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GLIMMPSE Domain Objects and Communication Layer

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Revision History

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| --- | --- | --- | --- |
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# Introduction

## Purpose of this document

This document describes the domain objects which are shared across software modules within the GLIMMPSE system. The domain objects represent subcomponents of research study designs, such as variable names, hypotheses, and associated matrices. This document describes the domain objects used in version 2.0.0 of the GLIMMPSE software system.

The domain objects are used to transmit information between the GLIMMPSE user interface and the web services layer. Objects are encoded in JSON and sent over HTTP. The objects also provide a convenient format for persisting study design information to a relational database.

The domain layer is implemented in the Web Services Common Library. The library is compatible with Google Web Toolkit based user interfaces, Android native applications, and Java applications such as servlets.

## Definitions, Acronyms, and Abbreviations

**JSON**1 - JavaScript Object Notation, is a lightweight text-based open standard designed for human-readable data interchange.

**AJAX** – asynchronous HTTP request. In this context, AJAX requests are issued to update the study design information with the Study Design Service, or to perform a matrix operation.

**Warfile** – web application archive file. This format is used to run web applications under Apache Tomcat.

**Google Web Toolkit**2 – A Google package for creating browser-independent web user interfaces

## References

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5. Glueck DH, Muller KE. Adjusting power for a baseline covariate in linear models. *Stat Med*. 2003;22(16):2535–2551.

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## Overview of the document

In Section 2, we describe the integration of the domain object layer and Web Services Common library into the GLIMMPSE software system. In Section 3, we detail each domain object.

# System Architecture Description

## Web Services Common Library

The domain object layer is defined in a Java shared library called Web Services Common. The library also contains utility routines for UUID handling and database interaction which are shared across multiple web services. Classes for each domain object are found in the edu.ucdenver.webservice.common.domain package.

The Web Services Common library is compiled into three jar files:

* edu.ucdenver.bios.webservice.common-*version*-jar
* edu.ucdenver.bios.webservice.common-gwt-*version*-jar
* edu.ucdenver.bios.webservice.common-android-*version*-jar

The first is designed for integration with Java Web Services, and the second for Google Web Toolkit projects, and the third for native Android applications.

## Integration with Java Web Services

The edu.ucdenver.bios.webservice.common-*version*-jar shared library for Web Services Common can be integrated with Java Web Services. For development, the file should be included in the Java classpath. For deployment, the library should be in the “libs” directory of the warfile.

## Integration with Google Web Toolkit

The edu.ucdenver.bios.webservice.common-gwt-*version*-jar shared library for Web Services Common can be integrated with a Google Web Toolkit project. Unlike a standard jar file, this jar includes both class files and Java source files. The Google Web Toolkit compiler requires the source files to facilitate translation of the classes into JavaScript.

For development, the jar should be included in the Java classpath. In addition, the module must be inherited in the gwt.xml file (see Google documentation for full details2) as follows

Figure 1. Example gwt.xml file including the Web Services Common module

<?xml version="1.0" encoding="UTF-8"?>

<module rename-to='*project*'>

<!-- Inherit the core Web Toolkit stuff. -->

<inherits name='com.google.gwt.user.User'/>

…

<!-- Other module inherits -->

<!-- UC Denver Web Service Common api -->

<inherits name="edu.ucdenver.bios.webservice.common.common"/>

<!-- Specify the app entry point class. -->

<entry-point class='*entry point class*'/>

…

</module>

# Module and Component Descriptions

## Component overview

The domain layer allows GLIMMPSE modules to communicate using a common object language. The objects described below are all Plain Old Java Objects (Pojos). Each object provides getter/setter methods for each field, although these are omitted from this document for clarity. Any additional methods are outlined for each object below.

Objects are transmitted between the GLIMMPSE user interface and the web services layer in JSON.

### The StudyDesign Object

The StudyDesign object contains all study design information required for power and sample size analysis. This includes the type of calculation, predictor and response variables, and hypotheses. The StudyDesign object contains matrix representations of the study design, and meta information such as variable names, clustering hierarchy if applicable, etc.

The StudyDesign object contains following fields and sub-objects.

