PRACTICAL APPLICATIONS OF PROC PRINTTO
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ABSTRACT
By using Proc Printto, output from SAS procs can be manipulated to meet the needs and/or desires of the user. Simple programs are presented for creating concise summaries of analyses by reducing and enhancing output.

INTRODUCTION
SAS contains many useful statistical procedures. One of the few drawbacks is that the output frequently is cumbersome and hard to control. Proc Printto makes it possible to read the output so it can be treated like any other SAS data set. This means that the user can control what is printed. Reducing or reordering output has received many votes on the SAS balloting, and the macros depict methods for achieving these goals.

The following examples are presented:
1 - suppressing the carriage control
2 - reordering the output
3 - enhancing the output
4 - compressing the output
5 - rerouting the output.

The following data set and macros are used in all examples. The macros used for reading the carriage control (INCC), reading the output line (INL), printing the line (PUTL) and reading the by variable (INBV) are listed below. The data set used in all examples has variables Y and X (dependent variable and covariate), 3 treatments, 5 blocks and 3 levels of the by variable (BYVAR).

DATA DATA; DO BYVAR=1 TO 3; DO TRT=1 TO 3;
    DO BLK=1 TO 5; DO REP=1 TO 20;
    X=NORMAL(0); Y=X*5+NORMAL(0); OUTPUT;
END; END; END:

MACRO DSNIN
DATA DSN; INFILE FT20FOOl LENGTH=L; %
MACRO PPT PROC PRINTTO %
MACRO INCC INPUT @1 CC $CHAR1. @ %
MACRO INL L=L-1, INPUT @2 LINE $VARYING64. L %
MACRO PUTL PUT LINE $CHAR64. %
MACRO INBV RETAIN BYVAR,
    IF CC='1' THEN INPUT #3 @2 BYVAR= @ %

1. SUPPRESSING THE CARRIAGE CONTROL
Some heavily used procs have a rather low lines per page ratio. For example, Proc GLM with a one way analysis of covariance and means will print less than 50 lines of output on 3 pages. Since the page size is usually about 60, the output will fit on one page. The code in example 1 takes the output from each GLM and prints the result on one page for each level of the by variable. Figure 1 displays the result.

A sensible addition to the program would be to count the number of lines per page (from a Proc) and print a new page only when there is not enough room (determined from the linesleft option on a print file). This is a useful way for handling procs such as Proc Freq, where the number of lines printed varies from a few to many, and the page breaks are unimportant. Figure 2 displays the results from a program similar to example 1.

2. REORDERING THE OUTPUT
Reading SAS generated output with Proc Printto as above and locating and reading the by variable which produced the page, the output can be sorted before printing, giving the effect of a global by statement.

The code in example 2 produces GLM output on one page followed by a page of standard Univariate output.

3. ENHANCING THE OUTPUT
By reading the output as before and merging a data set with user generated statistics, it is possible to make useful additions to SAS procs. Example 3 consists of Proc Univariate output with trimmed means added to each page.

Figure 3 contains output from this program. Similar programs which have proved useful add outlier tests or Winzorized statistics to each Univariate output, tests of assumptions and pairwise comparisons (other than those available) to GLM, or exact RxC contingency tables to Freq.
4. COMpressing the output

SAS output can usually be printed on 64 character lines without increasing the number of pages printed. The method is similar to that described in example #2, but merging rather than interleaving the output. The resulting data set contains one analysis on each side of the page. Figures 4, 4a and 5 display this technique. Figure 6 contains ten pages of Freq output, produced by a similar program. Example 4 contains the source code for Figure 5.

Examples of this side-by-side output that have proved particularly useful are

\begin{verbatim}
GLM next to a print of cell means
GLM * plot * *
GLM * GLM of transformed data
GLM * Univariate on residuals
Freq * Freq
\end{verbatim}

Taking this one step further, one can design programs to take selected lines or pages from SAS procs and print them as you wish. The following example contains the essential output from 6 GLM's (an analysis of variance with lmeans, test of homogeneity of slopes and an analysis of covariance with lmeans, for one and two way models). The reduction in output is considerable, from fourteen pages to one page.

5. Re-routing the output

Output from SAS can be sent to other devices, for example a plotter (useful for making slides). Example 5 contains code to read the output from GLM and write TELAGRAF commands, which are executed through Proc Tag and the Run statement.

