VARIATE'          NY = (Y)3
'FACTOR'           NTP $ 4 = T1,T2,T3
    :              COPY  $ 3 = 36(1...3)
    :              NT4 $ 3 = (T4)3
    :              DUMMY $ 36 = (1...36)3
    :              NT $ 12 = (T)3
    :              NR $ 3 = (R)3
    :              NB $ 4 = (B)3
'DEVALUE'          Y,T1,T2,T3,T,R,B
'DESCRIBE'         NY $ 3
'LINES'            10
'TREATMENT'        NT//(NTP*COPY+NT4)
'BLOCKS'           NR/NB/DUMMY
'CAPTION'          ''
This analysis uses copies of the data and in the analysis of variance table
gives three times the numbers in the above analysis ''
'ANOVA/PR=03013'  NY
'RUN'
```

This analysis uses copies of the data and in the analysis of variance table gives three times the numbers in the above analysis
1

***** ANALYSIS OF VARIANCE *****

VARIATE: NY

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
NR STRATUM	2	4.832E 1	21.75	2.416E 1	
NR.NB STRATUM					
NT	9	1.107E 2	49.84	1.230E 1	
TOTAL	9	1.107E 2	49.84	1.230E 1	
NR.NB.DUMMY STRATUM					
NT	11	2.539E 1	11.43	2.308E 0	0.796
RESIDUAL	13	3.771E 1	16.98	2.901E 0	
TOTAL	24	6.310E 1	28.41	2.629E 0	
NR.NB.DUMMY.*UNITS* STRATUM					
NT	11	0.000E 0	0.00	0.000E 0	
RESIDUAL	61	0.000E 0	0.00	0.000E 0	
TOTAL	72	0.000E 0	0.00	0.000E 0	
GRAND TOTAL	107	2.221E 2	100.00		

GRAND MEAN 10.214
TOTAL NUMBER OF OBSERVATIONS 108

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS	
NR.NB STRATUM			
NTP	0.012		
NTP.COPY	0.198		
NR.NB.DUMMY STRATUM			
NTP	0.099	NR.NB	
NTP.COPY	0.247	NR.NB	
NR.NB.DUMMY.*UNITS* STRATUM			
NTP	0.889	NR.NB	NR.NB.DUMMY
NTP.COPY	0.556	NR.NB	NR.NB.DUMMY

ALIASED MODEL TERMS
NT

***** TABLES OF EFFECTS *****

VARIATE: NY

*** NR.NB STRATUM ***

NTP EFFECTS: REP 27 ESE

NTP	1	2	3	4
	-7.625	3.575	-1.025	5.075

NTP.COPY EFFECTS: REP 9 ESE

COPY	1	2	3
NTP			
1	0.969	-1.356	0.388
2	-1.456	-1.531	2.988
3	-1.881	1.494	0.388
4	2.369	1.394	-3.762

** NR.NB.DUMMY STRATUM ***

NTP EFFECTS: REP 27 ESE 1.0430

NTP	1	2	3	4
	-0.725	0.800	0.062	-0.137

NTP.COPY EFFECTS: REP 9 ESE 1.1425

COPY	1	2	3
NTP			
1	-0.160	-0.640	0.800
2	-1.055	1.570	-0.515
3	1.025	-0.145	-0.880
4	0.190	-0.785	0.595

* NR.NB.DUMMY.*UNITS* STRATUM ***

NTP EFFECTS: REP 27 ESE 0.0000

NTP	1	2	3	4
	0.000	0.000	0.000	0.000

:OPY EFFECTS: REP 36 ESE 0.0000

COPY	1	2	3
	0.000	0.000	0.000

TP.COPY EFFECTS: REP 9 ESE 0.0000

COPY	1	2	3
NTP			
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000

***** TABLES OF MEANS *****

VARIATE: NY

GRAND MEAN 10.214

NT	1	2	3	4	5	6	7	8	9	10	11
NTP	2	2	3	2	3	2	3	2	3	2	3
COPY	2	2	2	2	2	2	2	2	2	2	2
NT4	1	2	3	1	3	2	2	3	1	3	2
	10.517	10.058	10.067	10.517	10.067	10.058	10.058	10.067	10.517	10.067	10.058

NT	12
NTP	3
COPY	2
NT4	1
	10.517

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	NT
REP	9
SED	0.4014

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
NR	2	0.8192	8.0
NR.NB	0	*	*
NR.NB.DUMMY	13	0.9833	9.6
NR.NB.DUMMY.*UNITS*	61	0.0000	0.0

'CLOSE'

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A REGRESSION MODEL FOR GENOTYPICAL STABILITY

INTRODUCTION

Yates and Cochran (1938) have described a model for relating the performance of a set of genotypes across a set of environments. The model has been used in studies of crop variety performance (Finlay and Wilkinson, 1963, Eberhart and Russell, 1966) and also in the evaluation of variety-isolate interactions in studies of disease resistance and pathogen virulence (Leonard and Moll, 1979, Jenns and Leonard, 1981).

The model takes the form

$$Y_{ij} = g_i + b_i I_j + d_{ij}$$

where Y_{ij} is response of the ith genotype grown in the jth environment,
g_i is the mean of the ith genotype,
b_i is the coefficient of regression for the response of the ith genotype on I_j, an environmental index, and
d_{ij} is deviation from regression.

The environmental index is variously taken as the mean response of all genotypes within an environment or as the mean response of a specific genotype within an environment. Generally, the coefficients, b_i, are used to characterise stability, or general adaptation, of the set of genotypes over the series of environments that are covered by the test. For further details on interpretation of the model, the reader is referred to the literature.

MACROS

The model is readily fitted by Genstat. Three Macros are used.

ERINDEX computes the environmental indices. There are four input parameters. *Y* is the response variate, *GEN* and *ENV* are factors for genotype and environment respectively. *INDEX* is a scalar taking a value of zero if environmental means are to be used for indexing. If a specific genotype is to be used as the index, then *INDEX* must be set to the formal level of that genotype. *ERINDEX* must be used before either of the following macros.

ERFIT partitions variation into genotypical effects, a general linear environmental effect, specific linear effects due to the interaction of individual genotypes with the linear effect of environments and deviations from regression.

ERPLOT may be used to produce graphical displays and will also perform a test for linearity on each genotype.

EXAMPLE

The following example was taken from Leonard and Moll (1979) who used the data of Clifford and Clothier (1974). Four varieties of barley were inoculated with each of eighteen cultures of leaf rust. The rust cultures were treated as separate environments. Output comprises a table of the environmental indices, a regression analysis for the entire set of data and graphs of response versus index for each genotype. Note that the residual sum of squares for the maximal model was zero for this particular analysis as a consequence of the analysis being conducted on the published two-way table of means rather than on replicated data.

THE MACROS

```
'MACRO' ERINDEX $
''ARGUMENTS  IN: GEN,ENV,Y,INDEX  OUT: EINDEX,IMEANS''
'LOCA' TINDEX,L1
'SCAL' L1
'JUMP' L1*(INDEX.EQ.0)
'REST' Y $ GEN=INDEX
'LABE' L1 'TABL' TINDEX $ ENV 'TABU' VARIATE=Y ; MEANS=TINDEX
'PRIN' TINDEX
'REST' Y
'VARI' IMEANS $ ENV 'EQUATE' IMEANS=TINDEX
'CALC' EINDEX=ELEM(IMEANS;FLOAT(ENV))
'DEVA' TINDEX
'ENDMACRO'

'MACRO' ERFIT $
''ARGUMENTS  IN: GEN,ENV,Y,EINDEX''
'CAPT' ''*** STABILITY ANALYSIS ***''
'TERM/DVSET=F' Y+GEN*EINDEX+GEN/ENV  'Y' Y
'FIT/Z,ANDEV=I' GEN
'ADD/Z' GEN.ENV
'DROP/Z' GEN.ENV
'ADD/Z' EINDEX*GEN
'ADD/Z,ANDEV=T' GEN.ENV
'DROP/C,INT=N,' EINDEX+GEN.ENV
'ENDMACRO'
```