|  |  |  |  |
| --- | --- | --- | --- |
| # | Variable | Type | Description |
|  | uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
|  | name | String | Name of the study design. |
|  | participantLabel | String | The participant label for study design. |
|  | solutionTypeEnum | SolutionTypeEnum | The solutionTypeEnum indicates whether the user is solving for power, sample size, or detectable difference. Valid values are  “Power”  ”Sample Size”  ”Detectable Difference”  This is an instance of SolutionTypeEnum object (see section 3.1.1.2). |
|  | viewTypeEnum | StudyDesignViewTypeEnum | The viewTypeEnum indicates whether the user is using guided mode, matrix mode or upload mode. Valid values are  “Guided Mode”  ”Matrix Mode”  ”Upload”  This is an instance of StudyDesignViewTypeEnum object (see section 3.1.1.3). |
|  | matrixSet | Set | Set containing all matrices required for a power or sample size calculation. The matrices are instances of NamedMatrix (see section 3.1.4). |
|  | betweenParticipantFactorList | Set | List of fixed predictor names and values. Each factor is an instance of the BetweenParticipantFactor object (see section 3.1.9). |
|  | gaussianCovariate | Boolean | If true, this flag indicates that the user wishes to control for a Gaussian covariate in their study design. |
|  | clusteringTree | Set | Describes the hierarchy of clustering for the study design via a set of ClusterNode objects (see section 3.1.11). |
|  | repeatedMeasuresTree | Set | Describes nested repeated measures (i.e. singly, double, triply repeated, etc.) for the study design via a set of RepeatedMeasuresNode objects. (see section 3.1.13). |
|  | hypothesis | Set | Describes the primary study hypothesis via a Hypothesis object (see section 3.1.15). Only a single hypothesis is allowed for version 2.0.0. |
|  | covariance | Set | Covariance information for within subject factors and the Gaussian covariate (see section 3.1.20). |
|  | confidenceIntervalDescription | ConfidenceIntervalDescription | Describes inputs required to produce a power confidence interval. This variable is instance of the ConfidenceIntervalDescription object (see section 3.1.25). For version 2.0.0, only a single confidence interval description is allowed. |
|  | powerCurveDescription | PowerCurveDescription | Describes inputs necessary for producing a power curve from the calculation results. This object is instance of the PowerCurveDescription object (see section 3.1.23). For version 2.0.0, only a single power curve description is allowed. |
|  | alphaList | List | This is a list of Type I error values. Each value is an instance of a TypeIError object (see section 3.1.27). |
|  | betaScaleList | List | This is a list of beta scale values, which allow the user to calculate power and sample size for a variety of possible mean differences. Each value is an instance of a BetaScale object (see section 3.1.29). |
|  | sigmaScaleList | List | This is a list of sigma scale values, which allow the user to calculate power and sample size for a variety of possible covariance values. Each value is an instance of a SigmaScale object (see section 3.1.31). |
|  | relativeGroupSizeList | List | This is a list of relative group size values, assuming a cell means coding. Each value is an instance of a RelativeGroupSize object (see section 3.1.33). |
|  | statisticalTestList | List | This is a list of statistical tests for which user wants to calculate power and sample size. Each value is an instance of a StatisticalTestListobject (see section 3.1.35). |
|  | powerMethodList | List | This is a list of power methods to use. Each value is an instance of the PowerMethod object (see section 3.1.37). |
|  | quantileList | List | This is a list of quantiles associated with the quantile power method. Each value is an instance of the Quantile object (see section 3.1.39). |
|  | nominalPowerList | List | This is a list of desired minimum power values. Only used when performing a sample size calculation. Each value is an instance of the NominalPower object (see section 3.1.41). |
|  | responseList | List | This is a list of response variable names. Names are represented as strings. NOTE: These are the outcomes assessed at a single measurement episode. Outcomes representing repeated measures should be specified as a part of the repeatedMeasuresTree object. Each value is an instance of a ResponseNode object (see section 3.1.43). |
|  | sampleSizeList | List | This is a list of sample size values. Only used when performing a power calculation. Each value is an instance of a SampleSize object (see section 3.1.45). |

#### StudyDesign UUIDs

StudyDesign objects are uniquely identified by a UUID. Within the Study Design Service, the study design UUID is used to synchronize persistence of the StudyDesign object across multiple database tables. The GLIMMPSE user interface uses the UUID to update and retrieve data for a given StudyDesign object.

The StudyDesign UUID is a 16-byte (128-bit) long as described by Leach et al.3 Examples of UUIDs in hexadecimal:

067e6162-3b6f-4ae2-a171-2470b63dff00

54947df8-0e9e-4471-a2f9-9af509fb5889

The UUIDs are ‘practically unique’ rather than ‘guaranteed unique’. There are 1632= 340,282,366,920,938,463,463,374,607,431,768,211,456 possible UUIDs.

Thus the probability of creating a few tens of trillions of UUIDs in a year and having one duplicate is 0.00000000006.

#### The SolutionTypeEnum Object

Each study design object is associated with a Solution Type. This ENUM class lists a variety of possible solution types. The SolutionTypeEnum object contains following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| POWER | Enum | Indicates the user is solving for power |
| SAMPLE\_SIZE | Enum | Indicates the user is solving for sample size |
| DETECTABLE\_DIFFERENCE | Enum | Indicates the user is solving for the mean difference |
| Idx | String | Internal identifier |

#### The StudyDesignViewTypeEnum Object

Each study design object is associated with a view type. This ENUM class lists a variety of possible view types. The StudyDesignViewTypeEnum object contains following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| GUIDED\_MODE | Enum | Guided mode designs describe the study design in terms of between and within participant factors, hypotheses, etc. |
| MATRIX\_MODE | Enum | Matrix mode designs describe the study design purely as matrices. |
| Idx | String | Internal identifier |

### The StudyDesignList Object

The StudyDesignList object describes a list of StudyDesign objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| studyDesignList | List<StudyDesign> | List of StudyDesign objects. (see section 3.1.1 ). |

This object was added as a work around for Jackson Serialization issues.

### The Blob2DArray Object

The Blob2DArray object is used to represent two dimensional arrays. In particular, this is used to represent matrices. The “Blob” type is a MySQL data type which holds arbitrary size data. The Blob2DArray object has following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| data | Double[][] | Contents of a matrix |

### The NamedMatrix Object

The NamedMatrix object describes a named, *n*×*m* matrix. The NamedMatrix object has following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | Primary identifier of the object. |
| name | String | Name of the matrix. |
| rows | int | Number of rows in the matrix |
| columns | int | Number of columns in the matrix |
| data | Blob2DArray | Matrix contents |

### The NamedMatrixList object

The NamedMatrixList object is a list of NamedMatrix objects. It extends ArrayList<NamedMatrix>. This object was added as a work around for Jackson Serialization issues.

### The NamedMatrixSet object

The NamedMatrixSet object describes set of NamedMatrix objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| matrixSet | Set<NamedMatrix> | Set containing all matrices required for a power or sample size calculation. The matrices are instances of NamedMatrix (see section 3.1.4 ) |

This object was added as a work around for Jackson Serialization issues.

