

GLIMMPSE Validation Report:

GLMM(F) Example 3. Power for a two sample t-test for various sample sizes and mean differences

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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 for Example 3 is a balanced, two sample design with a single response variable. We calculate power for a two-sample t-test comparing the mean responses between the two independent groups. The example demonstrates changes in power with different sample sizes and mean differences.

2.1. Inputs to the Power Calculation

2.1.1. List Inputs

Type I error rates

0.0100000

Beta scale values

0.0000000, 0.0500000, 0.1000000, 0.1500000, 0.2000000, 0.2500000, 0.3000000, 0.3500000, 0.4000000, 0.4500000, 0.5000000, 0.5500000, 0.6000000, 0.6500000, 0.7000000

Sigma scale values

1.0000000

Per group sample size values

3, 6, 9, 12, 15, 18

Statistical tests

UNIREP

Power methods

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2.1.2. Matrix Inputs

$$E_s(\mathbf{X})_{(2 \times 2)} = \begin{bmatrix} 1.0000 & 0.0000 \\ 0.0000 & 1.0000 \end{bmatrix}$$

$$\mathbf{B}_{(2 \times 1)} = \begin{bmatrix} 0.0000 \\ 0.7000 \end{bmatrix}$$

$$\mathbf{C}_{(1 \times 2)} = [1.0000 \quad -1.0000]$$

$$\mathbf{U}_{(1 \times 1)} = [1.0000]$$

$$\Theta_0_{(1 \times 1)} = [0.0000]$$

$$\Sigma_E_{(1 \times 1)} = [0.0680]$$

3. Validation Results

A total of 90 power values were computed for this experiment.

3.1. Timing

	Total Time (seconds)	Mean Time (seconds)
Calculation	0.0160000	1.78E-4
Simulation	15.2870000	1.70E-1

3.2. Summary Statistics

Max deviation from SAS	0.00000090
Max deviation from simulation	0.01038172

3.3. Full Validation Results

Power	SAS Power (deviation)	Sim Power (deviation)	Test	Sigma Scale	Beta Scale	Total N	Alpha
0.0100000	0.0100000 (0.0000000)	0.0103000 (0.0003000)	UNIREP	1.0000000	0.0000000	6	0.0100000
0.0100000	0.0100000 (0.0000000)	0.0101000 (0.0001000)	UNIREP	1.0000000	0.0000000	12	0.0100000
0.0100000	0.0100000 (0.0000000)	0.0093000 (0.0007000)	UNIREP	1.0000000	0.0000000	18	0.0100000
0.0100000	0.0100000 (0.0000000)	0.0104000 (0.0004000)	UNIREP	1.0000000	0.0000000	24	0.0100000
0.0100000	0.0100000 (0.0000000)	0.0098000 (0.0002000)	UNIREP	1.0000000	0.0000000	30	0.0100000
0.0100000	0.0100000 (0.0000000)	0.0092000 (0.0008000)	UNIREP	1.0000000	0.0000000	36	0.0100000
0.0109613	0.0109613 (0.0000000)	0.0115000 (0.0005387)	UNIREP	1.0000000	0.0500000	6	0.0100000
0.0130375	0.0130373 (0.0000002)	0.0132000 (0.0001625)	UNIREP	1.0000000	0.0500000	12	0.0100000
0.0152206	0.0152197 (0.0000009)	0.0133000 (0.0019206)	UNIREP	1.0000000	0.0500000	18	0.0100000
0.0174724	0.0174724 (0.0000000)	0.0156000 (0.0018724)	UNIREP	1.0000000	0.0500000	24	0.0100000
0.0197915	0.0197914 (0.0000001)	0.0180000 (0.0017915)	UNIREP	1.0000000	0.0500000	30	0.0100000
0.0221759	0.0221757 (0.0000002)	0.0244000 (0.0022241)	UNIREP	1.0000000	0.0500000	36	0.0100000
0.0139076	0.0139075 (0.0000001)	0.0130000 (0.0009076)	UNIREP	1.0000000	0.1000000	6	0.0100000
0.0229461	0.0229460 (0.0000000)	0.0221000 (0.0008461)	UNIREP	1.0000000	0.1000000	12	0.0100000
0.0331771	0.0331768 (0.0000003)	0.0292000 (0.0039771)	UNIREP	1.0000000	0.1000000	18	0.0100000
0.0443930	0.0443929 (0.0000000)	0.0412000 (0.0031930)	UNIREP	1.0000000	0.1000000	24	0.0100000
0.0565227	0.0565226 (0.0000002)	0.0533000 (0.0032227)	UNIREP	1.0000000	0.1000000	30	0.0100000
0.0695035	0.0695031 (0.0000004)	0.0704000 (0.0008965)	UNIREP	1.0000000	0.1000000	36	0.0100000
0.0190199	0.0190197 (0.0000002)	0.0190000 (0.0000199)	UNIREP	1.0000000	0.1500000	6	0.0100000
0.0419563	0.0419560 (0.0000002)	0.0421000 (0.0001437)	UNIREP	1.0000000	0.1500000	12	0.0100000