```
'MACRO' ERPLOT $
''ARGUMENTS  IN: Y,EINDEX,IMEANS,GEN,GLEV,ENV''
'LOCA' HEAD1,HEAD2,HEAD3,HEAD4,T1,YMEANS,VR,WDF,WSQ,DDF,DSQ
'SCAL' VR 'TABLE' T1 $ ENV 'VARI' YMEANS $ ENV
'HEAD' HEAD1=''GENOTYPE ''
: HEAD2=''F-STATISTIC FOR NON-LINEARITY=''
: HEAD3=''  DF='' : HEAD4=''MEAN=''
'FOR' I=1...GLEV
  'REST' Y $ GEN=I
  'TABU' VARIATE=Y ; MEANS=T1 'EQUATE' YMEANS=T1
  'GRAPH/NCF=80,NRF=30' YMEANS ; IMEANS
  'TERM' Y+EINDEX+ENV  'Y' Y
  'FIT/Z' ENV ; DF=WDF ; DEV=WSQ : EINDEX ; DF=DDF ; DEV=DSQ
  'CALC' DDF=DDF-WDF : VR=((DSQ-WSQ)/DDF)*(WDF/WSQ)
  'PRIN/C,LABR=1' HEAD1,I $ 9,3,/
  : HEAD2,VR,HEAD3,DDF,WDF $ 30,7.2,5,5,5,/
  'CALC' VR=MEAN(Y) 'PRIN/C,LABR=1' HEAD4,VR $ 5,8.3
'REPEAT'
'ENDMACRO'
```

EXAMPLE RUN

```
'UNIT' $ 72
'VARI' Y=36.0,30.0,29.4,32.5,33.6,43.8,39.1,41.2,41.4,32.4,47.7,45.3,
        57.8,51.0,65.3,63.9,37.0,46.5,54.0,55.8,29.0,25.0,44.1,27.9,
        42.2,46.1,28.1,23.7,19.2,20.9,21.2,23.6,59.4,41.4,49.9,40.7,
        66.1,47.5,67.3,42.6,47.6,44.1,53.9,45.9,50.8,50.7,51.9,41.7,
        35.8,29.6,41.4,13.5,38.2,44.7,48.4,25.2,36.3,46.5,46.7,28.2,
        19.6,19.9,21.3,15.2,60.1,40.6,64.2,42.9,54.7,44.7,68.9,32.2
'SCAL' GLEV=4 : ELEV=18 : INDEX=0
'FACT' GEN $ GLEV : ENV $ ELEV
'GENE' ENV,GEN
'USE/R' ERINDEX $
'USE/R' ERFIT $
'USE/R' ERPLOT $
'RUN'
```

```
             TINDEX
     ENV            1            2            3            4            5
         3.1975E  1  3.9425E  1  4.1700E  1  5.9500E  1  4.8325E  1

     ENV            6            7            8            9           10
         3.1500E  1  3.5025E  1  2.1225E  1  4.7850E  1  5.5875E  1

     ENV           11           12           13           14           15
         4.7875E  1  4.8775E  1  3.0075E  1  3.9125E  1  3.9425E  1

     ENV           16           17           18
         1.9000E  1  5.1950E  1  5.0125E  1
```

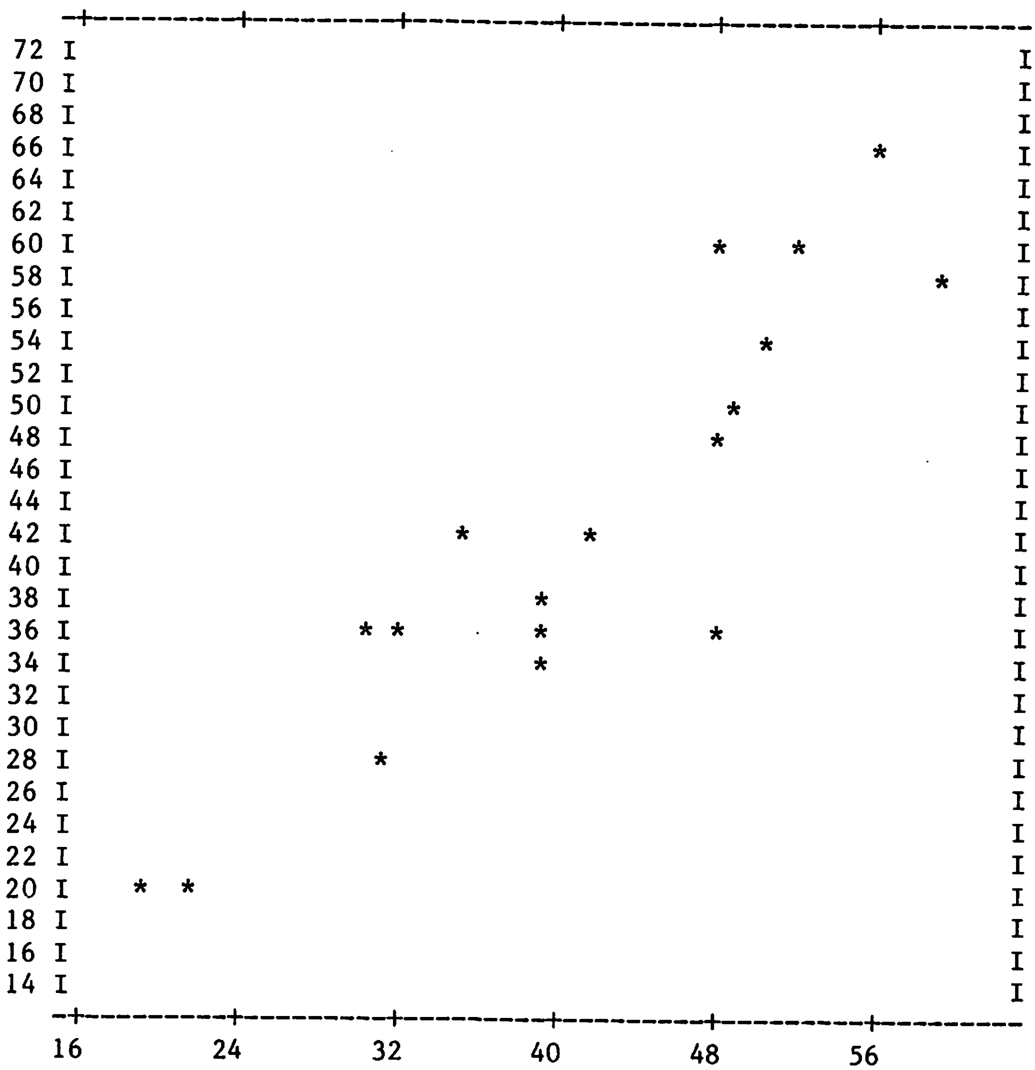
```
*** STABILITY ANALYSIS ***

*** SUMMARY ANALYSIS OF VARIANCE ***

Y-VARIATE: Y

                                 RESIDUAL       CHANGE              MEAN  VARIANCE
                                 DF      SS     DF      SS         CHANGE    RATIO
INITIAL MODEL
 CONSTANT                        71  12882.79    *           *

MODIFICATIONS TO MODEL
+GEN                             68  11661.80    3    1220.99      407.00     9.76
+GEN.ENV                          0     -0.00   68   11661.80      171.50     4.11
-GEN.ENV                         68  11661.80  -68  -11661.80      171.50     4.11
+EINDEX                          67   2918.92    1    8742.88     8742.88   209.61
+EINDEX.GEN                      64   2669.44    3     249.48       83.16     1.99
**DENOMINATOR OF RATIO IS RES. SS /RES.DF FROM LINE ABOVE,=        41.71
+GEN.ENV                          0      0.00   64    2669.44       41.71     1.00


