A Brief Manual for LINMOD

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LINMOD (LINEar MODels) performs a wide variety of General Linear Multivariate Model (GLMM) computations in SAS/IML. This software is especially useful for repeated measures, complex designs, and teaching.

The source code (mostly IML, with a tiny amount of macro language), installation instructions, an extensive manual, and sample programs are available at http://www.bios.unc.edu/~muller

No warranty is provided or implied.

TITLE1 "EXAMPLE1.SAS--Demonstrate simple LINMOD use";
* 0. Define raw data file;
FILENAME IN01 "..\EXAMPLES\PAYNE.DAT";
DATA PAYNE; INFILE IN01;
* 1. Define directory in which LINMOD source code stored;
   * Change highlighted text in next line for your computer;
%LET LMDIRECT = ..\SOURCE\;
* 2. Define SAS macro code needed;
%INCLUDE "&LMDIRECT.MACROLIB.MAC" / NOSOURCE2;
* 3. Reduce raw data to a TYPE=CORR file named _CORRDS_;
&PROCSCP DATA=PAYNE;
VAR CONTROL LOW MODERATE HIGH INIT
   SCORE2 SCORE4 SCORE6 SCORE8 SCORE10;
PROC IML WORKSIZE=1000 SYMSIZE=1000; *4.1 Start IML;
&LINMOD ; *4.2 Grab code;
* 5. Retrieve the file _CORRDS_ created in Step 3 ;
RUN GETCORSS;
* 6. Define the model and estimate primary parameters;
INDVARS = { CONTROL LOW MODERATE HIGH INIT };
DEPVARS=NAMELIST("SCORE",2,10,2);
RUN FITMODEL;
* 7.1 Conduct a test (and estimation) step;
PRINT " * MANOVA Test of Main Effect of Treatment, *
   " * comparing each treatment to control group ** ;
   C = ( 1 -1 0 0 0 ,
       1 0 -1 0 0 ,
       1 0 0 -1 0 ) ;
THETARNM= { "C - LOW" "C - MOD" "C - HIGH" };
*U defaults to Identity matrix, if NROW(U)=0;
RUN TESTGLH;

TITLE1 "EXAMPLE2.SAS--Demonstrate LINMOD using MAKESS";
FILENAME IN01 "..\EXAMPLES\PAYNE.DAT";
DATA PAYNE;
   INFILE IN01;
%LET LMDIRECT = ..\SOURCE\;
%INCLUDE "&LMDIRECT.MACROLIB.MAC" / NOSOURCE2;
PROC IML WORKSIZE=1000 SYMSIZE=1000;
&LINMOD ;
OPT_OFF = { MSH };
OPT_ON = { LISTINFO AVAILOPT };
RUN SETOPT;
*Read raw data into IML;
USE PAYNE;
READ ALL VAR(GROUP) INTO GROUP;
READ ALL VAR(INIT) INTO INIT;
READ ALL VAR(SCORE2 SCORE4 SCORE6 SCORE8 SCORE10) INTO Y;
CLOSE PAYNE;
*Use functions to create indicators for design matrix;
N=NROW(Y); * # observations in sample;
CONSTANT=J(N,1,1); *Column of 1's for intercept, etc;
CELLMEAN=DESIGN(GROUP); *Cell mean coding;
EFFECT =CONSTANT||DESIGNF(GROUP); *Effect coding;
REFERENC=CONSTANT||CELLMEAN(*,2:NCOL(CELLMEAN));*Reference cell coding;
*Assemble all predictors and responses into one matrix, Z;
* ZNAMES must also exist;
Z = CELLMEAN || INIT || Y;
ZNAMES = { CONTROL LOW MODERATE HIGH INIT }||{ SCORE2 SCORE4 SCORE6 SCORE8 SCORE10 };
RUN MAKES; *Create SSCP matrix and associated parameters;
*Fit a model;
INDVARS = { CONTROL LOW MODERATE HIGH INIT };
DEPVARS = { SCORE2 SCORE4 SCORE6 SCORE8 SCORE10 };
RUN FITMODEL;
*Conduct any test or estimation desired;
*C= ----; *U= ----; *RUN TESTGLH;

If the LINMOD code has been stored (see the for usage of this SAS/IML User's Guide feature) in the STORED directory, replacing SOURCE by STORED in the LMDIRECT= statement will read stored IML code and speed program initialization.