REFERENCES


* Example #1 - Suppressing the carriage control *

* PPTN; PROC GLM; BY BYVAR; CLASS TRT; *
MODEL Y=X TRT / SS2;
LSMEANS TRT / PDIFF;
OUTPUT OUT=R RESIDUAL=R; PPT;
MACRO DSN _NULL * DSNIN; FILE PRINT; INCC; INL;

* Example #2 - Reordering output *

* PPTN; PROC GLM; BY BYVAR; CLASS TRT; *
MODEL Y=X TRT / SS2;
LSMEANS TRT / PDIFF;
OUTPUT OUT=R RESIDUAL=R; PPT;
MACRO DSN DS1 % DSNIN; INCC; INBV;
RETAIN BYVAR; INL; DS=1;
DATA NULL; FILE PRINT;
SET DS1 DS2; BY BYVAR DS;
IF FIRST.DS THEN PUT _PAGE_; PUT;

* Example #3 - Enhancing output *

* PPTN; PROC UNIVARIATE; BY BYVAR; *
VAR Y; ID REP; OUTPUT OUT=N KEEP=BYVAR N=N; PPT;
MACRO DSN OP % DSNIN; INCC; INBV; INL;
DATA DATA; MERGE DATA N; BY BYVAR;
ARRAY S(J) S1-S5; IF FIRST.BYVAR THEN I=0; I=1; DO J=1 TO 5;
IF NOT((N*(J-1)/40<=N*(41-J)/40)
THEN S=; ELSE S=Y; END;
PROC MEANS NOPRINT DATA=DATA; BY BYVAR;
VAR S1-S5; OUTPUT OUT=TRIM N=N1-N5 MEAN=M1-M5 STD=S1-S5;
DATA _NULL_; FILE PRINT LL=LL;
MERGE OP TRIM, BY BYVAR; IF FIRST.BYVAR THEN PUT PAGE_; PUTL;
IF LAST.BYVAR THEN DO, PUT / @25 'TRIMMED MEANS' /,
DO P=0 TO 20 BY 5,
C=P*2+10; PUT @C P 8.% @10 (M1-M5) (10.2) / @5 'MEAN' @10 (S1-S5) (10.2) , END;

* Example #4 - Side by side *

* PPTN; PROC GLM; BY BYVAR; CLASS TRT; *
MODEL Y=TRT|BLK / HREF=0; PPT;
PROC MEANS NOPRINT DATA=DATA; BY BYVAR;
VAR Y; OUTPUT OUT=MEAN MEAN=MEAN;

* Example #5 - suppress printing of the TRIMMED MEANS & BYVAR *

MACRO READO DSNIN; INCC; IF CC='1'
THEN DO; C+1; P=MOD(C-1,WP)+1;
IF P>SP THEN I=0; INBV; END;
RETAIN P; I=1; INL; LC; *
PPTN; PROC GLM; BY BYVAR; CLASS TRT BLK; *
MODEL Y=TRT|BLK / SS2;
LSMEANS TRT / PDIFF;
OUTPUT OUT=RES RESIDUAL=RES; PPT;
MACRO DSN _NULL * DSNIN; FILE PRINT; INCC; INL;

MACRO DSN LEFT % MACRO LINE LEFT %
MACRO DSN LEFT % MACRO LINE LEFT %
MACRO LC IF 2-P=3 % READO;
PROC MEANS NOPRINT DATA=DATA; BY BYVAR;
TRT BLK;VAR Y;OUTPUT OUT=MEAN MEAN=MEAN;
PPTN; PROC PLOT DATA=MEAN; BY BYVAR;
PLOT MEAN*BLK=TRT / HREF=0; PPT;
* EXAMPLE 5 - MANY GLMS PER PAGE *