### The UuidMatrix object

The UuidMatrix object describes following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| matrix | NamedMatrix | A single matrix which is saved in/retrieved from a database. The matrix is instance of NamedMatrix (see section 3.1.4). |

This object was added as a work around for Jackson Serialization issues.

### The UuidMatrixName object

The UuidMatrixName object describes following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| matrixName | String | The name of a matrix which is to be retrieved from database. |

This object is added as a work around for Jackson Serialization issues.

### The BetweenParticipantFactor Object

The BetweenParticipantFactor object describes a fixed predictor in the study design. Fixed predictors are determined by the study design. Values of fixed predictors are known prior to drawing a sample. The BetweenParticipantFactor object has following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | Int | Primary identifier of the object. |
| predictorName | String | Name of the predictor. |
| categoryList | List<Category> | List of valid values for the predictor (see section 3.1.9.1). |

#### The Category Object

The Category object (See section 3.1.9) describes categories for a BetweenParticipantFactor object. The Category object has following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | Int | Primary identifier of the object. |
| category | String | Describes the name of category. A BetweenParticipantFactor holds multiple categories (See section 3.1.9). |

#### The CategoryList Object

The CategoryList object describes List of Category objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | A unique identifier for the Category (see section 3.1.9.2). |
| categoryList | List | Describes list of valid values for the category (see section 3.1.9.1). |

This object was added as a work around for Jackson Serialization issues.

### The BetweenParticipantFactorList Object

The BetweenParticipantFactorList object describes List of BetweenParticipantFactor objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| betweenParticipantFactorList | List<BetweenParticipantFactor> | List of fixed predictor names and values. Each factor is an instance of the BetweenParticipantFactor object (see section 3.1.9). |

This object is added as a work around for Jackson Serialization issues.

### The Cluster Node Object

In a multilevel study design, participants are organized into clusters. Observations on participants within a cluster are assumed to be correlated. Clustering may have one or more levels. Multilevel features of the study design are represented by a tree of ClusterNode objects. The ClusterNode describes clustering at a single level, and the tree determines the hierarchical organization of these nodes.

For example, consider a study design which examines the impact of a new reading program on standardized test scores. Suppose that 5 counties participate, sampling 10 schools within each county, and recruiting 100 students within each school. Suppose that the within county correlation is 0.01, and the within-school correlation is 0.005. The clustering for this design would be represented as follows

Level 1:

Name: County

Size: 10 schools

ICC: 0.01

Level 2:

Name: School

Size: 100 students

ICC: 0.005

For version 2.0.0, we assume equal cluster sizes at each level. The ClusterNode object has following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | Int | Primary identifier of the object. |
| groupName | String | Name of this clustering level. For example, “school”, “census tract”, etc. |
| groupSize | int | Size of the cluster. |
| intraClusterCorrelation | Double | The intra-cluster correlation. Valid values range from -1 to 1. |
| node | Integer | Position of the node in the clustering tree when traversed in depth-first order. For the root node, position = 1. |
| parent | Integer | Position of node’s parent in the clustering tree. |

### The ClusterNodeList Object

The ClusterNodeList object describes a list of ClusterNode objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| clusterNodeList | List<ClusterNode> | Describes the hierarchy of clustering of the study design via a set of ClusterNode objects (see section 3.1.11). |

This object was added as a work around for Jackson Serialization issues.

### The Repeated Measures Node Object

In a longitudinal study design, response variables are observed on multiple occasions or under multiple conditions for each participant. Repeated measures may occur across multiple dimensions. For example, a study may measure weight each day for one month, and on each day measure weight in the morning and afternoon. Repeated measures features of the study design are represented by a tree of RepeatedMeasuresNode objects. The RepeatedMeasuresNode describes repeated measures information across a single dimension, and the tree determines the hierarchical organization of these nodes.

The RepeatedMeasuresNode object has following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | Primary identifier of the object. |
| dimension | String | Name of repeated measures dimension. For example, “week”. |
| repeatedMeasuresDimensionType | RepeatedMeasuresDimensionType | Type of dimension. Valid values for this field are as follows;  “NUMERIC” – ratio or interval measurement scale. Allows unequal spacing.  “ORDINAL” – ordinal measurement scale  “NOMINAL” – nominal measurement scale.  For more details on RepeatedMeasuresDimensionType object please see section 3.1.13.2. |
| numberOfMeasurements | Integer | Number of measurements for the current dimension. |
| spacingList | List<Spacing> | For numeric values, a list of integers representing the spacing of measurements. For example, for measurements at 1,3, and 10 weeks, this list would contain (1,3,10). (see section 3.1.13.1) |
| node | int | Position of the node in the clustering tree when traversed in depth-first order. For the root node, position = 1. |
| parent | Integer | Position of the node’s parent in the clustering tree. |

**Example**: Consider a study design which takes heart rate measurements on 20 subjects. Heart rate is measured at week 1, 3, and 10. Within each week, measurements are taken on Monday, Wednesday, and Friday. Lastly, within each day, heart rate is measured in supine, sitting, and standing. The following RepeatedMeasuresNode objects would be required to describe this study design

Dimension 1:

Name: week

Type: numeric

NumberOfMeasurements: 3

SpacingList: 1,3,10

Dimension 2:

Name: weekday

Type: ordinal

NumberOfMeasurements: 3

Dimension 3:

Name: body position

Type: nominal

NumberOfMeasurements: 3

#### The Spacing Object

The Spacing object describes spacing values for a RepeatedMeasuresNode object (See section 3.1.13). The Spacing object has following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | Primary identifier of the object. |
| Value | int | Spacing value for a RepeatedMeasuresNode object (See section 3.1.13). |