LINMOD Options and Default Values

<table>
<thead>
<tr>
<th>Option</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SETOPT</td>
<td>MAKESS</td>
</tr>
<tr>
<td>LISTINFO</td>
<td>MPARMS</td>
</tr>
<tr>
<td>CURROPTS</td>
<td>MSS</td>
</tr>
<tr>
<td>NEWOPTS</td>
<td>MSS</td>
</tr>
<tr>
<td>COMPRESS</td>
<td>NOT COMPRESS</td>
</tr>
<tr>
<td>NOPRINT</td>
<td>ON</td>
</tr>
</tbody>
</table>

(ON) indicates the default ON.
The absence of (ON) indicates the default is OFF.
### Matrices Available from FITMODEL

<table>
<thead>
<tr>
<th>MATRIX</th>
<th>OPTION</th>
<th>ROWNAME</th>
<th>COLNAME</th>
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</thead>
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<tr>
<td><em>BETA</em></td>
<td>BETA, EXBETA</td>
<td><em>XNAME</em></td>
<td><em>XNAME</em></td>
</tr>
<tr>
<td><em>BPVAL</em></td>
<td>EXBETA</td>
<td><em>XNAME</em></td>
<td><em>YNAME</em></td>
</tr>
<tr>
<td><em>BSE</em></td>
<td>EXBETA</td>
<td><em>XNAME</em></td>
<td><em>YNAME</em></td>
</tr>
<tr>
<td><em>BT</em></td>
<td>EXBETA</td>
<td><em>XNAME</em></td>
<td><em>YNAME</em></td>
</tr>
<tr>
<td><em>LINDEP</em></td>
<td>LINDEP</td>
<td><em>XNAME</em></td>
<td><em>VNAME</em></td>
</tr>
<tr>
<td><em>PARM1</em></td>
<td>UNIBETA</td>
<td>--------</td>
<td><em>PM1CNM</em></td>
</tr>
<tr>
<td><em>SCORR</em></td>
<td>SCORR</td>
<td><em>YNAME</em></td>
<td><em>YNAME</em></td>
</tr>
<tr>
<td><em>SIGMA</em></td>
<td>SIGMA</td>
<td><em>YNAME</em></td>
<td><em>YNAME</em></td>
</tr>
<tr>
<td><em>SS</em></td>
<td>SSFIT</td>
<td><em>VNAME</em></td>
<td><em>VNAME</em></td>
</tr>
<tr>
<td><em>STAT</em></td>
<td>UNIBETA</td>
<td><em>YNAME</em></td>
<td><em>STRNM</em></td>
</tr>
<tr>
<td><em>XPXINV</em></td>
<td>XPXINV</td>
<td><em>XNAME</em></td>
<td><em>XNAME</em></td>
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</tbody>
</table>