MACRO MACGLM PPTN; PROC GLM DATA=DATA;
   CLASS T B; MODEL Y = MDL / SS3;
   LSMEANS T / PDIFF; PPT;
   DSNIN; INCC; IF CC='1' THEN DO, PC+1;
   MACRO MACGLM;
   MACRO LC PG=2 & (I=10 I=13), %
   MACRO MDL T X X*T % MACRO ANEQ 2 %
   MACRO LC PG=2 & (I=10 | I=15),
   MACRO MDL TIB X X*T*B % MACRO ANEQ 3 %
   MACRO LC 2<=PG<=3 % MACGLM:
   MACRO MDL TIB % MACRO ANEQ 1 %
   MACRO PDS LDS % MACRO LINE LDS %
   MACR T TRT % MACRO B BLK %
   DATA LDS RDS; BYVAR=.; PG=.; AN=.; 1=.;
   PG=MOD{PC-1,3)+1; RETAIN PG; 1=0, INBV,
   MACRO T TRT % MACRO B BLK %
   DATA NULL ; FILE PRINT LL=LL;
   IF FIRST.BYVAR THEN PUT PAGE 7
   IF LAST.BYVAR THEN DO WHILE(LL>1),
   IF FIRST.BYVAR THEN PUT PAGE,}

* EXAMPLE 6 - RE-ROUTING THE OUTPUT *

PPTN; PROC GLM; BY VAR; CLASS TRT;
   MODEL Y=X TRT / SS2; PPT;
   MACRO DSN INP %
   DSNIN; INCC; INLV; DUMMY=1;
   DATA NULL ; FILE SASH; SET INP;
   BY DUMMY BYVAR; IF FIRST.BYVAR THEN PUT "PROC TAG; BY BYVAR; /PARMCARDS;","IF FIRST.BYVAR THEN PUT "GEN PAGE;="/WINDOW 1. 7.5 1. 10.="/ "TB 1 STYLE TRIPLEX, TEXT", PPT;
   IF LAST.BYVAR THEN PUT ";" / "GO."; RUN;
   // DD DSN=*,SASIN,DISP=(OLD,DELETE),
   // UNIT=DISK, VOLREF=*.SASIN

FIGURE 41
SUPPRESSING THE CARRIAGE CONTROL - ONE PAGE FOR GLM OUTPUT
BYVAR=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE Y

SOURCE | DF | SUM OF SQUARES | MEAN SQUARE
------- | --- | ---------------- | ---------------
MODEL | 3  | 7405.41452418 | 2468.47150066
ERROR | 299 | 296.04624401 | 1.00016299
CORRECTED TOTAL | 299 | 7701.46276818 |

MODEL F = 2468.07
PR > F = 0.0001

R-SQUARE C. V. | STD DEV | Y MEAN
------ | ------- | -------
0.940159 | 234.16290 | 1.000008149 | 0.42716450

SOURCE | DF | TYPE II SS | F VALUE | PR > F
------- | --- | ---------- | -------- | -------
X | 1 | 7341.57520170 | 7340.38 | 0.0001
TRT | 5 | 35770.9855 | 0.1573 | 0.9604824401

BYVAR=1

GENERAL LINEAR MODELS PROCEDURE

LEAST SQUARES MEANS

TRT | Y | FPROB > F | HTYPE(1)=LH: HMEAN(J1)
----- | --- | ---------- | --------
1 | 0.4072700X | 0.4003 | 0.7261
2 | 0.3187250X | 0.2403 | 0.2612
3 | 0.35741105 | 0.7261 | 0.2612

NOTE: TO ENSURE OVERALL PROTECTION LEVEL, ONLY PROBABILITIES ASSOCIATED WITH PRE-PLANNED COMPARISONS SHOULD BE USED.

FIGURE 42
LOTS OF FREQUENCIES

BYVAR=1

TABLE OF LEVEL BY TRT

LEVEL | TRT | 1 | 2 | 3 | TOTAL
------- | --- | --- | --- | --- | -------
0 | 31 | 47 | 33 | 151
1 | 51 | 47 | 53 | 149
TOTAL | 100 | 100 | 100 | 300

BYVAR=2

TABLE OF LEVEL BY TRT

LEVEL | TRT | 1 | 2 | 3 | TOTAL
------- | --- | --- | --- | --- | -------
0 | 49 | 61 | 46 | 151
1 | 57 | 30 | 54 | 149
TOTAL | 100 | 100 | 100 | 300

BYVAR=3

TABLE OF LEVEL BY TRT

LEVEL | TRT | 1 | 2 | 3 | TOTAL
------- | --- | --- | --- | --- | -------
0 | 49 | 41 | 35 | 124
1 | 57 | 46 | 55 | 158
TOTAL | 100 | 100 | 100 | 300