*** WHILE DROPPING TERM EINDEX
    REFITTED  1 PARAMETER(S) OF TERM EINDEX.GEN
*** WHILE DROPPING TERM CONSTANT
    REFITTED  1 PARAMETER(S) OF TERM GEN
```

***** REGRESSION ANALYSIS *****

*** REGRESSION COEFFICIENTS ***

Y-VARIATE: Y

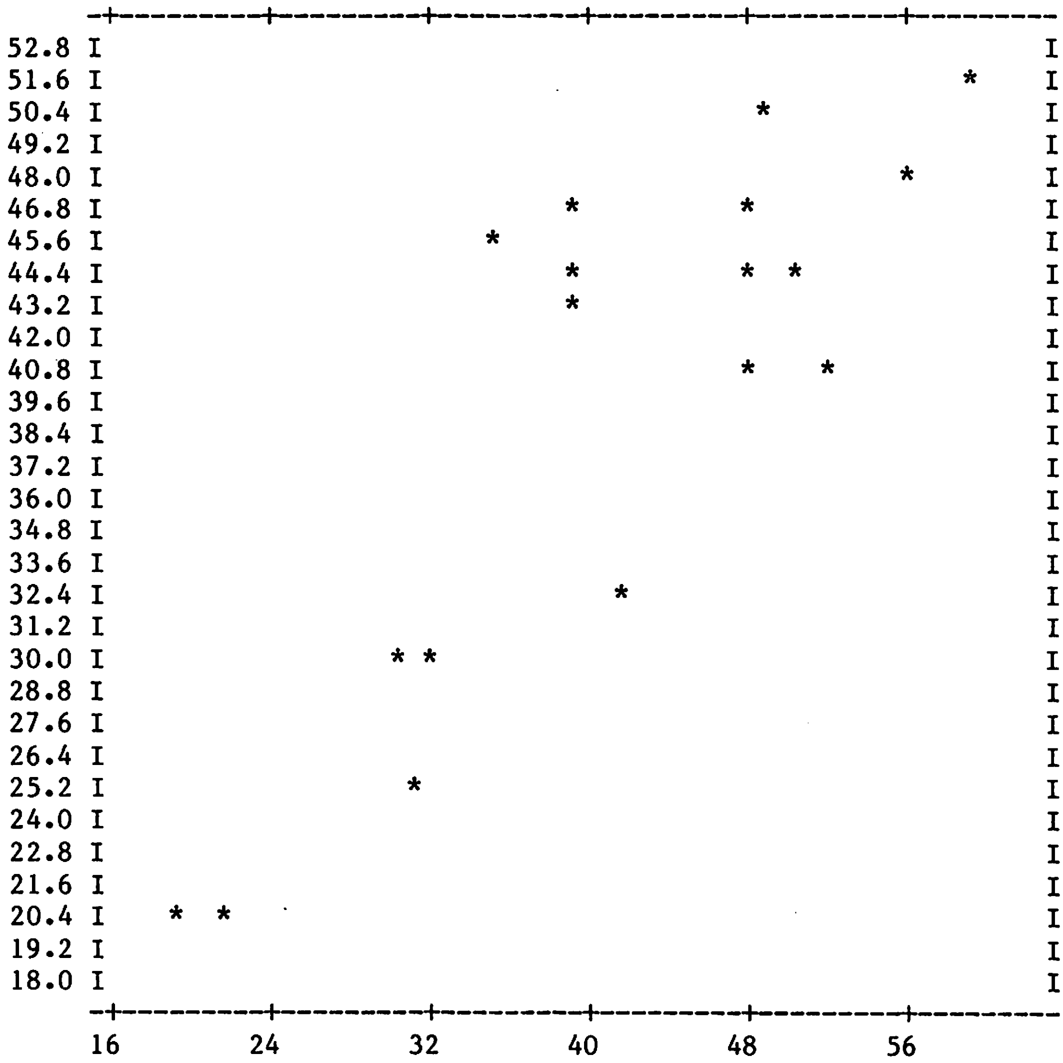
	ESTIMATE	S.E.	T
GEN 1	-2.02730	5.87034	-0.35
GEN 2	8.52237	5.87034	1.45
GEN 3	-2.60626	5.87034	-0.44
GEN 4	-3.88881	5.87034	-0.66
EINDEX.GEN 1	1.08466	0.13814	7.85
EINDEX.GEN 2	0.74720	0.13814	5.41
EINDEX.GEN 3	1.20435	0.13814	8.72
EINDEX.GEN 4	0.96379	0.13814	6.98



GENOTYPE 1

F-STATISTIC FOR NON-LINEARITY= * DF= 16 0

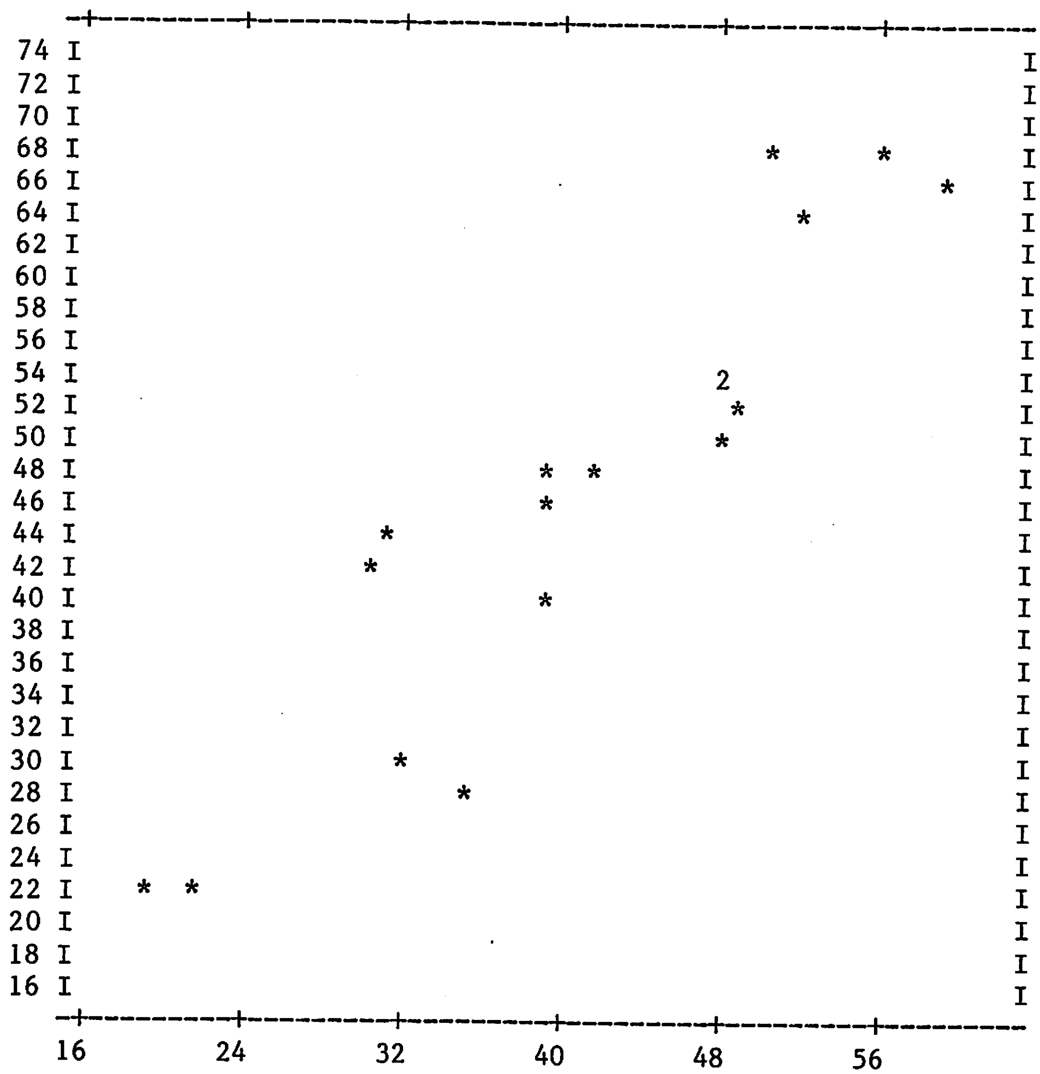
MEAN= 42.489



GENOTYPE 2

F-STATISTIC FOR NON-LINEARITY= * DF= 16 0

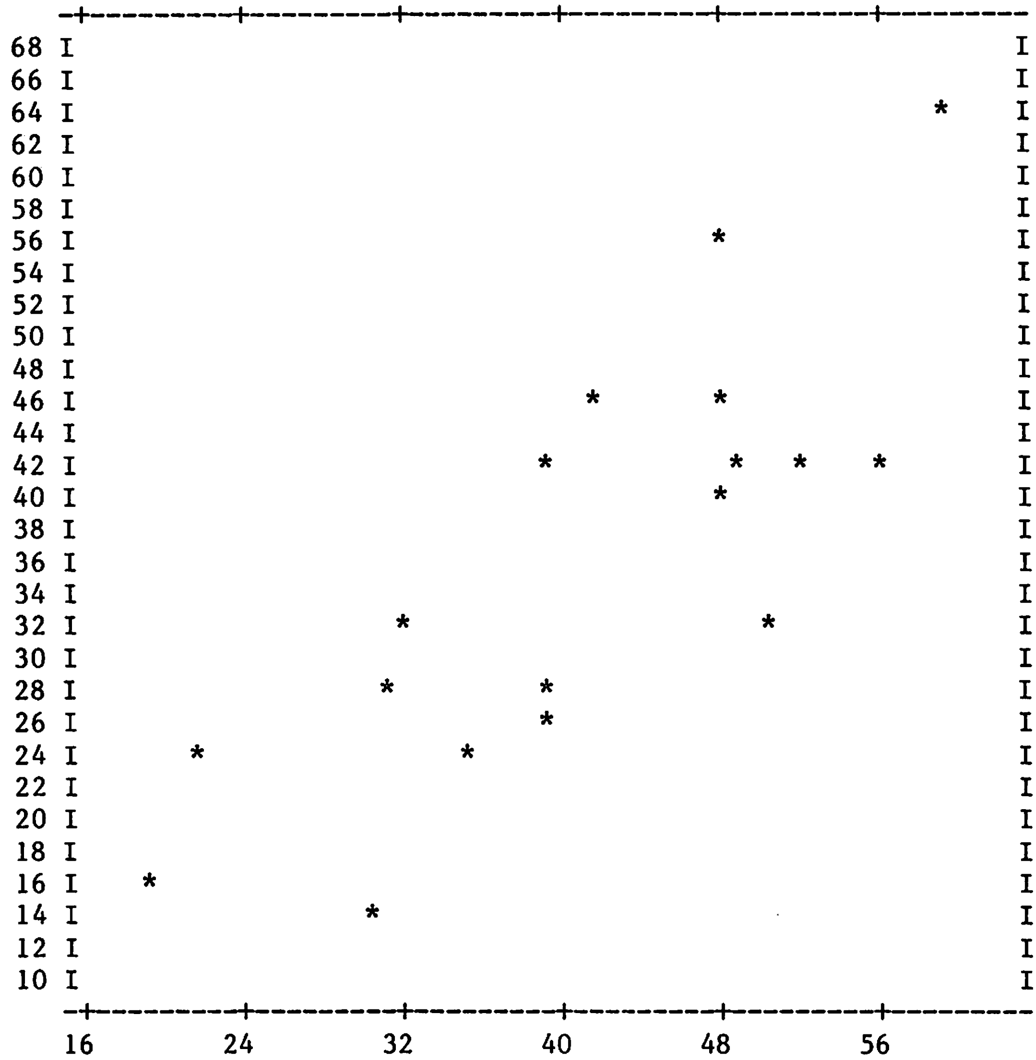
MEAN= 39.189



GENOTYPE 3

F-STATISTIC FOR NON-LINEARITY= * DF= 16 0

MEAN= 46.822



GENOTYPE 4

F-STATISTIC FOR NON-LINEARITY= * DF= 16 0

MEAN= 35.667

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Clifford, B.C. and Clothier, R.B. (1974) Physiologic specialisation of Puccinia hordei in barley hosts with non-hypersensitive resistance. Trans. Britt. Mycol. Soc., 63, 421-430.

Eberhart, S.A. and Russell, W.A. (1966) Stability parameters for comparing varieties. Crop Sci., 6, 36-40.

Finlay, K.W. and Wilkinson, G.N. (1963) Analysis of adaptation in a breeding programme. Aust. J. Agr. Res., 14, 742-754.

Jenns, A.E. and Leonard, K.J. (1981) Estimation of specific resistance by regression analysis of disease in host lines inoculated with several pathogen isolates. (Abs.) Phytopathology, 71, 883.

Leonard, K.J. and Moll, R.H. (1979) Durability of general resistance: Evaluation of cultivar x isolate interactions. Proc. 9th Int. Cong. Plant Protect., 1, 190-193.

Yates, F. and Cochran, W.G. (1938) The analysis of groups of experiments. J. Agric. Sci., 28, 556-580.

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NON-HIERARCHICAL CLASSIFICATION - CLASSIFY (AND CLASSF)

'CLASSIFY' has a number of pitfalls for the unwary; those which I know about I describe below, if users find any others they might care to write to this Newsletter or inform me.

1. NUMERICAL ACCURACY

The various criteria available in 'CLASSIFY' are not calculated afresh after each step in the transfer and swapping process, instead their values are updated. At any stage it might be the case that a particular transfer or swap (move) improves the criterion by a fairly accurately known small amount; however, if the criterion value is relatively large some of the accuracy of the improvement is lost. Over many moves this loss of accuracy can become quite large and, as with all problems involving numerical accuracy, can vary markedly across different types of computer. If an accurate determination of the criterion value is important, it would be safest to save the resulting classification (in a FACTOR called FINAL, say) and use the extra statement

'CLASSIFY/PRINT = CI, ITERATE = N' VSET; START = FINAL

which will print the Criterion value for the Initial classification and will Not iterate from the classification given in FINAL.

2. LOCAL OPTIMA

