Volume 3, Number 1.
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Editor:
H. L. Smythe.
EDITORIAL COMMENT

This Bulletin marks the beginning of Volume 3 and the commencement of a New Year. The staff of the Computer Centre cordially extend to our readers and clients our sincere wishes for a rewarding and prosperous New Year.

It has been very pleasing to see the rapidly-increasing number of applications to receive the Bulletin that have swamped the Editor's desk in the last few months. We hope that the Bulletin will continue to be of interest and assistance to readers throughout 1970. The Editor especially invites articles of computing interest from University Departments and external organizations, as the publication of several of these last year, generated considerable interest. This month, a biometrician describes briefly some of the applications of the computer to biometry in animal production research. Other items include operational information and a list of recent library accessions.

STAFF NEWS

INTRODUCING A SENIOR DEMONSTRATOR ..... 

The Department of Computer Science welcomes into its ranks Michael (Mike) McLean who has been appointed to the position of Senior Demonstrator.

Mike hails from England, having graduated with Honours in Civil Engineering in 1968 after a four year "sandwich" course of six monthly alternations of study and industrial training at the City University, London. Undaunted, Mike then proceeded to the Institute of Computer Science at the University of London where he gained his Master of Science degree with Distinction in Computer Science. His project involved the implementation of memory protection facilities under the control of the monitor in the PDP 9.

We hope that Mike will enjoy life in Australia, and recommend that he disregard FORTRAN for the infinitely-richer language, STRINE.

..... AND A COMPUTER OPERATOR

Another new member of staff, Angela Vidanovic, is no stranger to the Computer Centre. Angela was formerly employed as a Data Preparation Assistant, but after an absence of several months, has returned to her old haunt to become a Machine Operator.
PROGRAMMER'S PRAYER

To begin the year in a suitable spirit, the following "prayer" is included for every aspiring programmer.

Our Computer, which art in Centre,  
Hallowed by thy BATCH,  
Thy output come.  
Thy source statements be done  
In MACRO as they are in FORTRAN.  
Give us this day our daily compilations.  
And forgive us our Syntax Errors  
As we forgive them that give us the wrong input data  
And lead us into fatal diagnostics;  
But deliver us from Parity errors,  
For thine is the Computation,  
The Software and the Hardware,  
For ever and ever,  
Exit.

CARD FORTRAN INFORMATION

Users are reminded that during CARD FORTRAN execution, setting switch 16 will cause the examination of all I, F, E output fields to determine whether sufficient field length has been allowed. If the field width is insufficient, the field will be expanded and a diagnostic message output on the console typewriter. It is important to note that even though an explicit sign may not be output, allowance must be made for it when calculating a field width. (If the quantity is positive, the + sign will be replaced by a blank.) This means, incidentally, that an II field cannot be used in this mode. A problem may arise in a compile and run job if switch 16 was set during compilation to suppress the punching of a binary object deck, since there may be no opportunity to reset switch 16 before proceeding to the run phase of the job.

For further operational details, users are referred to Chapter 10 of the Technical Manual No. 2, CARD FORTRAN (MNT-2), copies of which may be obtained from the Computer Centre.
LIBRARY ACCESSIONS

This month's list outlines the books and periodicals on computer science that the Libraries of the University of Queensland acquired in August 1969.

Artandi, Susan S.  
*An Introduction to Computers in Information Science.* 1968. (029.7 ART, Main Lib.)

Rogers, Andrei.  
*Network Analysis.* 1966. (Q311.23 ROG, Engin.Lib.)

Salzman, Lawrence.  
*Computerized Economic Analysis.* 1968. (330.018 SAL, Engin.Lib.)

*An Introduction to Cost-Benefit Analysis.* 1967. (338.522 SYM, Main Lib.)

Trezy, George I.  
*Computer Problem Kit for Economics.* 1969. (330.0184 TRE, Economics Lib.)

Kucera, Henry.  
*Computational Analysis of Present-Day American English.* 1967. (Q427.973 KUC, Main Lib.)

Mann, Henry B. ed.  
*Error Correcting Codes.* 1968. (519.7 MAN, Elect.Engin.Lib.)

Computer Communications Symposium, University of California at Los Angeles, 1967.  
*Computers and Communications.* 1968. (621.38 COM, Main Lib.)

