

This document contains screenshots for Homework 3, a multilevel study with a between independent sampling unit factor.

- Click the “New Study” button to start a new power and sample size analysis.
- Click the “Upload” button to upload a json file with a previous study design that you have saved.

◆ GLIMMPSE

General Linear Mixed Model Power and Sample Size

Design a Study

Welcome to GLIMMPSE. The GLIMMPSE software calculates power and sample size for study designs with normally distributed outcomes. Select one of the options below to begin a power or sample size calculation.

New Study

Start a new design.

Upload

You have previously used GLIMMPSE and wish to work on a saved design.

For a new study: Add title here

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Untitled Study: Study title

Progress  Help  Save  Home 

Please pick a concise title for the study:



Click the “Power” or “Sample Size” button depending on what you want to solve for.
In this case, we are solving for power.

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module3: Solve for

Progress ○ Help ? Save ↓ Home 🏠

Please indicate whether you would like to solve for power or total sample size.
If you have a rough idea of the number of research participants you will be able to recruit, then solve for power.
If you have few restrictions on recruitment then you may wish to solve for sample size.

Power Sample Size



We now move to select the hypothesis test of interest. Thus, we click the Hotelling-Lawley trace.

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module3: Statistical tests

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Please choose one or more statistical tests. If you are unsure which to pick, we recommend the Hotelling Lawley Trace test due to its equivalence to a mixed model test.

- Hotelling Lawley Trace
- Pillai-Bartlett Trace
- Wilks Likelihood Ratio
- Box Corrected
- Geisser-Greenhouse Corrected
- Huynh-Feldt Corrected
- Uncorrected



Now we choose the Type I error rate.

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module3: Type I error rates

Progress Help Save Home

A Type I error occurs when a scientist declares a difference when none is present in the population. The Type I error rate is the probability of that kind of error, a false positive, and is often referred to as α (alpha). A Type I error rate can range from 0 to 1. Although the most commonly used value is 0.05, we recommend 0.01.



Type I Error Rate
0.05

remove



Enter the information about the three outcome variables as shown below.

Enter the name of each outcome variable one at a time in the underlined space below. For example, in a study investigating cholesterol-lowering medication, the outcome variables could be HDL, LDL, and total cholesterol.

Note that repeated measurement information will be addressed on the next screen.

Please name the one or more outcomes.

Outcome	remove
grade	
lsk	
ctopp	



For this problem, we do not have repeated measures.

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module3: Repeated measures

Progress  Help  Save  Home 



GLIMMPSE allows you to define within-participant factors, specified as repeated measures. An independent sampling unit provides one or more observations such that observations from one unit are statistically independent from any other distinct unit while observations from the same unit may be correlated. Repeated measures are present when a response variable is measured on each independent sampling unit on two or more occasions or under two or more conditions. The values of the repeated measures (that is, the levels of the within-participant factors) distinguish the occasions or conditions.

If the study includes repeated measures, click "Add Repeated Measure" and follow the prompts.

You may specify up to 5 repeated measures. Each repeated measure you add will apply to each outcome you specified on the previous page.

Define Repeated Measure



Enter the independent sampling unit as shown below.

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module3: Clustering

Progress  Help  Save  Home 

What term would you like to use for the independent sampling unit in the study? (For example, school.)

All levels of clustering are nested within the independent sampling unit.

schools

Cancel

Next: Levels

Specify each level of clustering as shown below.

Name each level of clustering within the independent sampling unit, and specify the number of elements each level (e.g. level 1 class has 5 members; level 2 student has 22 members):

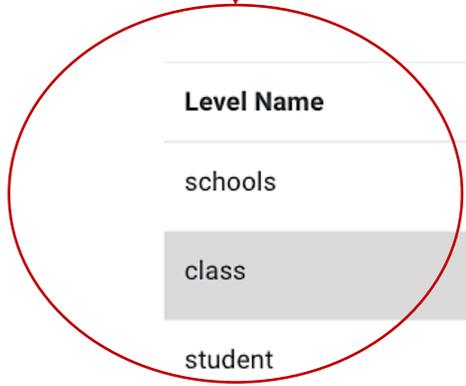
The sample size in this study is **N** schools(s).

Clustering level name:

Number of elements:

2

Elements must be an integer between 2 and 10000 (inclusive)



Level Name	No. Elements	Remove/Edit
schools	N schools(s) in study	
class	4 class(s) in each schools	
student	5 student(s) in each class	

Cancel Back **Update clustering**

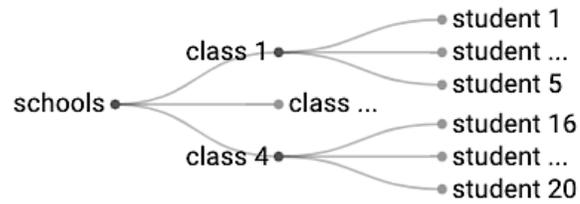
This screen shows a summary of the clustering structure.