There is absolutely no guarantee that the global, rather than a local, optimum will be found. Like being burgled - it always happens to someone else. Beware: it can, and will, happen to you, especially if you do not guard against non-global optima and if your data set is large (what constitutes large depends on the problem - as few as two dozen units might cause problems). The classical approach is to run the classification a few times from randomly chosen starting points and compare the results (NB (1) above). Alternatively, you might choose a 'good' starting classification and hope for success, or even use various 'good' starting points and compare results. These two approaches, 'random' and 'good' starting points, are well known; what I was not aware of until recently was that there also exist 'bad' starting points that must be avoided (see below). Since 'random' can be 'good', 'bad' or 'indifferent', I suggest that a variety of 'good' starting points be used and results compared. I stress 'variety'; do not use a few minor variations of one 'good' starting point ('CLASSIFY' could most probably find these anyway, given the 'good' one).

3. BAD STARTING CLASSIFICATIONS

These comments stem from one example I have seen recently. A set of binary variates for over 100 units was used and no starting classification was provided. About a third of the units were identical and, unfortunately, were allocated amongst several groups in the pseudo-random starting classification used by 'CLASSIFY'. Of course, the identical units should all be in the same group; however, a local optimum was found for which the identical units were still spread around several groups. Clearly, any pair of these units in different groups could be swapped without altering the criterion value, generating many classifications with equal criterion values and thus a mass of output (which was why I became aware of this problem). The moral of this story is to make sure that identical units start in the same groups. More practically, very similar units ought to start in the same group. (I know that that is precisely why you use 'CLASSIFY', but it is worth a little trouble to weed out the 'bad' starting points.)

4. GOOD STARTING CLASSIFICATIONS

There are a number of ways of getting a reasonable starting point. The macro CLASSF chooses a set of mutually distant points as nuclei and assigns units to their nearest nucleus to form a set of groups. This ought to be quite a good starting point under normal conditions but it does take a while to run and can fail (see below). Doing a preliminary hierarchical classification, using 'HIERARCHY', and assigning units according to the resulting clusters is another method that could be used. This requires two separate runs: the first determines the grouping, or equivalently the clustering threshold level at which the grouping is to be taken; the second does the non-hierarchical classification with the starting classification either fed in 'by hand' or obtained by rerunning the hierarchical classification with the GL option set to the required threshold level. A different scheme, which has the advantage of simplicity, is to take the mean over all the variates for each unit and use this to determine a grouping; eg for variates with values in the range zero to ten