*Computerized Process Control.* 1968. (658.5 COM, Engin.Lib.)

Corlett, Peter N.  
*Practical Programming.* 1968. (651.8 COR, Education Methods Lib.)

IFIP Working Conference of Simulation Programming Languages, Oslo, 1967.  
*Simulation Programming Languages.* 1968. (651.8 IFI, Engin.Lib.)

Meier, Robert C.  
*Simulation in Business and Economics.* 1969. (658 MEI, Main Lib.)

Sanders, Donald H.  
*Computers in Business.* 1968. (658.5 SAN, Accountancy Seminar Room)

International Computers Limited.  
*Computer International.* Current year only retained. (651.269 INT, Engin.Lib.)

West Virginia University Conference on Computer Applications in Music, Morgantown, 1966.  
*Papers.* 1967. (780.1 WES, Music Lib.)
APPLICATION OF COMPUTERS TO BIOMETRY IN ANIMAL PRODUCTION

P.M. Pepper

The author of this article, Miss Patricia Pepper, holds a Bachelor of Science degree and a postgraduate Diploma in Automatic Computing from the University of Queensland.

Miss Pepper works as a Biometrician in the Animal Industry Division at the Department of Primary Industries.

Biometry is an important tool in animal production research. It is used in the design of experiments so that the maximum amount of useful information can be obtained from an experiment and is statistically analysed to evaluate the significance of the results. As many trials are of similar design and frequently a large number of variates are measured in one experimental design, the method of analysis is largely routine. Thus, the use of a computer is very valuable. In addition, computations can be lengthy, especially with an unbalanced design.

Programs have been written for experimental designs most frequently used in the Animal Industry Division at the Department of Primary Industries, and these are discussed. A linear model with normally distributed variates is assumed. However, there is provision for various transformations on the raw data if these assumptions do not hold (Bartlett, 1947).

The most common design employed is the balanced factorial where there is the same number of observations in all cells. The effects can be fixed or random. If the levels of an effect are a random sample from a normally distributed population of levels, the effect is said to be random. An effect can be nested within another effect. This is sometimes called an hierarchical classification.

In the first example of an analysis of variance of a balanced factorial, the design was a 3 x 3 x 2 factorial with fixed effects. These factors were types of grain, levels of roughage, and levels of salt respectively. Four steers were allocated at random to each treatment combination. As there were three missing values, there is a loss of three error degrees of freedom. The analysis of covariance technique in which a pseudo variate is introduced for each missing value is employed in the program (Nair, 1940). Only a sample of the tables of means is given in Example 1.

In the second example, the model was a mixed model of fixed and random effects. Factor A represents treatments which are fixed. Groups (B) were also fixed, whilst animals within groups (C.B.) were random. The appropriate errors against which the
effects have been tested, are printed out in a preliminary outline of the analysis.

Covariance is quite a useful tool for eliminating from the estimates of treatment effects, some effect which can be measured but not controlled (Cochran & Cox, 1966). Thus, gain in body weight could be adjusted for feed intake by using feed intake as a covariate. Balanced factorials can include split plots when the whole plot (which may be a plot of grain or a pen of animals) is subdivided into subplots to which levels of another factor are allocated at random.

The third example illustrates the use of covariance. The analysis of the number of days animals took to attain a fixed slaughter weight, with and without adjustment for initial body weight by covariance, is given. The design in this example was a $4 \times 2 \times 2 \times 2 \times 2$ balanced factorial with fixed effects.

Another type of balanced design often used is the *latin square*, the rows and columns of which should represent the major sources of variation in the experimental material.

In feeding trials with dairy cattle, the measurement criterion (e.g. milk yield) changes with time, and the rate of change may vary markedly from cow to cow. The design which gives the most sensitive treatment comparisons is the switchback or reversal design. Brandt (1938) showed that the difference between two treatments was confounded with the $(n - 1)$th component of the interaction (period x treatment sequence) when there were $n$ test periods. Lucas (1956) extended the design to more than two treatments. This is the method used in the program for analysing switchback designs.

In the fourth example, the design was:

<table>
<thead>
<tr>
<th>Treatment sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B C A B C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>B C A C A B</td>
</tr>
</tbody>
</table>

| A B C A B C |

with two cows per treatment sequence.