0.0699877	0.0699876 (0.0000001)	0.0675000 (0.0024877)	UNIREP	1.0000000	0.1500000	18	0.0100000
0.1020538	0.1020532 (0.0000005)	0.0982000 (0.0038538)	UNIREP	1.0000000	0.1500000	24	0.0100000
0.1374104	0.1374103 (0.0000001)	0.1349000 (0.0025104)	UNIREP	1.0000000	0.1500000	30	0.0100000
0.1753562	0.1753558 (0.0000004)	0.1748000 (0.0005562)	UNIREP	1.0000000	0.1500000	36	0.0100000
0.0265787	0.0265785 (0.0000003)	0.0256000 (0.0009787)	UNIREP	1.0000000	0.2000000	6	0.0100000
0.0732277	0.0732270 (0.0000007)	0.0752000 (0.0019723)	UNIREP	1.0000000	0.2000000	12	0.0100000
0.1331028	0.1331024 (0.0000005)	0.1302000 (0.0029028)	UNIREP	1.0000000	0.2000000	18	0.0100000
0.2015335	0.2015333 (0.0000002)	0.1982000 (0.0033335)	UNIREP	1.0000000	0.2000000	24	0.0100000
0.2747581	0.2747580 (0.0000001)	0.2768000 (0.0020419)	UNIREP	1.0000000	0.2000000	30	0.0100000
0.3495674	0.3495672 (0.0000003)	0.3532000 (0.0036326)	UNIREP	1.0000000	0.2000000	36	0.0100000
0.0369347	0.0369344 (0.0000004)	0.0360000 (0.0009347)	UNIREP	1.0000000	0.2500000	6	0.0100000
0.1199876	0.1199875 (0.0000001)	0.1221000 (0.0021124)	UNIREP	1.0000000	0.2500000	12	0.0100000
0.2272459	0.2272458 (0.0000002)	0.2230000 (0.0042459)	UNIREP	1.0000000	0.2500000	18	0.0100000
0.3435774	0.3435773 (0.0000001)	0.3460000 (0.0024226)	UNIREP	1.0000000	0.2500000	24	0.0100000
0.4580674	0.4580670 (0.0000004)	0.4580000 (0.0000674)	UNIREP	1.0000000	0.2500000	30	0.0100000
0.5635183	0.5635181 (0.0000001)	0.5739000 (0.0103817)	UNIREP	1.0000000	0.2500000	36	0.0100000
0.0504714	0.0504709 (0.0000005)	0.0483000 (0.0021714)	UNIREP	1.0000000	0.3000000	6	0.0100000
0.1844119	0.1844115 (0.0000004)	0.1872000 (0.0027881)	UNIREP	1.0000000	0.3000000	12	0.0100000
0.3502150	0.3502145 (0.0000005)	0.3463000 (0.0039150)	UNIREP	1.0000000	0.3000000	18	0.0100000
0.5120327	0.5120324 (0.0000003)	0.5151000 (0.0030673)	UNIREP	1.0000000	0.3000000	24	0.0100000
0.6507801	0.6507800 (0.0000002)	0.6505000 (0.0002801)	UNIREP	1.0000000	0.3000000	30	0.0100000
0.7598767	0.7598763 (0.0000004)	0.7638000 (0.0039233)	UNIREP	1.0000000	0.3000000	36	0.0100000