BYVAR=4

TABLE OF LEVEL BY TRT

LEVEL | TRT | 1 | 2 | 3 | TOTAL
------- | --- | --- | --- | --- | -------
0 | 49 | 41 | 35 | 124
1 | 57 | 46 | 55 | 158
TOTAL | 100 | 100 | 100 | 300
**FIGURE #3**
ENHANCED OUTPUT

<table>
<thead>
<tr>
<th>VARIABLE-Y</th>
<th>BYVAR=1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>MOMENTS</th>
<th>N = 300</th>
<th>SUM WRTS = -200</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>-0.324529</td>
<td>SUM</td>
</tr>
<tr>
<td>STD DEV</td>
<td>0.35952687</td>
<td>VARIANCE</td>
</tr>
<tr>
<td>SKEWNESS</td>
<td>-0.5165</td>
<td>KURTOSIS</td>
</tr>
<tr>
<td>UGS</td>
<td>8011.94</td>
<td>CSS</td>
</tr>
<tr>
<td>CV</td>
<td>-1.2929</td>
<td>STD MEAN</td>
</tr>
<tr>
<td>M</td>
<td>-1.08803</td>
<td>PRODRT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QUANTILES</th>
<th>100% MAX</th>
<th>14.2462</th>
<th>99%</th>
<th>10.8808</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>4.207971</td>
<td>75%</td>
<td>4.207971</td>
<td></td>
</tr>
<tr>
<td>50% MEAN</td>
<td>-0.324529</td>
<td>50%</td>
<td>-0.324529</td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td>-0.5165</td>
<td>25%</td>
<td>-0.5165</td>
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</tr>
<tr>
<td>MIN</td>
<td>-1.2929</td>
<td>MIN</td>
<td>-1.2929</td>
<td></td>
</tr>
<tr>
<td>RANGE</td>
<td>28.5935</td>
<td>RANGE</td>
<td>28.5935</td>
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</tr>
<tr>
<td>Q3-01</td>
<td>5.8733</td>
<td>Q3-01</td>
<td>5.8733</td>
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<tr>
<td>MODE</td>
<td>-1.08803</td>
<td>MODE</td>
<td>-1.08803</td>
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</tr>
</tbody>
</table>

**FIGURE #4**

<table>
<thead>
<tr>
<th>VARIABLE-RES</th>
<th>N = 300</th>
<th>SUM WRTS = -200</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>3.407E-16</td>
<td>SUM</td>
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<tr>
<td>STD DEV</td>
<td>4.99974</td>
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<td>SKEWNESS</td>
<td>-0.544326</td>
<td>KURTOSIS</td>
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<tr>
<td>UGS</td>
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<tr>
<td>CV</td>
<td>1.467E+10</td>
<td>STD MEAN</td>
</tr>
<tr>
<td>T MEAN</td>
<td>19.7817</td>
<td>PRODRT</td>
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</tbody>
</table>

<table>
<thead>
<tr>
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<th>11.9163</th>
<th>99%</th>
<th>11.1351</th>
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<tbody>
<tr>
<td>90%</td>
<td>3.25615</td>
<td>90%</td>
<td>3.25615</td>
<td></td>
</tr>
<tr>
<td>50% MEAN</td>
<td>0.155254</td>
<td>50%</td>
<td>0.155254</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>-0.67786</td>
<td>10%</td>
<td>-0.67786</td>
<td></td>
</tr>
<tr>
<td>MIN</td>
<td>-10.7017</td>
<td>MIN</td>
<td>-10.7017</td>
<td></td>
</tr>
<tr>
<td>RANGE</td>
<td>22.6981</td>
<td>RANGE</td>
<td>22.6981</td>
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<tr>
<td>Q3-01</td>
<td>7.17094</td>
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<td>7.17094</td>
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<tr>
<td>MODE</td>
<td>-10.7017</td>
<td>MODE</td>
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</tr>
</tbody>
</table>

**GENERAL LINEAR MODELS PROCEDURE**

<table>
<thead>
<tr>
<th>TRT</th>
<th>Y PROB &gt; 1</th>
<th>NO LSMEAN(I) = LSMEAN(J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.16974124</td>
<td>0.1323</td>
</tr>
<tr>
<td>2</td>
<td>0.29461230</td>
<td>0.1323</td>
</tr>
<tr>
<td>3</td>
<td>0.30710944</td>
<td>0.1323</td>
</tr>
</tbody>
</table>