Data collected in the field on breeding trials is often *non-orthogonal*. For example, the data may be classified by age of dam and sex of offspring, which
results in disproportionate numbers of observations in each cell, and sometimes in
data completely missing for some cells. The program to analyse this type of
data when interactions can be assumed negligible, uses the method of fitting
constants (Rao, 1955).

Although the most common use of the analysis of variance is to obtain tests of
significance of treatment effects, it can also be used to estimate components of
variance assignable to random variables. This has applications in selecting
sampling designs and estimating repeatabilities and heritabilities.

In the program for estimating components of variance and covariance in a
non-orthogonal experiment, the sums of squares and products are computed by the
method of fitting constants, and these are equated to their expectations
(Henderson, 1953; Gates and Shiue, 1962). In the fifth example which illustrates
this program, the sources of variation were animals and periods.

It is frequently required to fit regression equations to data in order to predict
some variable from one or more independent variables. The form of these
regressions can be linear, curvilinear, multiple, a combination of multiple and
curvilinear (e.g. $y = a + b_1x_1 + b_2x_1^2 + b_3x_2$) or asymptotic ($y = a + br^x$ where
$0 < r < 1$). The method used in the program to fit asymptotic regression equations
involves the iterative least squares estimation of the parameters (Stevens, 1951).

In the sixth example, an asymptotic regression representing body weight of one of
the animals on a restricted diet as a function of time, is given.

\[
\begin{align*}
    a & \text{ is the asymptotic value of body weight (y).} \\
    b & \text{ is the change in body weight when time (x) passes from 0 to + infinity.} \\
    r & \text{ is the factor by which the deviation of y from its asymptotic value, is reduced by unit increase in x.}
\end{align*}
\]

REFERENCES


Brandt, A.E., 1938. Tests of Significance in Reversal or Switchback Trials.


Gates, Charles E. and Shiue Cherng-Jiann, 1962. The Analysis of Variance of the
8-stage Hierarchal Classifications. Biometrics 18, 529-536.


DEPT, PRIMARY INDUSTRIES 103/82
INTENSIVE FINISHING OF CATTLE 1966
A B C D ABC
A = GRAIN TYPES
A0 = WHEAT
A1 = BARLEY
A2 = SORGHUM
B = ROUGHAGE LEVEL
B0 = 2 KG
B1 = 1 KG
B2 = NIL
C = SALT LEVEL
C0 = NIL
C1 = SALT

BLOOD INORGANIC PHOSPHORUS |MG/106=1|
T02D0100A03M02P02
6.73188*00

ANALYSIS OF VARIANCE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>MSQ</th>
<th>F</th>
<th>PROB.</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>2.5604655*08</td>
<td>4.929</td>
<td>*0.011</td>
<td>7.207139*01</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>2.9042656*01</td>
<td>0.559</td>
<td>0.61</td>
<td>1.845934*01</td>
</tr>
<tr>
<td>AB</td>
<td>4</td>
<td>1.4274238*08</td>
<td>2.171</td>
<td>0.073</td>
<td>0.776445*02</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>3.8026423*09</td>
<td>0.073</td>
<td>0.609</td>
<td>0.163781*01</td>
</tr>
<tr>
<td>AC</td>
<td>2</td>
<td>1.845934*01</td>
<td>0.353</td>
<td>1.81</td>
<td>0.154593*01</td>
</tr>
<tr>
<td>BC</td>
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<td>6.8376445*02</td>
<td>0.092</td>
<td>0.64</td>
<td>0.154593*01</td>
</tr>
<tr>
<td>ABC</td>
<td>4</td>
<td>3.163781*01</td>
<td>0.609</td>
<td>0.65</td>
<td>0.154593*01</td>
</tr>
<tr>
<td>ABCD</td>
<td>51</td>
<td>5.1942808*01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
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</table>

A MEANS

<table>
<thead>
<tr>
<th>A</th>
<th>A</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6.63</td>
<td>7.12</td>
<td>6.46</td>
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</table>

SIG DIFFS
1 0 * 1 2**

AVE SE= 0.15
LSD 0.43 (5 PC) 0.57 (1 PC)

BC MEANS

<table>
<thead>
<tr>
<th>C</th>
<th>B</th>
<th>B</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6.85</td>
<td>6.70</td>
<td>6.59</td>
</tr>
<tr>
<td>1</td>
<td>6.81</td>
<td>6.84</td>
<td>6.63</td>
</tr>
</tbody>
</table>