#### The RepeatedMeasuresDimensionType Object

This ENUM class lists the possible types of repeated measures and allows the following values.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| NUMERICAL | Enum | Numeric repeated measures are on the interval or ratio scale and support unequal spacing |
| ORDINAL | Enum | Ordinal repeated measures have an implied order (such as first, second, third) but assume equal spacing |
| CATEGORICAL | Enum | Categorical repeated measures have no implied order (such as arm and leg) |
| Idx | String | Internal identifier |

### The RepeatedMeasuresNodeList Object

The RepeatedMeasuresNodeList object describes a list of RepeatedMeasuresNode objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| repeatedMeasuresList | List< RepeatedMeasuresNode> | Describes the hierarchy of Repeated Measures for the study design via a set of RepeatedMeasuresNode objects. (see section 3.1.13). |

This object was added as a work around for Jackson Serialization issues.

### The Hypothesis Object

The Hypothesis Object describes the primary study hypothesis. Possible hypotheses include main effects, interactions, and trends. The Hypothesis objects has following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | Int | Primary identifier of the object. |
| type | HypothesisTypeEnum | This field describes type of hypothesis. Valid values are  “Main effect” – tests the effect of a single factor  “Interaction” – tests the interaction between two or more covariates  “Trend” – tests for a trend in a single factor  (see section 3.1.15.3). |
| betweenParticipantFactorList | List | List of between participant factors tested in the hypothesis. |
| repeatedMeasuresNodeList | List | List of repeated measures (within participant) factors tested in the hypothesis. |

#### The HypothesisBetweenParticipantFactor Object

The HypothesisBetweenParticipantFactor object is a mapping between a Hypothesis object and a BetweenParticipantFactor object. The HypothesisBetweenParticipantFactor object has following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| hypothesis | Hypothesis | Reference to the parent Hypothesis object. |
| betweenParticipantFactor | BetweenParticipantFactor | Reference to the BetweenParticipantFactor object. |
| type | HypothesisTrendTypeEnum | Type of trend tested for this factor. Valid values are  “None”  “Change from baseline”  “All polynomial trends”  “Linear trend”  “Quadratic trend”  “Cubic trend”  (see section 3.1.15.4). |

#### The HypothesisRepeatedMeasuresNode Object

The HypothesisRepeatedMeasuresNode object is a mapping between a Hypothesis object and a RepeatedMeasuresNode object. The HypothesisRepeatedMeasuresNode object has following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| hypothesis | Hypothesis | Reference to the parent Hypothesis object. |
| repeatedMeasuresNode | RepeatedMeasuresNode | Reference to the RepeatedMeasuresNode object. |
| type | HypothesisTrendTypeEnum | Type of trend tested for this factor. Valid values are  “None”  “Change from baseline”  “All polynomial trends”  “Linear trend”  “Quadratic trend”  “Cubic trend”  (see section 3.1.15.4). |

#### The HypothesisTypeEnum Object

This ENUM class lists possible hypothesis types. The HypothesisTypeEnum object contains following fields

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| GRAND\_MEAN | Enum | Tests of the grand mean compare the overall mean response in a sample of participants against a known value. |
| MAIN\_EFFECT | Enum | Main effect hypotheses test for the effect of a single predictor variable averaged across all other factors. |
| INTERACTION | Enum | Interaction effect hypotheses test if the effect of one predictor changes depending on the value of one or more additional predictors. |
| TREND | Enum | Interaction effect hypotheses test if the effect of one predictor changes depending on the value of one or more additional predictors. |
| Idx | String | Internal identifier |

#### The HypothesisTrendTypeEnum Object

This ENUM class lists the possible hypothesis trend types. The HypothesisTrendTypeEnum object contains following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| NONE | Enum | No trend |
| CHANGE\_FROM\_BASELINE | Enum | Tests for a difference from the first to the last measurement for a given factor. |
| ALL\_POYNOMIAL | Enum | Tests for all possible polynomial trends through cubic |
| LINEAR | Enum | Tests for a linear trend in a given factor |
| QUADRATIC | Enum | Tests for a quadratic trend in a given factor |
| CUBIC | Enum | Tests for a cubic trend in a given factor |
| Idx | String | Internal identifier |

### The HypothesisSet Object

The HypothesisSet object describes a set of Hypothesis objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| hypothesisSet | Set<Hypothesis> | Set containing all hypothesis required for a power or sample size calculation. The hypothesis are instances of Hypothesis object (see section 3.1.15 ). |

This object was added as a work around for Jackson Serialization issues.

### The UuidHypothesis Object

The UuidHypothesis object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| hypothesis | Hypothesis | A single hypothesis which is saved in/retrieved from a database. The hypothesis is instance of Hypothesis object (see section 3.1.15 ). |

This object was added as a work around for Jackson Serialization issues.

### The UuidHypothesisType Object

The UuidHypothesis object describes following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| type | HypothesisTypeEnum | Type of hypothesis. Valid values are  “Main effect” – tests the effect of a single covariate  “Interaction” – tests the interaction between two or more covariates  “Trend” (see section 3.1.15.3). |

This object was added as a work around for Jackson Serialization issues.

### The Covariance Object

The GLIMMPSE system can account for variability from following sources.

* Between participant correlation due to clustering, i.e. intra-cluster correlation
* Within participant covariance due to repeated measures
* Covariance between outcomes and a Gaussian covariate

Note that intra-cluster correlation is described by the ClusterNode object (see section 3.1.11).

Covariance information can be represented in three difference forms.