0.0675635	0.0675628 (0.0000007)	0.0652000 (0.0023635)	UNIREP	1.0000000	0.3500000	6	0.0100000
0.2665117	0.2665109 (0.0000008)	0.2718000 (0.0052883)	UNIREP	1.0000000	0.3500000	12	0.0100000
0.4911063	0.4911062 (0.0000001)	0.4887000 (0.0024063)	UNIREP	1.0000000	0.3500000	18	0.0100000
0.6781323	0.6781316 (0.0000007)	0.6752000 (0.0029323)	UNIREP	1.0000000	0.3500000	24	0.0100000
0.8104911	0.8104907 (0.0000003)	0.8093000 (0.0011911)	UNIREP	1.0000000	0.3500000	30	0.0100000
0.8946312	0.8946310 (0.0000001)	0.8955000 (0.0008688)	UNIREP	1.0000000	0.3500000	36	0.0100000
0.0885341	0.0885339 (0.0000001)	0.0857000 (0.0028341)	UNIREP	1.0000000	0.4000000	6	0.0100000
0.3634450	0.3634447 (0.0000002)	0.3686000 (0.0051550)	UNIREP	1.0000000	0.4000000	12	0.0100000
0.6328414	0.6328411 (0.0000003)	0.6297000 (0.0031414)	UNIREP	1.0000000	0.4000000	18	0.0100000
0.8144004	0.8144001 (0.0000002)	0.8093000 (0.0051004)	UNIREP	1.0000000	0.4000000	24	0.0100000
0.9148963	0.9148958 (0.0000005)	0.9156000 (0.0007037)	UNIREP	1.0000000	0.4000000	30	0.0100000
0.9638164	0.9638163 (0.0000002)	0.9651000 (0.0012836)	UNIREP	1.0000000	0.4000000	36	0.0100000
0.1136191	0.1136189 (0.0000002)	0.1100000 (0.0036191)	UNIREP	1.0000000	0.4500000	6	0.0100000
0.4696002	0.4695997 (0.0000005)	0.4774000 (0.0077998)	UNIREP	1.0000000	0.4500000	12	0.0100000
0.7581350	0.7581345 (0.0000006)	0.7561000 (0.0020350)	UNIREP	1.0000000	0.4500000	18	0.0100000
0.9074833	0.9074830 (0.0000003)	0.9033000 (0.0041833)	UNIREP	1.0000000	0.4500000	24	0.0100000
0.9687630	0.9687629 (0.0000001)	0.9666000 (0.0021630)	UNIREP	1.0000000	0.4500000	30	0.0100000
0.9904018	0.9904016 (0.0000001)	0.9912000 (0.0007982)	UNIREP	1.0000000	0.4500000	36	0.0100000
0.1429310	0.1429307 (0.0000003)	0.1394000 (0.0035310)	UNIREP	1.0000000	0.5000000	6	0.0100000
0.5775349	0.5775341 (0.0000008)	0.5803000 (0.0027651)	UNIREP	1.0000000	0.5000000	12	0.0100000
0.8555403	0.8555401 (0.0000002)	0.8559000 (0.0003597)	UNIREP	1.0000000	0.5000000	18	0.0100000
0.9604597	0.9604594 (0.0000004)	0.9599000 (0.0005597)	UNIREP	1.0000000	0.5000000	24	0.0100000