```
'VARIATE  LIMS = 1...9

'CALC'    ROWMEAN = VMEAN(VSET)

'GROUP'   MYSTART = LIMITS(ROWMEAN;LIMS)
```

will give a classification into (up to) ten groups. A less crude method, based on the same idea, would be to produce a graph of the first two principal component scores and group the units according to that. Finally, what might be the best method: use your own preconceived ideas. If you set the PRINT letter *I*, you can see how far wrong you were!

5. MACRO CLASSF

This operates as follows. For n units and p variables the units are considered as n points in a p-dimensional space. The first two nuclei are the two most distant points; the third nucleus is the point most distant from the line joining the first pair of nuclei; the fourth nucleus is the point most distant from the plane defined by the first three nuclei and so on. When the required number of nuclei have been found, the units are assigned to their nearest nucleus. This works well, but there is a restriction that no more than $p+1$ groups can be formed, eg when $p=2$ all the points lie on a plane which is precisely the plane defined by the first three nuclei, so a fourth nucleus cannot be found. As a consequence, when all the points lie in a k-dimensional subspace, no more than $k+1$ groups will be formed, even if more were asked for by the user. In the current version of the macro, no comment is made when this occurs; however, future versions (ie with Genstat 4.04 and later) produce a warning and print out the classification (into $k+1$ groups) when this occurs.

I hope that these remarks are useful to future classifiers; I am sure that the editors would welcome letters from users with other comments.

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GENSTAT AND PRIME CPL

The New Zealand Ministry of Agriculture and Fisheries has a PRIME computer network on which Genstat can be used in either batch or interactive mode.

For applications in which a general Genstat program can be used with certain parameters, options, calculations or printing specified by the user, we have found it useful to combine Genstat with PRIME CPL (Prime's Command Procedure Language).

Using CPL data allows people, who are not familiar with Genstat programming, to use Genstat even for quite complex applications.

One application where we have used Genstat and CPL together was in a program to investigate properties of three class attribute sampling plans.

The program calculates the operating characteristic for the scheme specified, assuming that samples are normally distributed. It then graphs the O.C. curve and prints the probabilities if this option has been set.

The following listings show the program, a sample run and the output from the run.

We have written a more general version of this program in which there is a choice between several different sampling distributions, and also an option to compare more than one scheme at a time.

Many of the CPL commands are self-explanatory. They can occur outside the Genstat program or even amongst the Genstat commands: in either case CPL evaluates them before running the Genstat program.

Some of the CPL commands used in the example are:-

R filename	Used to run the CPL program.
&	Most CPL directives begin with an ampersand.
&S	Used to set a value to a CPL variable.
%x%	References to variables are enclosed in % signs.
[ ]	Function calls are enclosed in brackets.
QUERY	Asks a question with supplied prompt.

RESPONSE Inputs data in response to prompt.

TYPE Prints a line of text on the screen.

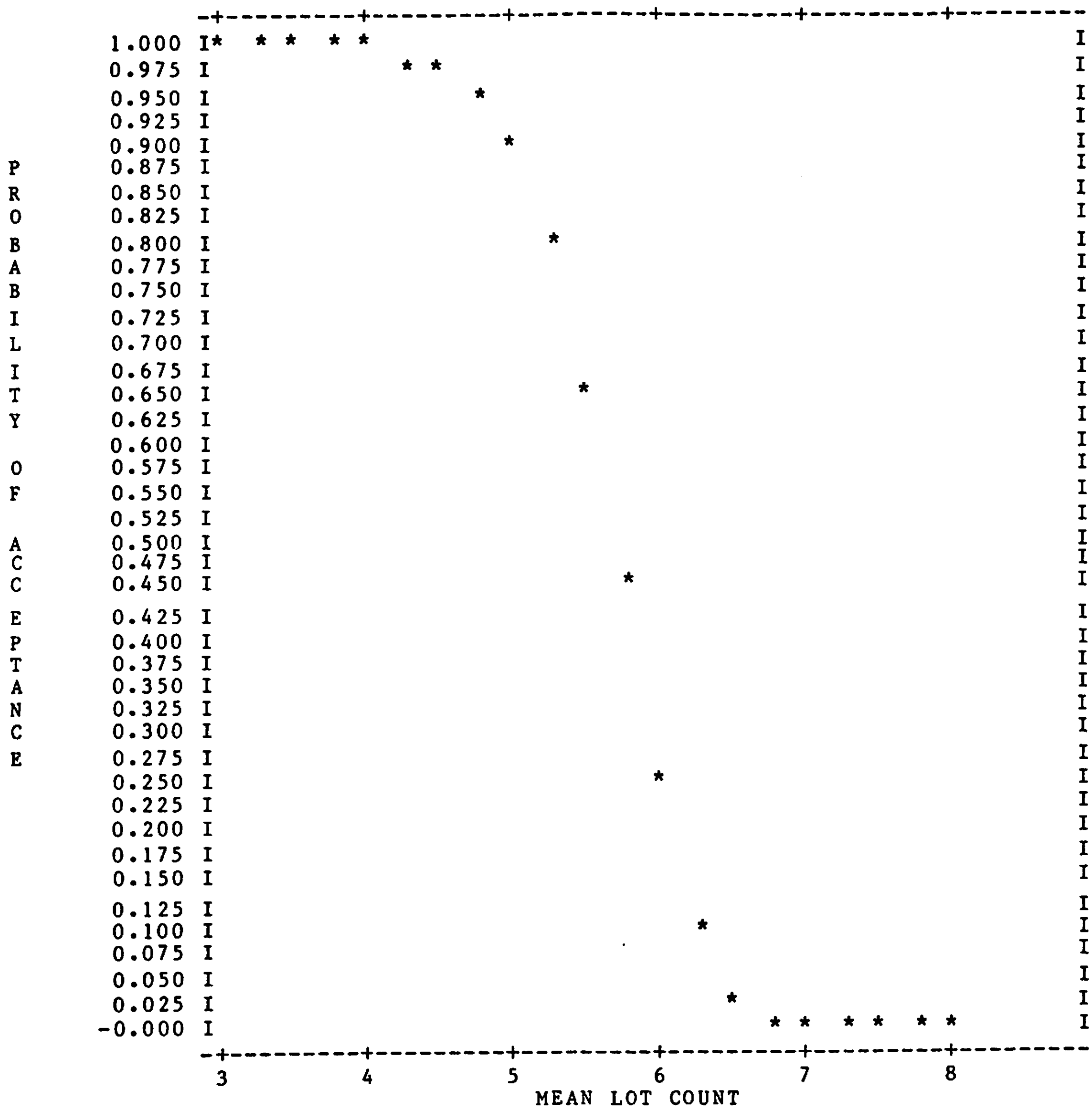
PROGRAM LISTING

```
TYPE                         /*  3 CLASS SAMPLING PLANS
TYPE CHARACTERISTICS OF SAMPLING SCHEMES
&S N := [RESPONSE 'Number of samples' ]
&S C := [RESPONSE 'Acceptance number' ]
TYPE
TYPE LIMITS OF ALLOWABLE QUALITY
&S M1 := [RESPONSE 'Best quality defined as marginal' ]
&S M2 := [RESPONSE 'Best quality defined as bad' ]
TYPE
TYPE RANGE OF QUALITY OF INTEREST
&S X0 := [RESPONSE 'Lower limit for mean lot values' ]
&S X1 := [RESPONSE 'Upper limit for mean lot values' ]
&S S := [RESPONSE 'Standard deviation' ]
TYPE
&S NN := [RESPONSE 'Number of values calculated (Default=21, Max=99)' 21]
&IF %NN% > 99 &THEN %NN% := 99
&DATA GENSTAT -L2 CLASS3.OUT
'REFE/PR=N' CLASS3_SCHEMES
'SCAL' NN = %NN% : N = %N% : C = %C% : M1 = %M1% : M2 = %M2%
  :    X0 = %X0% : X1 = %X1% : S = %S% : STEP,J(1...C)
'VARI' MN_VALUE,P_ACCEPT,P_GOOD,P_MARG,P_G_OR_M,PQ,TT $NN
'VARI' Y=1...NN        'VARI' BVAL=0,1,*,*
'HEAD' H1=''OPERATING CHARACTERISTIC CURVE FOR 3-CLASS SAMPLING PLAN''
'HEAD' H2=''PROBABILITIES OF ACCEPTANCE FOR THIS 3-CLASS PLAN''
'HEAD' H3='' (INFINITE LOT SIZES)''
'HEAD' HY=''PROBABILITY OF ACCEPTANCE''     'HEAD' HX=''MEAN LOT COUNT''
'HEAD' HEADY = ''
NUMBER OF SAMPLES                   %N%
ACCEPTANCE NUMBER                   %C%
LIMIT FOR MARGINALS                 %M1%
LIMIT FOR BADS                      %M2%
LOWER LIMIT FOR MEAN LOT VALUES     %X0%
UPPER LIMIT FOR MEAN LOT VALUES     %X1%

