GLIMMPSE Validation Report:

GLMM(F) Example 9 MB: Power for a multivariate model with two within subject factors, using the Muller and Barton approximation

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1. Introduction

The following report contains validation results for the JavaStatistics library, a component of the GLIMMPSE software system. For more information about GLIMMPSE and related publications, please visit

http://samplesizeshop.org.

The automated validation tests shown below compare power values produced by the JavaStatistics library to published results and also to simulation. Sources for published values include POWERLIB (Johnson *et al.* 2007) and a SAS IML implementation of the methods described by Glueck and Muller (2003).

Validation results are listed in Section 3 of the report. Timing results show the calculation and simulation times for the overall experiment and the mean times per power calculation. Summary statistics show the maximum absolute deviation between the power value calculated by the JavaStatistics library and the results obtained from SAS or via simulation. The table in Section 3.3 shows the deviation values for each individual power comparison. Deviations larger than 10^{-6} from SAS power values and 0.05 for simulated power values are displayed in red.

2. Study Design

The study design in Example 9 is a one sample design with two within participant factors. We calculate power for a test of the trend by trend interaction of the two within participant factors. The design is based on an example from

Coffey, C. S., & Muller, K. E. (2003). Properties of internal pilots with the univariate approach to repeated measures. *Statistics in Medicine*, *22*(15), 2469-2485.

The power calculations use the approximation method described in

Muller, K. E., & Barton, C. N. (1989). Approximate Power for Repeated-Measures ANOVA Lacking Sphericity. *Journal of the American Statistical Association*, *84*(406), 549-555.

2.1. Inputs to the Power Calculation

2.1.1. List Inputs

Type I error rates

0.0400000

Beta scale values

1.0000000

Sigma scale values

0.5000000, 1.0000000, 2.0000000

Per group sample size values

20

Statistical tests

UNIREP-HF

Power methods

cond

2.1.2. Matrix Inputs

$$\underset{(1\times 1)}{\text{Es}\,(\mathbf{X})} = \begin{bmatrix}1.0000\end{bmatrix}$$

$$\underset{(1\times 9)}{\mathbf{B}} = \begin{bmatrix}0.1133 & 0.0714 & -0.1848 & -0.1848 & 0.1133 & 0.0714 & 0.0714 & -0.1848 & 0.1133\end{bmatrix}$$

$$\underset{(1\times 1)}{\mathbf{C}} = \begin{bmatrix}1.0000\end{bmatrix}$$

$$\underset{(9\times 4)}{\mathbf{U}} = \begin{bmatrix}0.4364 & -0.2520 & -0.3780 & 0.2182\\ -0.0000 & 0.5040 & 0.0000 & -0.4364\\ -0.4364 & -0.2520 & 0.3780 & 0.2182\\ 0.1091 & -0.0630 & 0.5669 & -0.3273\\ -0.0000 & 0.1260 & -0.0000 & 0.6547\\ -0.1091 & -0.0630 & -0.5669 & -0.3273\\ -0.5455 & 0.3150 & -0.1890 & 0.1091\\ 0.0000 & -0.6299 & 0.0000 & -0.2182\\ 0.5455 & 0.3150 & 0.1890 & 0.1091\end{bmatrix}$$

$$\underset{(1\times 4)}{\mathbf{\Theta}_0} = \begin{bmatrix}0.0000 & 0.0000 & 0.0000 & 0.0000\end{bmatrix}$$

$$\underset{(9\times 9)}{\mathbf{\Sigma}_E} = \begin{bmatrix}0.1451 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.1451 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.1451 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.1451 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.1451 & 0.0177 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.1451 & 0.0177 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.1451 & 0.0177 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.1451 & 0.0177\\ 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.0177 & 0.1451\end{bmatrix}$$

3. Validation Results

A total of 48 power values were computed for this experiment.