1. Lear Model4. A structured covariance model with three parameters describing the standard deviation, the correlation for measurements a minimum distance apart, and a rate of decay of the correlation as distance between measurements increases
2. Unstructured correlation. Requires specification of the standard deviation of each variable and the upper triangle (excluding the diagonal) of the correlation matrix for the variables.
3. Unstructured covariance. Requires specification of the upper triangle (including the diagonal) of the covariance matrix.

To capture the information in each of these forms, the Covariance object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | Int | Primary identifier of the object. |
| name | String | Name of the covariance matrix, either the repeated measures factor or the reserved identifier \_\_RESPONSE\_COVARIANCE\_\_ for multivariate response variables |
| standardDeviationList | List<standardDeviation> | Standard deviation for unstructured correlation (see section 3.1.19.1). |
| rho | Double | The base correlation parameter of the Lear model. |
| delta | Double | The rate of decay parameter of the Lear model. |
| rows | Int | Number of rows in the covariance matrix. |
| columns | Int | Number of columns in the covariance matrix. |
| blob | Blob2DArray | Object which holds the matrix cell values as a double dimension array. The blob object is instance of Blob2DArray object. (See section 3.1.3). |
| type | CovarianceTypeEnum | Type of the covariance (see section 3.1.19.2). |

#### The StandardDeviation Object

The StandardDeviation object describes standard deviation for a covariance object (See section 3.1.19).

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | Primary identifier of the object. |
| Value | double | Value of the standard deviation. |

#### The CovarianceTypeEnum Object

The CovarianceTypeEnum object describes type a covariance object (See section 3.1.19).

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Idx | int | Primary identifier of the object. |
| LEAR\_CORRELATION | Enum | Indicates a structured covariance using the Lear model |
| UNSTRUCTURED\_CORRELATION | Enum | Indicates an unstructured covariance expressed as a correlation matrix with associated standard deviation values. |
| UNSTRUCTURED\_COVARIANCE | Enum | Indicates an unstructured covariance. |

### The CovarianceSet Object

The CovarianceSet object describes a set of Covariance objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| CovarianceSet | Set< Covariance> | Set containing all covariance required for a power or sample size calculation. The covariance are instances of Covariance object (see section 3.1.19 ) |

This object was added as a work around for Jackson Serialization issues.

### The UuidCovariance Object

The UuidCovariance object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| covariance | Covariance | A single covariance which is saved in/retrieved from a database. The covariance is instance of Covariance object (see section 3.1.19 ) |

This object was added as a work around for Jackson Serialization issues.

### The UuidCovarianceName Object

The UuidCovarianceName object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| covarianceName | String | The name of a covariance which is to be retrieved from database. |

This object was added as a work around for Jackson Serialization issues.

### The PowerCurveDescription Object

Upon completion of a power or sample size calculation, the user may request the creation of a power curve. The PowerCurveDescription object contains information required for drawing power curve. The object following fields:

|  |  |  |  |
| --- | --- | --- | --- |
| # | Field Name | Field Type | Description |
|  | Idx | Int | Primary identifier of the object. |
|  | title | String | Title for the plot. |
|  | horizontalAxisLabelEnum | HorizontalAxisLabelEnum | Indicates the value to plot on the horizontal axis. Valid values are  “Total Sample Size”  “Regression Coefficient Scale Factor”  “Variability Scale Factor”  (see section 3.1.23.1). |
|  | width | int | Width of image. |
|  | height | int | Height of image. |
|  | legend | boolean | boolean indicating if the legend should be displayed. |
|  | dataSeriesList | List<PowerCurveDataSeries> | List of data series included in the plot. (see section 3.1.23.2) |

#### The HorizontalAxisLabelEnum Object

This ENUM class lists possible Horizontal Axis Label types. The HorizontalAxisLabelEnum object supports the following values.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| VARIABILITY\_SCALE\_FACTOR | Enum | Plot the scale factors for the covariance matrix on the horizontal axis |
| TOTAL\_SAMPLE\_SIZE | Enum | Plot the total sample size on the horizontal axis |
| REGRESSION\_COEEFICIENT\_SCALE\_FACTOR | Enum | Plot the scale factor for regression coefficients (most often mean differences) on the horizontal axis |
| Idx | String | Internal identifier |

#### The PowerCurveDataSeries Object

The PowerCurveDataSeries object describes the data series (i.e. individual lines) on the power curve plot.

|  |  |  |  |
| --- | --- | --- | --- |
| # | Field Name | Field Type | Description |
|  | Idx | int | Primary identifier of the object. |
|  | label | String | Label for this data series. |
|  | confidenceLimits | boolean | Indicates if confidence limits should be included on plot. |
|  | statisticalTestTypeEnum | StatisticalTestTypeEnum | Only power values for the specified test will be included in the plot. Ignored if “Statistical Test” is the stratification variable (see section 3.1.23.2.2). |
|  | typeIError | double | Only power values for the specified Type I Error level will be included in the plot. Ignored if “Type I Error” is the stratification variable. |
|  | sampleSize | int | Only power values for the specified sample size will be included in the plot. Ignored if “Total Sample Size” is the stratification variable or horizontal axis type. |
|  | betaScale | double | Only power values for the specified beta scale level will be included in the plot. Ignored if “Regression Coefficient Scale Factor” is the stratification variable or horizontal axis type. |
|  | sigmaScale | double | Only power values for the specified sigma scale level will be included in the plot. Ignored if “Variability Scale Factor” is the stratification variable or horizontal axis type. |
|  | powerMethodEnum | PowerMethodEnum | Only power values for the specified power method will be included in the plot. Ignored if “Power Method” is the stratification variable (see section 3.1.23.2.1) |
|  | quantile | double | Only power values for the specified quantile will be included in the plot. Ignored if “Quantile” is the stratification variable. |
|  | nominalPower | double | Only power values for the specified nominal power will be included in the plot. |