NORMAL DISTRIBUTION

STANDARD DEVIATION   %S%       STEP SIZE VALUE ''
'CALC' J(1...C)=1...C
'CALC' STEP=(X1-X0)/(NN-1)
'CALC' MN_VALUE=X0+(Y-1)*STEP
'CALC' P_GOOD,P_G_OR_M=NPI((M1,M2-MN_VALUE)/S)
'CALC' P_MARG=P_G_OR_M - P_GOOD
'CALC' PQ=P_MARG/P_GOOD
'CALC' TT,P_ACCEPT=P_GOOD**N
'FOR' J=J(1...C)
'CALC' TT=TT*(N-J+1)*PQ/J
'CALC' P_ACCEPT=P_ACCEPT+TT
'REPE'
'OUTPUT' 2 $80
'GRAPH/BV=BVAL,ATY=HY,ATX=HX' P_ACCEPT;MN_VALUE
'PRINT/C,LABR=1' H1,H3,HEADY,STEP  $/,2(0),/,0,8.3
&IF [QUERY 'Do you want probabilities printed. (Default=Yes)' TRUE] &THEN &DO
   'PAGE'
   'PRINT/C,LABR=1' H1,H3,HEADY,STEP,H2,H3  $/,2(0),/,0,8.3,4/,2(0)
   'PRINT/P' MN_VALUE,P_ACCEPT
   &IF [QUERY 'Do you want extra probabilities printed' ] &THEN ~
       [UNQUOTE ',P_GOOD,P_MARG,P_G_OR_M']
   $15.2,(12.4)4
&END
'OUTPUT' 1
'RUN'
'CLOSE'
'STOP'
&END
&RETURN
```

EXAMPLE RUN

```
OK, R CLASS3

CHARACTERISTICS OF SAMPLING SCHEMES
Number of samples: 25
Acceptance number: 5

LIMITS OF ALLOWABLE QUALITY
Best quality defined as marginal: 7
Best quality defined as bad: 9

RANGE OF QUALITY OF INTEREST
Lower limit for mean lot values: 3
Upper limit for mean lot values: 8
Standard deviation: 1.5

Number of values calculated (Default=21, Max=99):
Do you want probabilities printed. (Default=Yes)?
Do you want extra probabilities printed? Y
>'REFE/PR=N' CLASS3_SCHEMES
>'SCAL' NN = 21 : N = 25 : C = 5 : M1 = 7 : M2 = 9
>  :    X0 = 3 : X1 = 8 : S = 1.5 : STEP,J(1...C)
>'VARI' MN_VALUE,P_ACCEPT,P_GOOD,P_MARG,P_G_OR_M,PQ,TT $NN
>'VARI' Y=1...NN        'VARI' BVAL=0,1,*,*
>'HEAD' H1=''OPERATING CHARACTERISTIC CURVE FOR 3-CLASS SAMPLING PLAN''
>'HEAD' H2=''PROBABILITIES OF ACCEPTANCE FOR THIS 3-CLASS PLAN''
>'HEAD' H3='' (INFINITE LOT SIZES)''
>'HEAD' HY=''PROBABILITY OF ACCEPTANCE''    'HEAD' HX=''MEAN LOT COUNT''
>'HEAD' HEADY = ''
>NUMBER OF SAMPLES                   25
>ACCEPTANCE NUMBER                   5
>LIMIT FOR MARGINALS                 7
>LIMIT FOR BADS                      9
>LOWER LIMIT FOR MEAN LOT VALUES     3
>UPPER LIMIT FOR MEAN LOT VALUES     8
>
>NORMAL DISTRIBUTION
>
>STANDARD DEVIATION   1.5       STEP SIZE VALUE ''
>'CALC' J(1...C)=1...C
>'CALC' STEP=(X1-X0)/(NN-1)
>'CALC' MN_VALUE=X0+(Y-1)*STEP
>'CALC' P_GOOD,P_G_OR_M=NPI((M1,M2-MN_VALUE)/S)
>'CALC' P_MARG=P_G_OR_M - P_GOOD
>'CALC' PQ=P_MARG/P_GOOD
>'CALC' TT,P_ACCEPT=P_GOOD**N
>'FOR' J=J(1...C)
>'CALC' TT=TT*(N-J+1)*PQ/J
>'CALC' P_ACCEPT=P_ACCEPT+TT
>'REPE'
>'OUTPUT' 2 $80
>'GRAPH/BV=BVAL,ATY=HY,ATX=HX' P_ACCEPT;MN_VALUE
>'PRINT/C,LABR=1' H1,H3,HEADY,STEP  $/,2(0),/,0,8.3
>   'PAGE'
>   'PRINT/C,LABR=1' H1,H3,HEADY,STEP,H2,H3  $/,2(0),/,0,8.3,4/,2(0)
>   'PRINT/P' MN_VALUE,P_ACCEPT
>       ,P_GOOD,P_MARG,P_G_OR_M
>   $15.2,(12.4)4
>'OUTPUT' 1
>'RUN'
```

EXAMPLE OUTPUT



OPERATING CHARACTERISTIC CURVE FOR 3-CLASS SAMPLING PLAN (INFINITE LOT SIZES)

NUMBER OF SAMPLES	25
ACCEPTANCE NUMBER	5
LIMIT FOR MARGINALS	7
LIMIT FOR BADS	9
LOWER LIMIT FOR MEAN LOT VALUES	3
UPPER LIMIT FOR MEAN LOT VALUES	8

NORMAL DISTRIBUTION

STANDARD DEVIATION 1.5 STEP SIZE VALUE 0.250

OPERATING CHARACTERISTIC CURVE FOR 3-CLASS SAMPLING PLAN (INFINITE LOT SIZES)

NUMBER OF SAMPLES	25
ACCEPTANCE NUMBER	5
LIMIT FOR MARGINALS	7
LIMIT FOR BADS	9
LOWER LIMIT FOR MEAN LOT VALUES	3
UPPER LIMIT FOR MEAN LOT VALUES	8

NORMAL DISTRIBUTION

STANDARD DEVIATION 1.5 STEP SIZE VALUE 0.250

PROBABILITIES OF ACCEPTANCE FOR THIS 3-CLASS PLAN (INFINITE LOT SIZES)

MN_VALUE	P_ACCEPT	P_GOOD	P_MARG	P_G_OR_M
3.00	0.9992	0.9962	0.0038	1.0000
3.25	0.9984	0.9938	0.0061	0.9999
3.50	0.9969	0.9902	0.0097	0.9999
3.75	0.9942	0.9849	0.0149	0.9998
4.00	0.9893	0.9772	0.0223	0.9996
4.25	0.9808	0.9666	0.0326	0.9992
4.50	0.9660	0.9522	0.0464	0.9986
4.75	0.9398	0.9332	0.0645	0.9977
5.00	0.8915	0.9088	0.0874	0.9962
5.25	0.8025	0.8783	0.1155	0.9938
5.50	0.6543	0.8413	0.1488	0.9902
5.75	0.4542	0.7977	0.1872	0.9849
6.00	0.2509	0.7475	0.2297	0.9772
6.25	0.1037	0.6915	0.2752	0.9666
6.50	0.0304	0.6306	0.3217	0.9522
6.75	0.0061	0.5662	0.3670	0.9332
7.00	0.0008	0.5000	0.4088	0.9088
7.25	0.0001	0.4338	0.4445	0.8783
7.50	0.0000	0.3694	0.4719	0.8413
7.75	0.0000	0.3085	0.4891	0.7977
8.00	0.0000	0.2525	0.4950	0.7475

June Atkinson
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GENSTAT ERROR NOTICE S3010

For some inexplicable reason a line was lost from Error Notice S2010, published in Newsletter No. 9. On page 34, three lines in the section headed

```
***** 4 LINES ABOVE LABEL 88
```

should read

```
*     GO TO 61
*  88 CALL PBYT(IDATA(ISAD),K4,KCH(55))
      LFORM(I)=4
```

The blank line (line 14) on page 35, between

```
 1181 DIAG=181
        and
      GO TO 1000
```

should be ignored.

ADDITIONS TO THE NOTICE BOARD

```
          ***** WARNING *****                     26/03/82
'GRAPH'   THE MANUAL STATES THAT FACTORS CANNOT BE USED TO
          SPECIFY PLOTTING SYMBOLS FOR LINES. IF FACTORS ARE
          USED NO DIAGNOSTIC IS PRINTED BUT THE GRAPHS PRODUCED
          ARE INCORRECT OFTEN WITH MISALIGNMENT OF THE RIGHT
          HAND SIDE OF THE FRAME.