3.1. Timing

	Total Time (seconds)	Mean Time (seconds)
Calculation	0.0000000	0.00E0
Simulation	29.2660000	6.10E-1

3.2. Summary Statistics

Max deviation from SAS	0.00000066
Max deviation from simulation	0.23161151

3.3. Full Validation Results

Power	SAS Power (deviation)	Sim Power (deviation)	Test	Sigma Scale	Beta Scale	Total N	Alpha
0.9755461	0.9755459 (0.0000002)	1.0000000 (0.0244539)	UNIREP	0.5000000	1.0000000	20	0.0400000
0.8220355	0.8220351 (0.0000004)	0.9986000 (0.1765645)	UNIREP	1.0000000	1.0000000	20	0.0400000
0.5739885	0.5739884 (0.0000001)	0.8056000 (0.2316115)	UNIREP	2.0000000	1.0000000	20	0.0400000
0.9968596	0.9968593 (0.0000003)	1.0000000 (0.0031404)	UNIREP	0.5000000	1.0000000	20	0.0400000
0.9127127	0.9127121 (0.0000005)	0.9903000 (0.0775873)	UNIREP	1.0000000	1.0000000	20	0.0400000
0.6554971	0.6554966 (0.0000004)	0.7849000 (0.1294029)	UNIREP	2.0000000	1.0000000	20	0.0400000
0.9995247	0.9995246 (0.0000001)	1.0000000 (0.0004753)	UNIREP	0.5000000	1.0000000	20	0.0400000
0.9528973	0.9528971 (0.0000002)	0.9821000 (0.0292027)	UNIREP	1.0000000	1.0000000	20	0.0400000
0.7061649	0.7061644 (0.0000005)	0.7551000 (0.0489351)	UNIREP	2.0000000	1.0000000	20	0.0400000
0.9999568	0.9999568 (0.0000001)	0.9999000 (0.0000568)	UNIREP	0.5000000	1.0000000	20	0.0400000
0.9778899	0.9778897 (0.0000003)	0.9751000 (0.0027899)	UNIREP	1.0000000	1.0000000	20	0.0400000

0.7541645	0.7541643 (0.0000002)	0.7531000 (0.0010645)	UNIREP	2.0000000	1.0000000	20	0.0400000
0.9103656	0.9103654 (0.0000002)	0.9995000 (0.0891344)	UNIREP-BOX	0.5000000	1.0000000	20	0.0400000
0.6267811	0.6267807 (0.0000004)	0.8388000 (0.2120189)	UNIREP-BOX	1.0000000	1.0000000	20	0.0400000
0.3458915	0.3458912 (0.0000003)	0.3255000 (0.0203915)	UNIREP-BOX	2.0000000	1.0000000	20	0.0400000
0.9695016	0.9695013 (0.0000003)	0.9986000 (0.0290984)	UNIREP-BOX	0.5000000	1.0000000	20	0.0400000
0.7019812	0.7019806 (0.0000007)	0.8246000 (0.1226188)	UNIREP-BOX	1.0000000	1.0000000	20	0.0400000
0.3412523	0.3412518 (0.0000005)	0.3195000 (0.0217523)	UNIREP-BOX	2.0000000	1.0000000	20	0.0400000
0.9883927	0.9883926 (0.0000002)	0.9968000 (0.0084073)	UNIREP-BOX	0.5000000	1.0000000	20	0.0400000
0.7502004	0.7502001 (0.0000004)	0.7992000 (0.0489996)	UNIREP-BOX	1.0000000	1.0000000	20	0.0400000
0.3313736	0.3313734 (0.0000003)	0.3218000 (0.0095736)	UNIREP-BOX	2.0000000	1.0000000	20	0.0400000
0.9965295	0.9965293 (0.0000002)	0.9958000 (0.0007295)	UNIREP-BOX	0.5000000	1.0000000	20	0.0400000
0.7960583	0.7960581 (0.0000002)	0.7942000 (0.0018583)	UNIREP-BOX	1.0000000	1.0000000	20	0.0400000
0.3176937	0.3176933 (0.0000004)	0.3182000 (0.0005063)	UNIREP-BOX	2.0000000	1.0000000	20	0.0400000
0.9213799	0.9213793 (0.0000006)	0.9997000 (0.0783201)	UNIREP-GG	0.5000000	1.0000000	20	0.0400000
0.6522377	0.6522375 (0.0000002)	0.8691000 (0.2168623)	UNIREP-GG	1.0000000	1.0000000	20	0.0400000
0.3704682	0.3704680 (0.0000002)	0.3681000 (0.0023682)	UNIREP-GG	2.0000000	1.0000000	20	0.0400000
0.9908842	0.9908841 (0.0000001)	0.9999000 (0.0090158)	UNIREP-GG	0.5000000	1.0000000	20	0.0400000
0.8408832	0.8408831 (0.0000002)	0.9416000 (0.1007168)	UNIREP-GG	1.0000000	1.0000000	20	0.0400000
0.5188983	0.5188980 (0.0000004)	0.5727000 (0.0538017)	UNIREP-GG	2.0000000	1.0000000	20	0.0400000
0.9987207	0.9987205 (0.0000001)	1.0000000 (0.0012793)	UNIREP-GG	0.5000000	1.0000000	20	0.0400000
0.9183204	0.9183200 (0.0000004)	0.9574000 (0.0390796)	UNIREP-GG	1.0000000	1.0000000	20	0.0400000
0.6051993	0.6051989 (0.0000004)	0.6379000 (0.0327007)	UNIREP-GG	2.0000000	1.0000000	20	0.0400000

