

root

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Name	ML_Core
Version	3.2.2
Description	Common definitions for Machine Learning
License	See LICENSE.TXT
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Authors	HPCCSystems
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DESCRIPTIONS

ANALYSIS Analysis

	Analysis
--	-----------------

Analyze and assess the effectiveness of a Machine Learning model.

Sub-modules provide support for both Classification and Regression.

Each of the functions in this module support multi-work-item (i.e. Myriad interface) data, as well as multi-variate data (supported by some ML bundles). The number field, which is usually = 1 for uni-variate data is used to distinguish multiple regressors in the case of multi-variate models.

Children

1. [Classification](#) : This sub-module provides functions for analyzing and assessing the effectiveness of an ML Classification model
2. [Regression](#) : This sub-module provides functions for analyzing and assessing the effectiveness of an ML Regression model
3. [FeatureSelection](#) : This sub module provides functions for assessing the features of a dataset, to perform feature selection

4. [Clustering](#) : This sub module provides various tests that help evaluate the effectiveness of clustering algorithms

CLASSIFICATION Classification

[Analysis](#) \

	Classification
--	-----------------------

This sub-module provides functions for analyzing and assessing the effectiveness of an ML Classification model. It can be used with any ML Bundle that supports classification.

Children

1. [ClassStats](#) : Given a set of expected dependent values, assess the number and percentage of records that were of each class
2. [ConfusionMatrix](#) : Returns the Confusion Matrix, counting the number of cases for each combination of predicted Class and actual Class
3. [Accuracy](#) : Assess the overall accuracy of the classification predictions
4. [AccuracyByClass](#) : Provides per class accuracy / relevance statistics (e.g
5. [AUC](#) : AUC Area under the Receiver Operating Characteristics (ROC) curve, is a measure of how well a classifier is able to distinguish between classes

CLASSSTATS ClassStats

[Analysis](#) \ [Classification](#) \

DATASET(Class_Stats)	ClassStats
(DATASET(DiscreteField) actual)	

Given a set of expected dependent values, assess the number and percentage of records that were of each class.

PARAMETER **actual** ||| TABLE (DiscreteField) — The set of training-data or test-data dependent values in DATASET(DiscreteField) format.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 class , INTEGER4 classCount , REAL8 classPct }) — DATASET(Class_Stats), one record per work-item, per classifier (i.e. number field) per class.

SEE ML_Core.Types.Class_Stats

CONFUSIONMATRIX ConfusionMatrix

[Analysis](#) \ [Classification](#) \

<code>DATASET(Confusion_Detail)</code>	ConfusionMatrix
<code>(DATASET(DiscreteField) predicted, DATASET(DiscreteField) actual)</code>	

Returns the Confusion Matrix, counting the number of cases for each combination of predicted Class and actual Class.

PARAMETER **predicted** ||| TABLE (DiscreteField) — The predicted values for each id in DATASET(DiscreteField) format.

PARAMETER **actual** ||| TABLE (DiscreteField) — The actual (i.e. expected) values for each id in DATASET(DiscreteField) format.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 actual_class , INTEGER4 predict_class , UNSIGNED4 occurs , BOOLEAN correct , REAL8 pctActual , REAL8 pctPred }) — DATASET(Confusion_Detail). One record for each combination of work-item, number (i.e. classifier), predicted class, and actual class.

SEE ML_Core.Types.Confusion_Detail

ACCURACY Accuracy

[Analysis](#) \ [Classification](#) \

DATASET(Classification_Accuracy)	Accuracy
(DATASET(DiscreteField) predicted, DATASET(DiscreteField) actual)	

Assess the overall accuracy of the classification predictions.

ML_Core.Types.Classification_Accuracy provides a detailed description of the return values.

PARAMETER **predicted** ||| TABLE (DiscreteField) — The predicted values for each id in DATASET(DiscreteField) format.

PARAMETER **actual** ||| TABLE (DiscreteField) — The actual (i.e. expected) values for each id in DATASET(DiscreteField) format.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 recCnt , UNSIGNED8 errCnt , REAL8 Raw_Accuracy , REAL8 PoD , REAL8 PoDE , REAL8 Hamming_Loss }) — DATASET(Classification_Accuracy). One record for each combination of work-item, and number (i.e. classifier).

SEE ML_Core.Types.Classification_Accuracy

ACCURACYBYCLASS AccuracyByClass

[Analysis](#) \ [Classification](#) \

DATASET(Class_Accuracy)	AccuracyByClass
(DATASET(DiscreteField) predicted, DATASET(DiscreteField) actual)	

Provides per class accuracy / relevance statistics (e.g. Precision / Recall, False-positive Rate).