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module3: Clustering

Progress  Help  Save  Home 



Levels of clustering within independent sampling unit schools:

Level Name	No. Elements
schools	N schools(s) in study
class	4 class(s) in each schools
student	5 student(s) in each class

[Remove Clustering](#) [Edit Clustering](#)

Enter fixed predictors here.

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module3: Fixed predictors

Progress  Help  Save  Home 

Please name the
predictor:

Cancel

Next: Data Type

This screen shows a summary of predictors (treatment) and groups (three literacy programs).

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module3: Fixed predictors

Progress  Help  Save  Home 



Each independent sampling unit has one or more observations which are statistically independent from observations from any other unit.

GLIMMPSE allows you to define fixed predictors which divide the independent sampling unit into groups. One common example of a fixed predictor is treatment, with values placebo and drug, for which the independent sampling unit is randomized to a placebo group or a drug group. Another is gender, with values male or female.

If the design has no fixed predictors, do not define any here.

Define Fixed Predictor

Fixed Predictors

Name	Type	Units	Groups	Remove	Edit
treat	NOMINAL		["abra", "ela", "bi"]		



Select the option "No Gaussian Covariate" for this example.



A common experimental design is an analysis of covariance, which includes one or more fixed predictors and one or more continuous control variables, the "covariates." For example, one might run an experiment with 10 males and 10 females, with an indicator variable for gender as a fixed predictor and age as a covariate.

A common special case uses a series of repeated measurements on a continuous outcome. The first measurement, observed prior to treatment, is used as a baseline covariate. The other repeated measurements are outcomes in the general linear multivariate model.

GLIMMPSE can calculate power for hypotheses concerning the fixed predictors, optionally controlling for a single normally distributed covariate. If you plan to include a single normally distributed covariate in your model, use the switch below.

At present, the GLIMMPSE software does not calculate power for multiple normally distributed covariates nor non-normally distributed covariates.

No Gaussian Covariate

Gaussian Covariate



Select the specific study hypothesis as shown below.

Each power or sample size calculation is based on selecting a specific study hypothesis. The options below show the hypotheses which are available for the current study design. Specify the hypothesis that represents your scientific question.

GLIMMPSE chooses sensible contrast matrices based on cell means coding. Should you wish to define your own contrast matrices, pick the highest order interaction and choose from the advanced options in the hypothesis components.

Select a hypothesis from the list.

Effects Available for Consideration	Nature of Variation
<input checked="" type="radio"/> treat: Main Effect	Between
<input type="radio"/> Grand Mean	Between

Specify means for:
Factors in Hypothesis All Factors



In this example, “All mean differences zero” was selected to indicate the type of contrast desired.

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module3: Between hypothesis

Progress  Help  Save  Home 

What type of contrast do you wish among the levels of the between predictors?

All mean differences zero

A parameter is a characteristic of a population. The parameters of interest are the group means.

The null hypothesis is that all pairwise differences between group means are the same.

Show Advanced Options

This screen gives you the option to select a value different than zero for the contrast comparison constant.

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module3: Theta 0

Progress  Help  Save  Home 



A hypothesis compares parameters to a constant, the contrast comparison constant, θ_0 . This is almost always zero. If you choose a value other than zero, be sure that you understand that the hypothesis you define is scientifically meaningful. Also note that the description and interpretation of your hypothesis given when choosing your contrasts will be affected.



Enter the smallest group size as shown.

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module3: Smallest group size

Progress  Help  Save  Home 

Enter the number of independent sampling units in the smallest group in the study. You may enter multiple values for the smallest group size in order to consider a range of total sample sizes.

If you wish to consider fractional group sizes, specify an appropriate integer here and use fractional relative group size values.

Would you like to add another smallest group size?

Smallest Group Size

15

remove



Enter 1 for the group size ratios to reflect equal group sizes.

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General Linear Mixed Model Power and Sample Size

module3: Group size ratios

Progress  Help  Save  Home 

For equal group sizes, input a "1" in the block next to each group. This is the default study design.

For unequal group sizes, specify the ratio of the group sizes. For example, consider a design with an active drug group and a placebo group. If twice as many study participants receive the placebo, a value of "2" would be selected for the placebo group, and a value of "1" would be selected for the active drug group.

Group size ratios

treat	abra	1
	ela	1
	bi	1



Enter the mean values for the outcome Group Reading Assessment and Diagnostic Evaluation (GRADE) within each group.

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General Linear Mixed Model Power and Sample Size

module3: Marginal means

Progress  Help  Save  Home 

The table below shows the mean values for outcome **grade** within each group in the study. Each group is represented by a row in the table.

Enter the mean values you expect to observe for outcome **grade** within each group. The table should contain at least one value that is non-zero. Also, at least two groups should have means which differ by a scientifically meaningful amount.

Expected mean values, per group, for *grade*

abra	0.3
ela	0.1
bi	0.1

Set blank values to

value

Enter the mean values for the outcome letter-sound knowledge (LSK) within each group.