0.9999457	0.9999457 (0.0000000)	0.9998000 (0.0001457)	UNIREP-GG	0.5000000	1.0000000	20	0.0400000
0.9749046	0.9749042 (0.0000004)	0.9681000 (0.0068046)	UNIREP-GG	1.0000000	1.0000000	20	0.0400000
0.7371767	0.7371765 (0.0000003)	0.7101000 (0.0270767)	UNIREP-GG	2.0000000	1.0000000	20	0.0400000
0.9230438	0.9230432 (0.0000005)	0.9997000 (0.0766562)	UNIREP-HF	0.5000000	1.0000000	20	0.0400000
0.6562571	0.6562568 (0.0000002)	0.8691000 (0.2128429)	UNIREP-HF	1.0000000	1.0000000	20	0.0400000
0.3744612	0.3744611 (0.0000002)	0.3681000 (0.0063612)	UNIREP-HF	2.0000000	1.0000000	20	0.0400000
0.9924676	0.9924674 (0.0000002)	0.9999000 (0.0074324)	UNIREP-HF	0.5000000	1.0000000	20	0.0400000
0.8566829	0.8566828 (0.0000001)	0.9416000 (0.0849171)	UNIREP-HF	1.0000000	1.0000000	20	0.0400000
0.5451475	0.5451473 (0.0000003)	0.5727000 (0.0275525)	UNIREP-HF	2.0000000	1.0000000	20	0.0400000
0.9990824	0.9990822 (0.0000002)	1.0000000 (0.0009176)	UNIREP-HF	0.5000000	1.0000000	20	0.0400000
0.9318978	0.9318976 (0.0000002)	0.9574000 (0.0255022)	UNIREP-HF	1.0000000	1.0000000	20	0.0400000
0.6411050	0.6411047 (0.0000002)	0.6379000 (0.0032050)	UNIREP-HF	2.0000000	1.0000000	20	0.0400000
0.9999568	0.9999568 (0.0000001)	0.9998000 (0.0001568)	UNIREP-HF	0.5000000	1.0000000	20	0.0400000
0.9778899	0.9778897 (0.0000003)	0.9681000 (0.0097899)	UNIREP-HF	1.0000000	1.0000000	20	0.0400000
0.7541645	0.7541643 (0.0000002)	0.7101000 (0.0440645)	UNIREP-HF	2.0000000	1.0000000	20	0.0400000

References

Glueck, D. H., & Muller, K. E. (2003). Adjusting power for a baseline covariate in linear models. *Statistics in Medicine*, *22*(16), 2535-2551.

Johnson, J. L., Muller, K. E., Slaughter, J. C., Gurka, M. J., & Gribbin, M. J. (2009). POWERLIB: SAS/IML Software for Computing Power in Multivariate Linear Models. *Journal of Statistical Software*, *30*(5), 1-27.

Muller, K. E., & Stewart, P. W. (2006). Linear model theory: univariate, multivariate, and mixed models. Hoboken, New Jersey: John Wiley and Sons.