ML_Core.Types.Class_Accuracy provides a detailed description of the return values.

PARAMETER **predicted** ||| TABLE (DiscreteField) — The predicted values for each id in DATASET(DiscreteField) format.

PARAMETER **actual** ||| TABLE (DiscreteField) — The actual (i.e. expected) values for each id in DATASET(DiscreteField) format.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 class , REAL8 precision , REAL8 recall , REAL8 FPR , REAL8 f_score }) — DATASET(Class_Accuracy). One record for each combination of work-item, number (i.e. classifier), and class.

SEE ML_Core.Types.Class_Accuracy

AUC AUC

[Analysis](#) \ [Classification](#) \

DATASET(AUC_Result)	AUC
(DATASET(Classification_Scores) scores, DATASET(DiscreteField) actual)	

AUC Area under the Receiver Operating Characteristics (ROC) curve, is a measure of how well a classifier is able to distinguish between classes. The ROC curve is a plot of the true positive rate vs. the false positive rate with varying threshold values. The value of this metric ranges from 0 to 1. Higher values are an indication of better classifiers.

PARAMETER scores ||| TABLE (Classification_Scores) — The probability or confidence per class that a sample belongs to that class in DATASET(Classification_Scores) format

PARAMETER actual ||| TABLE (DiscreteField) — The actual class to which a sample belongs in DATASET(DiscreteField) format

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 class , REAL8 auc }) — DATASET(AUC_Result) The AUC score, per class, per classifier, per work item

SEE ML_Core.Types.AUC_Result, ML_Core.Types.Classification_Score

REGRESSION Regression

[Analysis](#) \

Regression

This sub-module provides functions for analyzing and assessing the effectiveness of an ML Regression model. It can be used with any ML Bundle that supports regression.

Children

1. [Accuracy](#) : Assess the overall accuracy of the regression predictions

ACCURACY Accuracy

[Analysis](#) \ [Regression](#) \

<code>DATASET(Regression_Accuracy)</code>	Accuracy
<code>(DATASET(NumericField) predicted, DATASET(NumericField) actual)</code>	

Assess the overall accuracy of the regression predictions.

`ML_Core.Types.Regression_Accuracy` provides a detailed description of the return values.

PARAMETER `predicted` ||| `TABLE (NumericField)` — The predicted values for each id in `DATASET(DiscreteField)` format.

PARAMETER `actual` ||| `TABLE (NumericField)` — The actual (i.e. expected) values for each id in `DATASET(DiscreteField)` format.

RETURN `TABLE ({ UNSIGNED2 wi , UNSIGNED4 regressor , REAL8 R2 , REAL8 MSE , REAL8 RMSE })` — `DATASET(Regression_Accuracy)`. One record for each combination of work-item, and number (i.e. regressor).

SEE `ML_Core.Types.Regression_Accuracy`

FEATURESELECTION FeatureSelection

[Analysis](#) \

This sub module provides functions for assessing the features of a dataset, to perform feature selection.

Children

1. [Contingency](#) : Contingency Provides the contingency table for each combination of feature and sample (classifier)
2. [Chi2](#) : Chi2 Provides Chi2 coefficient and number of degrees of freedom for each combination of feature and classifier

CONTINGENCY Contingency

[Analysis](#) \ [FeatureSelection](#) \

<code>DATASET(Contingency_Table)</code>	Contingency
<code>(DATASET(DiscreteField) samples, DATASET(DiscreteField) features)</code>	

Contingency Provides the contingency table for each combination of feature and sample (classifier). The contingency table represents the number of samples present in the data for each combination of sample category and feature category. Can only be used when both classifier and feature are discrete. The sets provided need not be sample / feature sets. They can be any two discrete fields whose contingency table is needed.

PARAMETER samples ||| TABLE (DiscreteField) — The samples or dependent values in DATASET(DiscreteField) format

PARAMETER features ||| TABLE (DiscreteField) — The features or independent values in DATASET(DiscreteField) format

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 fnumber , UNSIGNED4 snumber , INTEGER4 fclass , INTEGER4 sclass , INTEGER8 cnt }) —
DATASET(Contingency_Table) The contingency table for each combination of sample (classifier) and feature, per work item

SEE ML_Core.Types.Contingency_Table

CHI2 Chi2

[Analysis \ FeatureSelection \](#)

DATASET(Chi2_Result)	Chi2
(DATASET(DiscreteField) features, DATASET(DiscreteField) samples)	

Chi2 Provides Chi2 coefficient and number of degrees of freedom for each combination of feature and classifier. Chi squared test is a statistical measure that helps establish the dependence of two categorical variables. In machine learning, it can be used to determine whether a classifier is dependent on a certain feature, and thus helps in feature selection. This test can only be used when both variables are categorical.