### Matrices Available from TESTGLH

<table>
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<th>Rowname</th>
<th>Colname</th>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td><em>THETA</em></td>
<td>THETA</td>
<td><em>THRNM</em></td>
<td><em>THCNM</em></td>
<td>7.2.2, 7.5.4</td>
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<td><em>MID</em></td>
<td>MID</td>
<td><em>THRNM</em></td>
<td><em>THRNM</em></td>
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<tr>
<td><em>SDTHTA</em></td>
<td>MATTHETA</td>
<td><em>THRNM</em></td>
<td><em>THCNM</em></td>
<td>7.5.7</td>
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<tr>
<td><em>THTA</em></td>
<td>MATTHETA</td>
<td><em>THRNM</em></td>
<td><em>THCNM</em></td>
<td>7.5.7</td>
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<td><em>PVTHTA</em></td>
<td>MATTHETA</td>
<td><em>THRNM</em></td>
<td><em>THCNM</em></td>
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<td><em>MSH</em></td>
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<td><em>THCNM</em></td>
<td><em>THCNM</em></td>
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<td><em>THCNM</em></td>
<td><em>THCNM</em></td>
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<td>ECCORR</td>
<td><em>THCNM</em></td>
<td><em>THCNM</em></td>
<td>7.5.11</td>
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<tr>
<td><em>HEIVAL</em></td>
<td>HEIVAL</td>
<td><em>CANNM</em></td>
<td><em>NONM</em></td>
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<td><em>CANVEC</em></td>
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<td><em>THCNM</em></td>
<td><em>CANNM</em></td>
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<td><em>CANSQ</em></td>
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<td><em>CANNM</em></td>
<td><em>NONM</em></td>
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<td><em>FSTATS</em></td>
<td>UNITHETA</td>
<td><em>THCNM</em></td>
<td><em>FSTRNM</em></td>
<td>7.5.6, 7.5.17</td>
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<td><em>STMAT1</em></td>
<td>MULTTEST</td>
<td><em>STMRNM</em></td>
<td><em>STMCNM</em></td>
<td>7.5.16, 7.5.17</td>
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<td>MULTTEST</td>
<td><em>NONM</em></td>
<td><em>TPCNM1</em></td>
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<td><em>URESUL</em></td>
<td>UNIREP</td>
<td><em>UCOLNM</em></td>
<td><em>UROWNM</em></td>
<td>7.5.18-7.5.21</td>
</tr>
</tbody>
</table>

Note that if THETARNM exists then _THTRNM_=THETARNM.
Also, if THETACNM exists then _THTCNM_=THETACNM.
NAMELIST Function
Usage: yourlist = NAMELIST(STEM,LOW,HIGH,BY);
This function generates a row of names, STEMlow to STEMhigh, by..., a character matrix.
STEM is a character string (1x1). Require 0<=LOW<=HIGH, and 1<=BY, integers (1x1). See the MAKESS example in section 4.9 of the full LINMOD manual for an example use. Example 1 in Section 1.5 of the full LINMOD manual includes the following code:
DEPVARS=NAMELIST("SCORE",2,10,2);

UMEAN Function
Usage: UAVE = UMEAN(P); This function returns J(P,1,1/P), which provides a column (vector) to use as an averaging U matrix.

UPOLY1 Module
This module produces a U matrix and associated names for a test of trends.
Usage: RUN UPOLY1(VALUES, NAME, U, NMOUT);
Inputs. VALUES, numeric treatment levels (values), a matrix with one row or column.
NAME, a character string providing stem of names for trends.
Outputs. U, a matrix with columns orthonormal polynomial coefficients (excludes zero order).
NMOUT, a character matrix with one row of names.

UPOLY2 Module
This module produces U matrices and associated names for tests of trend and interaction for a design with two within-subject factors.
Assume Factor 1, with levels VALUES1, varies slowly,
and that Factor 2, with levels VALUES2, varies rapidly.
Usage:
RUN UPOLY2(VALUES1,NAME1, VALUES2,NAME2,
U1, NMOUT1,U2, NMOUT2, U12 ,NMOUT12);
Inputs VALUES1=1st set of numeric treatment levels/values
NAME1 = 1st character string providing stem of names;
VALUES2=2nd set of numeric treatment levels/values
NAME2 = 2nd character string providing stem of names;
Outputs U1 = orthonormal polynomial coefficient columns
for 1st factor (excludes zero order)
NMOUT1 =1 row matrix of 1st factor names (character);
U2 = orthonormal polynomial coefficient columns
for 2nd factor (excludes zero order)
NMOUT2 =1 row matrix of 2nd factor names (character);
U12 = orthonormal polynomial coefficient columns
for interaction (excludes zero order)
NMOUT12=1 row matrix of interaction names (character);

UTREND Function
Create polynomial trends matrix (columnwise), excluding the zero order.
Usage: UPOLY = UTREND(VALUES);