##### The PowerMethodEnum Object

This ENUM class lists possible Power Method types. The following values are supported.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| CONDITIONAL | Enum | Calculate power conditional on knowing the values of the predictors. Used for designs without a baseline covariate. |
| UNCONDITIONAL | Enum | Calculate the unconditional power5. Used for designs with a baseline covariate. |
| QUANTILE | Enum | Calculate quantile power5. Used for designs with a baseline covariate. |
| Idx | String | Internal identifier |

##### The StatisticalTestTypeEnum Object

This ENUM class lists supported statistical tests for the general linear multivariate model. See Muller and Stewart6 for full details on each test. The following values are supported

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| UNIREP | Enum | The uncorrected univariate approach to repeated measures test |
| UNIREPBOX | Enum | The univariate approach to repeated measures test with Box correction |
| UNIREPGG | Enum | The univariate approach to repeated measures test with Geisser-Greenhouse correction |
| UNIREPHF | Enum | The univariate approach to repeated measures test with Huynh-Feldt correction |
| WL | Enum | The Wilk’s Lambda test |
| PBT | Enum | The Pillai-Bartlett trace test |
| HLT | Enum | The Hotelling-Lawley trace test |
| Idx | String | Internal identifier |

### The UuidPowerCurveDescription Object

The UuidPowerCurveDescription object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| powerCurveDescription | PowerCurveDescription | A single powerCurveDescription which is saved in/retrieved from a database. The covariance is instance of PowerCurveDescription object (see section 3.1.23). |

This object was added as a work around for Jackson Serialization issues.

### The ConfidenceIntervalDescription Object

The ConfidenceIntervalDescription object includes information required to produce a confidence interval on power values. The confidence intervals are produced using the methods described by Taylor and Muller7. When determining values for mean differences and covariance in a power and sample size analysis, scientists typically use data from prior research. We refer to this data as the pilot data. Since the estimated means and standard deviations from the pilot data have a degree of uncertainty, the power values will also contain some uncertainty. The ConfidenceIntervalDescription object includes fields which describe the uncertainty from the pilot data, and the width of the desired confidence interval for power values.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| betaFixed | Boolean | If true, the estimated mean values from the pilot data set are assumed certain and fixed. |
| sigmaFixed | Boolean | If true, the estimated covariance values from the pilot data set are assumed certain and fixed. |
| lowerTailProbability | Double | Lower tail probability for the confidence interval. |
| upperTailProbability | Double | Upper tail probability for the confidence interval. |
| sampleSize | int | Sample size of the pilot data from which the beta and sigma values were obtained. |
| rankOfDesignMatrix | int | Rank of the design matrix for the model used to analyze the pilot data. |

### The UuidConfidenceIntervalDescription Object

The UuidConfidenceIntervalDescription object has the following fields;

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| confidenceInterval | ConfidenceInterval | A single confidenceInterval which is saved in/retrieved from a database. The confidenceInterval is instance of ConfidenceIntervaDescription object (see section 3.1.25). |

This object was added as a work around for Jackson Serialization issues.

### The TypeIError Object

The TypeIError object is a wrapper class for Type I Error (α) rates. It contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| alphaValue | Double | Type I Error rate, a value between 0 and 1. Rates of 0.05, 0.01, and 0.1 are most common. |

### The TypeIErrorList Object

The TypeIErrorList object describes a list of TypeIError objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| typeIErrorList | List<TypeIError> | This is a list of TypeIError objects (see section 3.1.27). |

This object was added as a work around for Jackson Serialization issues.

### The BetaScale Object

The BetaScale object is a wrapper class for beta scale values. It contains the following fields

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | Double | Beta scale value. Must be a positive value. |

### The BetaScaleList Object

The BetaScaleList object describes a list of BetaScale objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| BetaScaleList | List< BetaScale > | List of BetaScale objects (see section 3.1.29). |

This object was added as a work around for Jackson Serialization issues.

### The SigmaScale Object

The SigmaScale object is a wrapper class for sigma scale values. It contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | Double | Sigma scale value must be a positive value. |

### The SigmaScaleList Object

The SigmaScaleList object describes a list of SigmaScale objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| SigmaScaleList | List< SigmaScale> | This is a list of SigmaScaleobjects. (see section 3.1.31). |

This object was added as a work around for Jackson Serialization issues.

### The RelativeGroupSize Object

The RelativeGroupSize object is a wrapper class for relative group size values. The value describes the size of the current group relative to the smallest group in the study. This object contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | int | Relative group size value. A value of 1 indicates equal size. Values greater than 1 indicate that one group has a larger number of participants than another. |

### The RelativeGroupSizeList Object

The RelativeGroupSizeList object describes a list of RelativeGroupSize objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| RelativeGroupSizeList | List< RelativeGroupSize> | This is a list of RelativeGroupSize objects. (see section 3.1.33). |

This object was added as a work around for Jackson Serialization issues.