NO SIG DIFFS

AVE SE= 0.21
LSD 0.61 (5 PC) 0.81 (1 PC)

EXAMPLE 1. ANALYSIS OF VARIANCE

8.
### Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>MSQ</th>
<th>F</th>
<th>Prob.</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4</td>
<td>3.3707235E+02</td>
<td>5.019</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>8.3229129E+02</td>
<td>3.204</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>4</td>
<td>1.5645298E+02</td>
<td>2.330</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.B</td>
<td>6</td>
<td>2.5977066E+02</td>
<td>3.868</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>A.B.C</td>
<td>24</td>
<td>6.7153478E+01</td>
<td>8.1947226E+00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Example 2. Analysis of Variance**
### DAYS ON EXPERIMENT
INITIAL SHRUNK WEIGHT AS UNVARIATE

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>dF</th>
<th>MSq</th>
<th>F</th>
<th>Prob.</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>2.576746 x 10^5</td>
<td>1.031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>3</td>
<td>1.927949 x 10^5</td>
<td>0.644</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC</td>
<td>3</td>
<td>2.444327 x 10^5</td>
<td>0.661</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AD</td>
<td>3</td>
<td>1.784800 x 10^5</td>
<td>0.800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BC</td>
<td>1</td>
<td>2.768946 x 10^5</td>
<td>1.034</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BD</td>
<td>1</td>
<td>2.807404 x 10^5</td>
<td>1.144</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td>1</td>
<td>5.391476 x 10^5</td>
<td>2.134</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABCD</td>
<td>37</td>
<td>2.561380 x 10^5</td>
<td>1.445</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EXAMPLE 3. USE OF COVARIANCE**
EXAMPLE 4. ANALYSIS OF SWITCHBACK DESIGN

SALIVA ANALYSES SHEEP SODIUM

ANALYSIS OF DISPERSION

\[
\begin{align*}
Y_1 & \quad Y_1 \\
A & \quad 10289.1079 \\
B & \quad 2324.6823 \\
AB & \quad 3797.7141 \\
RESIDUAL & \quad 1436.3131 \\
\end{align*}
\]

COEFFICIENTS OF COMPONENTS

\[
\begin{align*}
A & \quad 43.000000 \\
B & \quad 0.000000 \\
AB & \quad 37.904762 \\
RESIDUAL & \quad 31.238096 \\
\end{align*}
\] \hspace{1cm}
\begin{align*}
A & \quad 11.761904 \\
B & \quad 6.666666 \\
AB & \quad 31.238096 \\
RESIDUAL & \quad 29.000000 \\
\end{align*}
\]

VARIANCE AND COVARIANCE COMPONENTS

\[
\begin{align*}
Y_1 & \quad Y_1 \\
A & \quad 206.33988 \\
B & \quad 39.93141 \\
AB & \quad 99.37615 \\
RESIDUAL & \quad 49.52804 \\
\end{align*}
\]

EXAMPLE 5. ANALYSIS OF VARIANCE

11.
<table>
<thead>
<tr>
<th>REGN MS</th>
<th>DF</th>
<th>RESIDUAL MS</th>
<th>F</th>
<th>PERCENT VAR</th>
<th>SEE</th>
<th>SEID</th>
<th>SEID</th>
<th>SEID</th>
</tr>
</thead>
<tbody>
<tr>
<td>6025.646</td>
<td>21</td>
<td>31.74420</td>
<td>189.82</td>
<td>94.76</td>
<td>5.03420</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>323.7265</td>
<td>103.3007B</td>
<td>5.60100</td>
<td>0.46091</td>
<td>0.04049</td>
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<tr>
<td>6032.059</td>
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<td>31.3528</td>
<td>186.74</td>
<td>94.86</td>
<td>5.79990</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>323.62646</td>
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<td>6032.201</td>
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<td>31.12168</td>
<td>193.83</td>
<td>94.86</td>
<td>5.78868</td>
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<tr>
<td>A</td>
<td></td>
<td></td>
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<tr>
<td>323.63206</td>
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<td>0.44549</td>
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</tbody>
</table>

**ESTIMATES**

<p>| | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>323.64</td>
<td>323.64</td>
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</tbody>
</table>

**EXAMPLE 6. ASYMPTOTIC REGRESSION**

12.