0.9907104	0.9907100 (0.0000004)	0.9897000 (0.0010104)	UNIREP	1.0000000	0.5000000	30	0.0100000
0.9980507	0.9980504 (0.0000003)	0.9987000 (0.0006493)	UNIREP	1.0000000	0.5000000	36	0.0100000
0.1764385	0.1764379 (0.0000006)	0.1733000 (0.0031385)	UNIREP	1.0000000	0.5500000	6	0.0100000
0.6795185	0.6795182 (0.0000003)	0.6800000 (0.0004815)	UNIREP	1.0000000	0.5500000	12	0.0100000
0.9221874	0.9221871 (0.0000003)	0.9214000 (0.0007874)	UNIREP	1.0000000	0.5500000	18	0.0100000
0.9855968	0.9855965 (0.0000003)	0.9849000 (0.0006968)	UNIREP	1.0000000	0.5500000	24	0.0100000
0.9977751	0.9977749 (0.0000002)	0.9970000 (0.0007751)	UNIREP	1.0000000	0.5500000	30	0.0100000
0.9996987	0.9996986 (0.0000001)	0.9998000 (0.0001013)	UNIREP	1.0000000	0.5500000	36	0.0100000
0.2139545	0.2139536 (0.0000009)	0.2094000 (0.0045545)	UNIREP	1.0000000	0.6000000	6	0.0100000
0.7691467	0.7691462 (0.0000005)	0.7699000 (0.0007533)	UNIREP	1.0000000	0.6000000	12	0.0100000
0.9623522	0.9623520 (0.0000003)	0.9621000 (0.0002522)	UNIREP	1.0000000	0.6000000	18	0.0100000
0.9955473	0.9955471 (0.0000002)	0.9952000 (0.0003473)	UNIREP	1.0000000	0.6000000	24	0.0100000
0.9995727	0.9995726 (0.0000001)	0.9995000 (0.0000727)	UNIREP	1.0000000	0.6000000	30	0.0100000
0.9999648	0.9999647 (0.0000001)	1.0000000 (0.0000352)	UNIREP	1.0000000	0.6000000	36	0.0100000
0.2551350	0.2551347 (0.0000003)	0.2510000 (0.0041350)	UNIREP	1.0000000	0.6500000	6	0.0100000
0.8424737	0.8424729 (0.0000007)	0.8451000 (0.0026263)	UNIREP	1.0000000	0.6500000	12	0.0100000
0.9836876	0.9836873 (0.0000003)	0.9833000 (0.0003876)	UNIREP	1.0000000	0.6500000	18	0.0100000
0.9988353	0.9988352 (0.0000001)	0.9992000 (0.0003647)	UNIREP	1.0000000	0.6500000	24	0.0100000
0.9999344	0.9999344 (0.0000001)	0.9998000 (0.0001344)	UNIREP	1.0000000	0.6500000	30	0.0100000
0.9999969	0.9999969 (0.0000000)	1.0000000 (0.0000031)	UNIREP	1.0000000	0.6500000	36	0.0100000
0.2994945	0.2994939 (0.0000006)	0.2967000 (0.0027945)	UNIREP	1.0000000	0.7000000	6	0.0100000
0.8983646	0.8983643 (0.0000003)	0.8994000 (0.0010354)	UNIREP	1.0000000	0.7000000	12	0.0100000

0.9936840	0.9936838 (0.0000002)	0.9933000 (0.0003840)	UNIREP	1.0000000	0.7000000	18	0.0100000
0.9997429	0.9997428 (0.0000002)	0.9997000 (0.0000429)	UNIREP	1.0000000	0.7000000	24	0.0100000
0.9999920	0.9999920 (0.0000001)	0.9999000 (0.0000920)	UNIREP	1.0000000	0.7000000	30	0.0100000
0.9999998	0.9999998 (0.0000000)	1.0000000 (0.0000002)	UNIREP	1.0000000	0.7000000	36	0.0100000



References

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