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General Linear Mixed Model Power and Sample Size

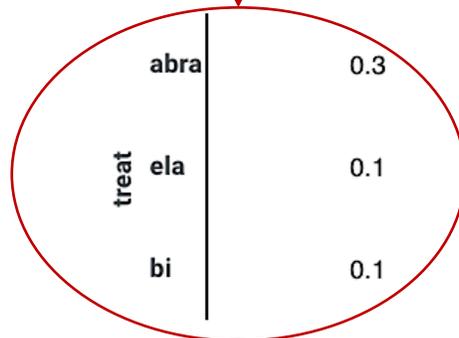
module3: Marginal means

Progress  Help  Save  Home 

The table below shows the mean values for outcome **lsk** within each group in the study. Each group is represented by a row in the table.

Enter the mean values you expect to observe for outcome **lsk** within each group. The table should contain at least one value that is non-zero. Also, at least two groups should have means which differ by a scientifically meaningful amount.

Expected mean values, per group, for *lsk*



abra	0.3
ela	0.1
bi	0.1

Set blank values to

value



Enter the mean values for the outcome Comprehensive Test of Phonological Processing (CTOPP) within each group.

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General Linear Mixed Model Power and Sample Size

module3: Marginal means

Progress  Help  Save  Home 

The table below shows the mean values for outcome **ctopp** within each group in the study. Each group is represented by a row in the table.

Enter the mean values you expect to observe for outcome **ctopp** within each group. The table should contain at least one value that is non-zero. Also, at least two groups should have means which differ by a scientifically meaningful amount.

Expected mean values, per group, for *ctopp*

abra	0.3
ela	0.1
bi	0.1

Set blank values to

value



Enter the scale factor for the means.

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General Linear Mixed Model Power and Sample Size

module3: Scale factor for the marginal means

Progress  Help  Save  Home 

In power analysis, it is not possible to know the exact values of means before the experiment is observed. Scale factors allow you to consider alternative values for the means by scaling the values entered on the previous screen.

For example, entering the scale factors 0.5, 1, and 2 would compute power for the mean values divided by 2, the mean values as entered, and the mean values multiplied by 2.

Enter a scale factor:

number > 0



Scale Factor

remove

1



Enter the standard deviation for each outcome.

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General Linear Mixed Model Power and Sample Size

module3: Variability across outcomes

Progress  Help  Save  Home 

Enter the standard deviation you expect to observe for each outcome.

Outcome	Standard Deviation
grade	4.4
lsk	4.2
ctopp	0.6



Enter the outcome correlation matrix.

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General Linear Mixed Model Power and Sample Size

module3: Outcome correlation

Progress  Help  Save  Home 

For a given research participant, responses vary across outcomes and across repeated measurements. The amount of variability can dramatically impact power and sample size.

Define the outcome correlation matrix, by entering correlations you expect to observe among the outcomes in the study:

outcome

grade	lsk	ctopp
1	0.9	0.2
0.9	1	0.4
0.2	0.4	1

(each off-diagonal correlation must be between -1 and 1, exclusive)



Enter the intra class correlation as shown below.

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module3: Intra-class correlation

Progress  Help  Save  Home 

Define the intra class correlation for cluster schools

The correlation within level **class** must be a number between $-0.333 < r < 1$

The correlation within level **student** must be a number between $-0.250 < r < 1$

0.11

0.04



Enter the scale factor for variability.

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module3: Scale factor variance

Progress  Help  Save  Home 

Changes in variability can dramatically affect power and sample size results. It is not possible to know the variability until the experiment is observed. Scale factors allow you to consider alternative values for variability by scaling the calculated covariance matrix. For example, entering the scale factors 0.5, 1, and 2 would compute power for the covariance matrix divided by 2, the covariance matrix as entered, and the covariance matrix multiplied by 2.

You may add up to 10 scale factors.

Choose a number greater than zero 

Scale Factor

remove

1





For this example, we don't need to specify the confidence intervals.

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General Linear Mixed Model Power and Sample Size

module3: Confidence intervals

Progress  Help  Save  Home 



If the means (\mathbf{B}) or the error covariance (Σ_e) are sample estimates, then the power values produced from these matrices will be random quantities. To account for this randomness, GLIMMPSE can calculate confidence intervals for power values using the techniques described by Taylor and Muller (1995), Gribbin et al. (2013), and Park (2007).



Include Confidence Intervals

When we hit the “Calculate” button, the results are shown in the power results table.

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General Linear Mixed Model Power and Sample Size

module3: Calculate

Progress  Help  Save  Home 

Calculate

Download result

Results Matrices Design

Design



Hypothesis



Design Dimensions



Parameters



Optional Specifications



We can save results and study design inputs by using the “Save” button.

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General Linear Mixed Model Power and Sample Size

module3: Calculate

Progress  Help  **Save**  Home 

Calculate

Download result

Results Matrices Design

Power	Total Sample Size	Means Scale Factor	Variability Scale Factor	Test	Power Method	Type I Error Rate
0.883	45	1	1	Hotelling Lawley Trace	conditional	0.05