     (SEE ERROR DG12)


          ***** ERROR *****                       16/03/82
'GRAPH'   IN SOME CIRCUMSTANCES COINCIDENCES ARE INCORRECTLY
          INDICATED, PARTICULARLY WHEN : IS THE INDICATOR.
          ALSO, IF PLOTTING SYMBOLS 1...8 HAVE BEEN SPECIFIED
          USING A HEADING THEY WILL BE MISTAKEN FOR INDICATORS
          OF COINCIDENCES IN PLOTS USING THE DEFAULT SYMBOL
          AND INCREMENTED BY 1.

     (SEE ERROR DG13)


          ***** WARNING *****                     05/05/82
'CVA,LRV  THE LRV ALGORITHM MAY FAIL (OVERFLOW), PARTICULARLY
 PCO,PCP' ON COMPUTERS WITH LIMITED EXPONENT RANGE
          (E.G. DEC,HONEYWELL,HARRIS,UNIVAC,VAX).

     (SEE ERROR MV3)
```

```
          ***** WARNING *****                         05/05/82
'TABLE'   IF MORE THAN 12 TABLES ARE DECLARED IN A TABLE
          STATEMENT A FORTRAN ERROR MAY OCCUR ON COMPUTERS
          WHICH CHECK ARRAY BOUNDS (E.G. UNIVAC, ICL 2980).
          THIS CAN BE AVOIDED BY SPLITTING THE STATEMENT
          INTO SEVERAL STATEMENTS.

     (SEE ERROR EX3)


          ***** ERROR *****                           27/09/82
'ESTIMATE' A FAULT OCCURS, WHEN ESTIMATING PARAMETERS
          IN TRANSFER FUNCTION MODELS, IF ARIMA MODELS ARE
          SPECIFIED FOR SOME INPUT SERIES BUT NOT FOR ALL.

     (SEE ERROR TS2)


          ***** ERROR *****                           27/09/82
'EXPAND'  A FAULT OCCURS WHEN EXPANDING MODELS WHICH HAVE
          FEW PARAMETERS COMPARED TO THE NUMBER IN THE
          EXPANDED FORM.  AN EXAMPLE IS THE STANDARD
          AIRLINE - PASSENGER MODEL.

     (SEE ERROR TS3)


***** GENSTAT 4.03  ERROR NOTICE NO. 11  15.7.82
**
**
***** ERROR DG12
***** MODULE DGA SUBROUTINE GRAFF
**
***** DECLARE SYMNO AS INTEGER UNDER LOCALS
***** 2 LINES BELOW LABEL 21, OMIT 1 LINE:
**
   21 CONTINUE
      IF(NFM.NE.1)  GO TO 30
      DO 20  I=1,MVZ
      INTERP(I)=1
**
***** ON LINE LABELLED 34
**
C        HEADING
C
*  34 IF((KCNT.GT.1).OR.(IAC.GT.1))  GO TO 25
      IJK=VALOR(3)+1
      JB=IJK*NBV(4)
*     SYMNO=ISDATA(IJK)*NBV(4)+JB
      JA=JB
*  25 DO 35  J=1,NVZ
      NOLV(J)=1
   37 JA=JA+1
      CALL GBYT(IDATA,JA,KA)
*     IF(JA.GE.SYMNO)  JA=JB
      IF(KA.EQ.KCH(47))  GO TO 37
   38 JORIG(J)=ISAD
**
***** END OF ERROR DG12
**
**
```

```
***** ERROR DG13
***** MODULE DGB SUBROUTINE LPPLOT(F)
**
***** 5 LINES BELOW LABEL 90
**
      IF(ICPNT(1).NE.1)  GO TO 120
      IF(ISYM.EQ.KOLON)  GO TO 300
*     IF(KB.EQ.KCH(55))  GO TO 190
*     IF(KB.EQ.KCH(49))  GO TO 190
      KSYM=KCH(56)
      IF(.NOT.PRIME)  GO TO 190
**
***** END OF ERROR DG13
**
**
***** ERROR MV3
***** MODULE MVC   SUBROUTINE TQLA
**
***** BETWEEN STATEMENTS LABELLED 40 AND 50
***** THE FIRST AND LAST PAIRS OF STATEMENTS BELOW REMAIN UNALTERED
***** DECIDE WHETHER THE DOUBLE(*) OR SINGLE(CS) PRECISION VERSION
***** IS REQUIRED AND CHANGE THE REMAINING STATEMENTS APPROPRIATELY
**
      P=(DATA(IA)-DATA(IA-1))/(DTWO *DATA(IB))
C.SD 2
CS    IF(ABS(P).LT.DONE) GO TO 42
CS    R=ABS(P)*SQRT((1/P)*(1/P)+DONE)
*     IF(DABS(P).LT.DONE) GO TO 42
*     R=DABS(P)*DSQRT((1/P)*(1/P)+DONE)
      GO TO 44
C.SD 1
CS 42 R=SQRT(P*P+DONE)
*  42 R=DSQRT(P*P+DONE)
   44 PR=P+R
      IF(P.LT.DZERO) PR=P-R
**
**
***** END OF ERROR MV3
**
**
***** ERROR EX3
***** MODULE EX   SUBPROGRAM EXECD
**
***** AT LABEL 39:
**
   39 IF(NUNK.LE.0) GO TO 391
      IUNK=IUNK+1
      SCALNO(1)=ISDATA(IUNK)
      GO TO L39, (10,110)
  391 IF(GETATT(3,0).NE.0) GO TO 1000
**
**
***** END OF ERROR EX3
**
```

```
**
***** ERROR TS2
***** MODEL TSA  SUBPROGRAM ESTIMA
**
***** AT LABEL 230
**
C        MISSING VALUES IN LIST 3 ARE REPRESENTED BY ZEROES
C        IN ARRAY AT KMODL2
*     IF(N.EQ.NINPUT) GO TO 280
C        FOR MISSING VALUES IN LIST 2, SET UP DEGENERATE MODELS
      OLDMOD = .FALSE.
      IVEC = 0
      IVOR = -1
      IVAL = 2
      ISWIT = 1
  230 IF(VECSET(IVEC,ITYPE,IMODE,IVAL,IVOR,ISWIT,2).NE.0) GO TO 1000
**
**
***** END OF ERROR TS2
**
**
***** ERROR TS3
***** MODULE TSB  SUBPROGRAM TSINT
**
***** AT LABEL 90
**
   90 IP = IP*(1+ISDATA(IORD-2))*(1+ISDATA(IORD-1))
      IQ = IQ*(1+ISDATA(IORD))
      IR = IR+ISDATA(IORD-2)+ISDATA(IORD)
      IF(IORD.LE.IORIG+4) IORD = IORD-1
      IORD = IORD+4
      IF(IORD.LE.IMAX) GO TO 90
*     MAXPAR = IP+IQ+4
      IF(KODE.EQ.2) MAXPAR = IR
C        GET TEMPORARY WORKSPACE FOR NEW MODEL
**
**
***** END OF ERROR TS3
**
**
***** END OF ERROR NOTICE NO. 11
```

METHOD OF ISSUING SOURCE CORRECTIONS

Some site representatives at the 1982 NAG Users' Association meeting expressed dissatisfaction with the present method of issuing GENSTAT source corrections, and this is now being reviewed.

One improvement to be introduced at release 4.04 is that every revision issued will be recorded by a source comment identifying the sub-release: e.g.