**NOTE:** TO ENSURE OVERALL PROTECTION LEVEL, ONLY PROBABILITIES ASSOCIATED WITH PRE-PLANNED COMPARISONS SHOULD BE USED.

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### Figure 4A

**OEM DESIGN PLOT OF CELL MEANS**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>2</td>
<td>150.3621574</td>
<td>75.1810785</td>
<td>0.005</td>
</tr>
<tr>
<td>BLK</td>
<td>4</td>
<td>34.3421404</td>
<td>8.5853357</td>
<td>0.014</td>
</tr>
<tr>
<td>TRT+BLK</td>
<td>8</td>
<td>198.9505956</td>
<td>24.8694495</td>
<td>0.008</td>
</tr>
</tbody>
</table>

**BYVAR-1**

**Figure 4A**

### Figure 4b

**OEM DESIGN PLOT OF MEAN+BLK SYMBOL IS VALUE OF TRY**

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>2</td>
<td>150.3621574</td>
<td>75.1810785</td>
<td>0.005</td>
</tr>
<tr>
<td>BLK</td>
<td>4</td>
<td>34.3421404</td>
<td>8.5853357</td>
<td>0.014</td>
</tr>
<tr>
<td>TRT+BLK</td>
<td>8</td>
<td>198.9505956</td>
<td>24.8694495</td>
<td>0.008</td>
</tr>
</tbody>
</table>

**BYVAR-1**

**Table 2**

### Two Way ANOVA

**GENERAL LINEAR MODELS PROCEDURE**

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>2</td>
<td>150.3621574</td>
<td>75.1810785</td>
<td>0.005</td>
</tr>
<tr>
<td>BLK</td>
<td>4</td>
<td>34.3421404</td>
<td>8.5853357</td>
<td>0.014</td>
</tr>
<tr>
<td>TRT+BLK</td>
<td>8</td>
<td>198.9505956</td>
<td>24.8694495</td>
<td>0.008</td>
</tr>
</tbody>
</table>

**Table 5**

### One Way ANOVA

**GENERAL LINEAR MODELS PROCEDURE**

<table>
<thead>
<tr>
<th>SOURCE</th>
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<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
<th>PR &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT</td>
<td>2</td>
<td>150.3621574</td>
<td>75.1810785</td>
<td>0.005</td>
</tr>
<tr>
<td>BLK</td>
<td>4</td>
<td>34.3421404</td>
<td>8.5853357</td>
<td>0.014</td>
</tr>
<tr>
<td>TRT+BLK</td>
<td>8</td>
<td>198.9505956</td>
<td>24.8694495</td>
<td>0.008</td>
</tr>
</tbody>
</table>
### Figure 6A

**Page Full of Freqs**

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>TRT</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEL</td>
<td>FREQUENCY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>TOTAL</td>
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<td>100</td>
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</tbody>
</table>

### Figure 7

**Plotting Output**

### General Linear Models Procedure

**Dependent Variable:** Y

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>SUM OF SQUARES</th>
<th>MEAN SQUARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODEL</td>
<td>3</td>
<td>7359.81548336</td>
<td>2449.68594464</td>
</tr>
<tr>
<td>ERROR</td>
<td>296</td>
<td>281.15960174</td>
<td>0.9485141</td>
</tr>
<tr>
<td>CORRECTED</td>
<td>293</td>
<td>7621.07150088</td>
<td></td>
</tr>
</tbody>
</table>

**Model F = 2575.81 with F = 0.0001**

**R-Square**: 0.945088
**C.V.**: 5.07008
**STD DEV**: 0.117480321
**Y MEAN**: 0.0710

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>DF</th>
<th>TYPE I SS</th>
<th>F VALUE</th>
<th>PR</th>
<th>F</th>
</tr>
</thead>
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<td>7332.7527223</td>
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</tr>
</tbody>
</table>

**Least Squares Means**

<table>
<thead>
<tr>
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<th>2</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>1</td>
<td>2</td>
<td>3</td>
</tr>
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<td>-0.14891245</td>
<td>2</td>
<td>0.6257</td>
<td>0.0516</td>
</tr>
<tr>
<td>3</td>
<td>-0.4736950</td>
<td>3</td>
<td>0.0957</td>
<td>0.0518</td>
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</tbody>
</table>

**Note:** To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

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