### The StatisticalTest Object

The Test object describes the statistical test for which power or sample size is calculated.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| type | StatisticalTestTypeEnum | Statistical test. Valid values are:  “unirep” – Univariate approach to repeated measures, assuming sphericity (uncorrected)  “unirepBox” - Univariate approach to repeated measures with Box correction  “unirepGG” - Univariate approach to repeated measures with Geisser-Greenhouse correction  “unirepHF” - Univariate approach to repeated measures with Huynh-Feldt correction  “wl” – Wilk’s Lambda test (multivariate)  “pbt” – Pillai Bartlett Trace test (multivariate)  “hlt” – Hotelling Lawley Trace (multivariate)  (See section 3.1.23.4). |

### The StatisticalTestList Object

The StatisticalTestList object describes List of StatisticalTest objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| StatisticalTestList | List< StatisticalTest> | This is a list of StatisticalTest objects (see section 3.1.35). |

This object was added as a work around for Jackson Serialization issues.

### The PowerMethod Object

The PowerMethod object is a wrapper class for power calculation methods. This object contains following fields;

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| powerMethodEnum | PowerMethodEnum | Power calculation method. Valid values are  “conditional”  “unconditional”  “quantile”  (see section 3.1.23.3). |

### The PowerMethodList Object

The RelativeGroupSizeList object describes a list of RelativeGroupSize objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| RelativeGroupSizeList | List< RelativeGroupSize> | This is a list of RelativeGroupSize objects (see section 3.1.37). |

This object was added as a work around for Jackson Serialization issues.

### The Quantile Object

The Quantile object is a wrapper class for quantile values associated with the quantile power method. It contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | Double | Quantile of the distribution of power values. Must be between 0 and 1. |

### The QuantileList Object

The QuantileList object describes List of Quantile objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| QuantileList | List< Quantile> | This is a list of Quantile objects (see section 3.1.39). |

This object was added as a work around for Jackson Serialization issues.

### The NominalPower Object

The NominalPower object is a wrapper class for nominal power values associated with a sample size calculation. This object contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | Double | Nominal power value must be between 0 and 1. |

### The NominalPowerList Object

The NominalPowerList object describes the list of NominalPower objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| NominalPowerList | List< NominalPower> | This is a list of NominalPower objects (see section 3.1.41). |

This object was added as a work around for Jackson Serialization issues.

### The ResponseNode Object

The ResponseNode object is a wrapper class for response variables associated with a sample size calculation. This object contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| name | String | Response variable name |

### The ResponseList Object

The ResponseList object describes a list of ResponseNode objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| ResponseList | List< ResponseNode> | This is a list of ResponseNode objects (see section 3.1.43). |

This object was added as a work around for Jackson Serialization issues.

### The SampleSize Object

The SampleSize object is a wrapper class for sample size values. It contains the following fields.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| Idx | int | Primary identifier of the object. |
| value | int | Minimum possible value for sample size is 2. |

### The SampleSizeList Object

The SampleSizeList object describes a list of SampleSize objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1). |
| SampleSizeList | List< SampleSizeList> | This is a list of SampleSizeList objects (see section 3.1.46 ). |

This object was added as a work around for Jackson Serialization issues.

### The ConfidenceInterval Object

The ConfidenceInterval object describes a power confidence interval.

|  |  |  |
| --- | --- | --- |
| Variable | Type | Description |
| lowerLimit | Double | lower limit of the confidence interval. |
| upperLimit | Double | upper limit of the confidence interval. |
| alphaLower | Double | Lower tail probability for the confidence interval |
| alphaUpper | Double | Upper tail probability for the confidence interval |

### The FixedRandomMatrix Object

This object provides a matrix which contains fixed and random components. The combined matrix may be produced by concatenating the fixed and random sub matrices either vertically or horizontally. The FixedRandomMatrix object has the following fields.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| name | String | Name of the matrix. |
| fixedMatrix | NamedMatrix | Fixed submatrix (see section 3.1.4). |
| randomMatrix | NamedMatrix | Random submatrix (see section 3.1.4). |
| combineHorizontal | boolean | If true, the fixed and random submatrices are concatenated horizontally to produce the full matrix. Otherwise, the submatrices are concatenated vertically. |

### The PowerResult Object

This object contains a description of the general linear model power result.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| nominalPower | NominalPower | If solving for sample size, this is the desired target power. Otherwise, equals the actual power (see section 3.1.41). |
| actualPower | double | The calculated power |
| totalSampleSize | int | Total sample size |
| alpha | TypeIError | Type I error rate (see section 3.1.27). |
| betaScale | BetaScale | Scale factor for beta matrix (see section 3.1.29). |
| sigmaScale | SigmaScale | Scale factor for the sigma error matrix (see section 3.1.31). |
| test | StatisticalTest | Statistical test performed (see section 3.1.35). |
| powerMethod | PowerMethod | Power method used (see section 3.1.37). |
| Quantile | Quantile | Quantile if using quantile power, null otherwise (see section 3.1.39). |
| confidenceInterval | ConfidenceInterval | Confidence limits for power if requested  (see section 3.1.47). |
| errorCode | PowerCalculationErrorEnum | Error or warning code. Null if calculation was successful. For more details on PowerCalculationErrorEnum see section 3.1.49.1. |
| errorMessage | String | Error message. Null if calculation was successful. |

#### The PowerCalculationErrorEnum object

This object describes all possible errors from power calculations. The following values are supported.