```
C    RELEASE  4.04B  (date)
```

and this extended release identification will be printed at the head of each GENSTAT job.

It would be possible to combine this with the present system, issuing an additional such comment with each error notice. However, other methods of issuing source corrections are possible and users' comments, either in favour of the current system or suggesting improvements, would be welcomed. These may be sent to the author or to the GENSTAT co-ordinator at NAG.

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- NOTICES -

GENSTAT CONFERENCE 1983

The third International Conference of users of the Genstat statistical package will take place at Orsay (near Paris) France, during 10-12 October 1983. Sessions of selected contributed papers are planned on:

new facilities and future developments
macros
comparisons of Genstat with other packages
interesting applications of Genstat
the use of Genstat in education.

Participants will be able to view the Genstat video tapes, see demonstrations of the latest Genstat release and consult with expert users of the program.

Intending contributors should submit a one-page abstract, in English or in French, to:

R.W. Payne,
Statistics Department,
Rothamsted Experimental Station,
Harpenden,
Hertfordshire AL5 2JQ,
U.K.

before 1 April 1983.

If you would like to receive further information about the Conference, please complete and return the form below.

To: R.W. Payne, Statistics Department, Rothamsted Experimental Station, Harpenden, Hertfordshire AL5 2JQ, U.K.

I am interested in attending the third Genstat Conference. Please send further information.

Name: ______________________________

Organisation: ______________________________

Address: ______________________________

____

____

(If you intend to submit a paper, please give the title below:)

____

____

"AN INTRODUCTION TO GENSTAT"

This new book, by Norman Alvey, Nick Galwey and Peter Lane, has been issued in paperback by Academic Press, who have provided the following description:

> Introduction to Genstat *provides detailed guidance for students and researchers. No prior knowledge of computing is assumed and the statistical concepts used are explained. However, some familiarity with statistics will help the reader to follow the practical examples which illustrate the text. Many users will find all they need to know about Genstat in this book but for others it will serve as a helpful lead-in to the manual which documents the language. End of chapter exercises encourage the reader to write and run programs in the Genstat language. Solutions are provided in an appendix.*

Copies may be obtained from bookshops for £8.50 (U.K. only) or US $16.00 (elsewhere). Copies may also be ordered from NAG from £8.50 plus postage and packing.

GERMAN GENSTAT MANUAL

A German edition of the GENSTAT 4.03 manual is now available from NAG.

Produced in a single binder, this retails at £25 plus postage and packing.

Orders should be sent to

Numerical Algorithms Group Ltd
NAG Central Office
Mayfield House
256 Banbury Road
Oxford OX2 7DE
U.K.

ITSM ANNOUNCEMENTS

CALL FOR PAPERS - 9TH INTERNATIONAL TIME SERIES MEETING (ITSM): NOTTINGHAM UNIVERSITY (ENGLAND) 11-15 APRIL, 1983

The following provides a first list of those (some still tentative) whom we hope will be speaking at this Conference (44 people from 16 countries, so far):

R.J. Bhansali (U.K.)
W.R. Bell (U.S.A.)
R.J. Bennett (U.K.)
M. Borgard (France)
W. Bruggeman (Belgium)
D.W. Bunn (U.K.)
M. Daub (Canada)
Y. Hosoya (Japan)
A.J. de Hoyos (Brazil)
M. Deistler (Austria)
R.F. Galbraith (U.K.)
E.J. Godolphin (U.K.)
J.R.M. Hosking (U.K.)
R.R. Hyatt (U.S.A.)
P.B. Kenny (U.K.)
A.J. Lawrence (U.K.)
J. Lillestol (Norway)
A. Lopez C. (Chile)
R.M. Loynes (U.K.)
E.U. Makov (U.K.)
A. Maravall (Spain)
A. Milhoj (Denmark)

W. Mohr (West Germany)
G.V.L. Narasimham (U.S.A)
R.Y. Pei (U.S.A.)
J. Pemberton (U.K.)
D.A. Pierce (U.S.A.)
D.S. Poskitt (U.K.)
M.A. Rahim (Canada)
D. Ray (India)
M.J. Routman (U.S.A.)
S. Shahabuddin (U.S.A.)
J.Q. Smith (U.K.)
T.M.F. Smith (U.K.)
P. Stoica (Romania)
T. Subba Rao (U.K.)
G. Thury (Austria)
A.R. Tremayne (U.K.)
A.M. Walker (U.K.)
G.C. Watkins (U.S.A.)
M. West (U.K.)
H.O. Wold (Sweden)
Y. Yajima (Japan) and
S.K. Zaremba (U.K.)

Further contributed papers can still be considered, and 100-word abstracts (or enquiries concerning attendance) should be sent as soon as possible to the Convenor, Oliver D. Anderson, from whom details and application forms can also be obtained.

SCHEDULE OF INTERNATIONAL TIME SERIES MEETINGS (ITSM), 1982-5

General Interest ITSM, Cincinnati (U.S.A.) 19-22 August, 1982
General Interest ITSM, Nottingham (U.K.) 11-15 April, 1983
Special Topics ITSM, Valencia (Spain) 20-24 June, 1983
(Time Series Applications in Medicine and the Bio Sciences)
Special Topics ITSM, Toronto (Canada) 11-14 August, 1983
(Hydrological, Geophysical and Spatial Time Series)
General Interest ITSM, Toronto (Canada) 20-24 August, 1983
General Interest ITSM, Philadelphia (U.S.A.) 16-19 August, 1984
General Interest ITSM, Fort Collins (U.S.A.) 9-12 August, 1985

Fine Programmes of invited speakers are planned for these events, and 100-word abstracts for contributed papers and offers to act as session chairman should be sent to Oliver Anderson as soon as possible. As is usual with ITSMs, all Proceedings will be published.

The last four Conferences satellite the Annual ASA Joint Statistical Meetings: at each of these ASA meetings we hope to organise a special Time Series Analysis and Forecasting (TSA&F) session, featuring distinguished experts from outside North America.

If you would like to contribute, help (or just participate) at any of the above ITSM (or special TSA&F sessions), please write to Oliver D. Anderson.

SCOPE OF GENERAL INTEREST ITSM

Suitable time series topics for presentation include: Statistical Methodology; Applications to Economics and in Econometrics; Rational Expectations; Government, Business and Industrial Examples; Finance and Accountancy; the Hydrosciences, such as Limnology, Hydrology, Water Quality Regulation and Control, and the Modelling of Marine Environments; Persistence and Fractional Differencing; the Geosciences, especially such areas as Oil Exploration and Seismology; Civil Engineering and allied disciplines; Point Processes; Spatial and Space-Time Processes - their theory and application - especially in Geography and related areas, such as city planning or energy demand forecasting; Biology and Ecology;

Environmental Studies - Air and River Pollution; Medical Applications and Biomedical Engineering; Psychology; Speech Communication and Recognition; Accoustics; Radar; Sonar; Astronomy; Nuclear Science; Data Communication and Telephony; Irregularly Spaced Data (including Outliers and Missing Observations); Robust and Nonparametric Methods; Seasonal Modelling and Adjustment; Calendar Effects; Causality; Bayesian Approaches; Distributed Lags; Box-Jenkins Univariate ARIMA, Transfer-Function, Intervention, Vector ARIMA and other Multivariate Modelling; State Space; Nonlinear Models; Identification Problems; Estimation; Diagnostic Checking; Signal Extraction; Comparative Studies; Spectral Analysis, especially for the Physical Sciences; Business Cycle and Expectations Data; Data Revisions; Computer Software and Numerical Analysis; Forecasting (including new topics such as Traffic Forecasting and Safety, and Forecasting in Agriculture); and, no doubt, many other areas of the subject.

Suggestions (and offers of help) are always most welcome.

Oliver D Anderson
ITSM Convenor
9 Ingham Grove
Lenton Gardens
Nottingham NG7 2LQ
U.K.

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