PROCEDURE SWITCH is a user written SAS algorithm which calculates the analysis of variance, treatment means, standard deviation, R-square, and coefficient of variation for switchback experimental designs with three or more treatments. The switchback experimental design is useful for controlling period effects due to changes in environmental conditions and variation between subjects' response levels. The switchback design is described by H. L. Lucas (2). PROC SWITCH includes options to specify a blocking factor and a data set name. Parameters which must be specified are period, treatment, and subject variable names. A variable statement must be present which specifies the response variable. Error diagnostics include missing value indicators for subject, period, treatment, response, and block, a comparison of the treatments assigned to periods to insure that the design has been correctly specified, a check that at least 3 treatments are specified, and a check that the number of subjects is a correct multiple of the number of treatment sequences. The algorithm, documentation, sample program and output are available upon request from the authors. PROC SWITCH has been successfully implemented on an IBM 4341 at two separate locations (one OS, one CMS).

The switchback experimental design for more than two treatments was first described by H. L. Lucas (2). The design is particularly useful for controlling period effects due to changes in environmental conditions and variation between subjects' response levels. The switchback design is rarely employed except for an occasional reference in human or animal nutrition or toxicology (1,2,3,4). The principal reason for the infrequent use of the switchback design is the lack of generalized, widely available software. Generalized switchback experimental design software is not readily available in the major statistical packages such as SAS, SPSS, or BMDP.

To illustrate a switchback design, a four treatment experiment is given in Figure 1, where the letters (A,B,C,D) represent the four treatments. Notice that each individual receives only two treatments in three time periods. The first and last treatment for each individual are identical. Differences between first and last time periods can then be calculated in order to control for period effects and variation in subjects' response levels over time.
The PROC SWITCH algorithm code, example program and output are available from the authors upon request. PROC SWITCH has been successfully implemented on an IBM 4341 at two separate locations. One location (Southwest Missouri State University) uses the CMS operating system, and the other location (Louisiana State University) uses the OS operating system.

THE SWITCH PROCEDURE

The PROC SWITCH statement has the following format:

PROC SWITCH Options Parameters;

The Options are:

B= Block Variable Name

If the design includes a blocking factor, then the SAS variable name for the blocking variable must be specified for the analysis to incorporate effects due to blocking. If blocking was not a design factor, then "B=" need not be specified.

DATA= Data Set Name

This option specifies what data set is to be analyzed. If this option is omitted, the most recently created data set will be used.

The Parameters that must be specified in order for the procedure to execute are:

P= Period Variable Name

This is the SAS variable name which identifies the experimental period in which an observation occurred.

T= Treatment Variable Name

This is the SAS variable name which identifies what treatment was applied for the observation.

S= Subject Variable Name

This is the SAS variable name which identifies on which subject a given observation occurred.

The statement to be used with PROC SWITCH is the variable statement. It must be present and name the response variable to be analyzed. Only one response variable may be specified.

An example program for PROC SWITCH using the data from the Lucas article might look as follows:

DATA ONE;
INPUT BLOCK SUBJ PERIOD TREAT RESP;
CARDS;
1 1 1 1 34.6
1 1 2 3 32.3
1 1 3 1 28.5
1 2 1 2 22.8
1 2 2 3 21.0
1 2 3 2 18.6
1 3 1 3 32.9
1 3 2 1 33.1
1 3 3 3 27.5
1 4 1 1 48.9
1 4 2 3 46.9
1 4 3 1 42.0
1 5 1 2 21.8
1 5 2 1 23.9
1 5 3 2 21.7
1 6 1 3 25.4
1 6 2 2 26.0
1 6 3 3 23.9
2 7 1 1 30.4
2 7 2 3 29.5
2 7 3 1 26.7
2 8 1 2 35.2
2 8 2 1 33.5
2 8 3 2 28.4
2 9 1 3 30.8
2 9 2 2 29.3
2 9 3 3 26.4
3 10 1 1 38.7
3 10 2 2 37.4
3 10 3 1 34.4
3 11 1 2 25.7
3 11 2 3 26.1
3 11 3 2 23.4
3 12 1 3 21.4
3 12 2 1 22.0
3 12 3 3 19.4
PROC PRINT;
PROC SWITCH B=BLOCK P=PERIOD T=TREAT S=SUBJ;
VAR RESP;
TITLE;

Output from PROC SWITCH is a complete analysis of variance table along with treatment means, the standard deviation, R-square, and the coefficient of variation.

The example program output would look as follows:

SWITCHBACK ANOVA PROCEDURE

DEPENDENT VARIABLE; RESP

SOURCE  DF  SUM OF SQ..  MEAN SQ..  F VALUE
TOTAL  11  3.71486
BLOCK  2  0.18041  0.090208  0.32285
TREAT. 2  1.57961  0.78930  2.82495
ERROR  7  1.95583  0.27940

PR > F  0.73431
0.12604

STD DEV = 0.52858  R-SQUARE = 0.18057
C.V. = 0.95750
MEANS

<table>
<thead>
<tr>
<th>TRT</th>
<th>RESP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29.5431</td>
</tr>
<tr>
<td>2</td>
<td>29.0097</td>
</tr>
<tr>
<td>3</td>
<td>28.9889</td>
</tr>
</tbody>
</table>

Error diagnostics include missing value indicators for subject, period, treatment, response, and block, a comparison of the treatments assigned to periods to insure that the design has been correctly specified, a check that at least three treatments are specified, and a check that the number of subjects is a correct multiple of the number of treatment sequences.

A copy of the PROC SWITCH algorithm code, a sample program for a three treatment switchback experimental design using example data from the Lucas article, and the output for the sample program are available from the authors upon request.

REFERENCES


AUTHORS ADDRESSES

Dr. Nancy K. Keith
Computer Informations Systems Department
Southwest Missouri State University
Springfield, MO 65804
(417) 836-4131

Mr. George D. Williams
Budget and Planning
Thomas Boyd, Rm 311
Louisiana State University
Baton Rouge, LA 70803
(504) 388-1231