|  |  |  |  |
| --- | --- | --- | --- |
| # | Field Name | Field Type | Description |
|  | SAMPLE\_SIZE\_UNDEFINED | Enum | No valid sample size could be obtained for the study design. Typically occurs if the design specifies a mean difference of 0. |
|  | MAX\_SAMPLE\_SIZE\_EXCEEDED | Enum | Indicates that the system was unable to reach a large enough sample size to meet the desired power. May occur for designs with extremely large variance. |
|  | BETA\_SCALE\_UNDEFINED | Enum | Indicates that the design is missing a beta scale value |
|  | MAX\_BETA\_SCALE\_EXCEEDED | Enum | When solving for mean difference, indicates that the system could not find a beta scale large enough to meet the desired power. |
|  | POWER\_CI\_UNKNOWN\_TYPE | Enum | Invalid power confidence interval type |
|  | POWER\_CI\_MULTIVARIATE\_BETA\_SIGMA\_ESTIMATED | Enum | The user requested a confidence interval for a multivariate design in which beta and sigma were estimated. Statistical theory for this case is not currently available in GLIMMPSE. |
|  | POWER\_METHOD\_UNKNOWN | Enum | Invalid power calculation method |
|  | MISSING\_MATRIX\_DESIGN | Enum | The design does not include a design matrix |
|  | MISSING\_MATRIX\_BETA | Enum | The design does not include a beta matrix |
|  | MISSING\_MATRIX\_BETA\_RANDOM | Enum | A design with a baseline covariate does not include the random submatrix for beta. |
|  | MISSING\_MATRIX\_C | Enum | The design does not include a between participant contrast. |
|  | MISSING\_MATRIX\_C\_RANDOM | Enum | A design with a baseline covariate does not include the random submatrix of the between participant contrast. |
|  | MISSING\_MATRIX\_U | Enum | The design does not include a within participant contrast |
|  | MISSING\_MATRIX\_THETA\_NULL | Enum | The design does not include the matrix of null hypothesis values. |
|  | MISSING\_MATRIX\_SIGMA\_E | Enum | The design does not include a covariance of errors. |
|  | MISSING\_MATRIX\_SIGMA\_G | Enum | A design with a baseline covariate does not include the covariance of the Gaussian covariate. |
|  | MISSING\_MATRIX\_SIGMA\_YG | Enum | A design with a baseline covariate does not include the covariance of the Gaussian covariate and the outcomes. |
|  | MISSING\_MATRIX\_SIGMA\_Y | Enum | A design with a baseline covariate does not include the covariance of the outcomes. |
|  | MATRIX\_NONSQUARE\_SIGMA\_E | Enum | The covariance of errors matrix is not square |
|  | MATRIX\_NONSQUARE\_SIGMA\_Y | Enum | The covariance of outcomes for a design with a baseline covariate is not square. |
|  | MATRIX\_NONSQUARE\_SIGMA\_G | Enum | The covariance of the Gaussian covariate is not square. |
|  | MATRIX\_CONFORMANCE\_C\_BETA | Enum | The between participant contrast does not conform to the beta matrix. |
|  | MATRIX\_CONFORMANCE\_BETA\_U | Enum | The within participant contrast does not conform to the beta matrix. |
|  | MATRIX\_CONFORMANCE\_X\_BETA | Enum | The design matrix does not conform with the beta matrix. |
|  | MATRIX\_COMFORMANCE\_C\_THETA\_NULL | Enum | The between participant contrast does not conform to the matrix of null hypotheses |
|  | MATRIX\_CONFORMANCE\_U\_SIGMA\_E | Enum | The within participant contrast does not conform to the covariance of errors. |
|  | MATRIX\_CONFORMANCE\_U\_SIGMA\_Y | Enum | The within participant contrast does not conform to the covariance of outcomes. |
|  | MATRIX\_CONFORMANCE\_SIGMA\_G\_SIGMA\_YG | Enum | The covariance of the Gaussian covariate does not conform to the covariance of the outcomes with the Gaussian covariate. |
|  | MATRIX\_DIMENSION\_C\_TOO\_MANY\_ROWS | Enum | The degrees of freedom for the between participant contrast exceeds the maximum allowed by the design |
|  | MATRIX\_DIMENSION\_U\_TOO\_MANY\_COLUMNS | Enum | The degrees of freedom for the within participant contrast exceeds the maximum allowed by the design |
|  | MATRIX\_RANK\_DESIGN\_LTFR | Enum | The design matrix is not full rank |
|  | UNKNOWN\_TEST\_REQUESTED | Enum | Unsupported or invalid statistical test |
|  | UNKNOWN\_TEST\_REQUESTED\_RANDOM | Enum | Statistical test is not supported for designs with a baseline covariate |
|  | INVALID\_DISTRIBUTION\_NONCENTRALITY\_PARAMETER | Enum | The system was unable to generate the distribution of the noncentrality parameter for designs with a baseline covariate |
|  | INVALID\_DISTRIBUTION\_NONCENTRAL\_F | Enum | The degrees of freedom were invalid for the noncentral F approximation used in the power calculations for the specified design |
|  | DISTRIBUTION\_NONCENTRALITY\_PARAMETER\_CDF\_FAILED | Enum | The system was unable to obtain the cdf value for the distribution of the noncentrality parameter in designs with a baseline covariate. |
|  | MAX\_RANDOM\_PREDICTORS\_EXCEEDED | Enum | Too many random covariates were specified (version 2.0.0 of GLIMMPSE supports a single covariate) |

### The PowerResultList Object

The PowerResultList object describes a list of PowerResult objects. It extends ArrayList<PowerResult>.

This object was added as a work around for Jackson Serialization issues.

### The StudyNamedMatrixList Object

The StudyNamedMatrixList object describes a list of NamedMatrix objects.

|  |  |  |
| --- | --- | --- |
| Field Name | Field Type | Description |
| Uuid | Byte[16] | A unique identifier 3 for the StudyDesign (see section 3.1.1.1) |
| matrixList | List<NamedMatrix> | This is a list of NamedMatrix objects. (see section 3.1.4 ) |

This object was added as a work around for Jackson Serialization issues.



# 