PARAMETER **samples** ||| TABLE (DiscreteField) — The samples or dependent values in DATASET(DiscreteField) format

PARAMETER **features** ||| TABLE (DiscreteField) — The features or independent values in DATASET(DiscreteField) format

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 fnumber , UNSIGNED4 snumber , INTEGER8 dof , REAL8 x2 , REAL8 p }) — DATASET(Chi2_Result) Chi square values and degrees of freedom for each combination of feature and classifier, per work item.

SEE ML_Core.Types.Chi2_Result

CLUSTERING Clustering

[Analysis \](#)

Clustering

This sub module provides various tests that help evaluate the effectiveness of clustering algorithms.

Children

1. [ARI](#) : ARI The Rand index is a measure of the similarity between two data clusterings
2. [SampleSilhouetteScore](#) : SampleSilhouetteScore Silhouette analysis measures the closeness of a point, both with its assigned cluster and with other clusters

3. **SilhouetteScore** : Silhouette analysis measures the closeness of a point, both with its assigned cluster and with other clusters

ARI ARI

[Analysis](#) \ [Clustering](#) \

DATASET(ARI_Result)	ARI
(DATASET(ClusterLabels) predicted, DATASET(ClusterLabels) actual)	

ARI The Rand index is a measure of the similarity between two data clusterings. Adjusted Rand Index (ARI) is a version of rand index which is corrected for chance. This measure assumes values between -1 and 1. It produces values close to zero for random clusterings, values close to 1 for good clusterings and values close to -1 for clusterings that are worse than random guesses.

PARAMETER **predicted** ||| TABLE (ClusterLabels) — The labels predicted by the model in DATASET(ClusteringLabels) Format

PARAMETER **actual** ||| TABLE (ClusterLabels) — The actual labels, or the 'Ground Truth' in DATASET(ClusteringLabels) Format

RETURN TABLE ({ UNSIGNED2 wi , REAL8 value }) — DATASET(ARI_Result) The adjusted rand index per work item

SEE ML_Core.Types.ClusterLabels, ML_Core.Types.ARI_Result

SAMPLESILHOUETTESCORE SampleSilhouetteScore

[Analysis](#) \ [Clustering](#) \

DATASET(SampleSilhouette_Result)	SampleSilhouetteScore
(DATASET(NumericField) samples, DATASET(ClusterLabels) labels)	

SampleSilhouetteScore Silhouette analysis measures the closeness of a point, both with its assigned cluster and with other clusters. It provides an easy way of finding the optimum value for k during k-means clustering. Silhouette values lie in the range of (-1, 1). A value of +1 indicates that the sample point is far away from its neighboring cluster and very close to the cluster to which it is assigned. The euclidian distance metric is used to measure the distances between points.

PARAMETER samples ||| TABLE (NumericField) — The datapoints / independent data in DATASET(NumericField) format

PARAMETER labels ||| TABLE (ClusterLabels) — The labels assigned to these datapoints in DATASET(ClusterLabels) format

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , REAL8 value }) —

RESULT DATASET(SampleSilhouette_Result) The silhouette coefficient per sample, per work item

SEE ML_Core.Types.SampleSilhouette_Result

SILHOUETTESCORE SilhouetteScore

[Analysis](#) \ [Clustering](#) \

DATASET(Silhouette_Result)	SilhouetteScore
(DATASET(NumericField) samples, DATASET(ClusterLabels) labels)	

SilhouetteScore Silhouette analysis measures the closeness of a point, both with its assigned cluster and with other clusters. It provides an easy way of finding the optimum value for k during k-means clustering. Silhouette values lie in the range of (-1, 1). A value of +1 indicates that the sample point is far away from its neighboring cluster and very close to the cluster to which it is assigned. The euclidian distance metric is used to measure the distances between points. This function produces an average over SampleSilhouetteScore

PARAMETER samples ||| TABLE (NumericField) — The datapoints / independent data in DATASET(NumericField) format

PARAMETER labels ||| TABLE (ClusterLabels) — The labels assigned to these datapoints in DATASET(ClusterLabels) format

RETURN TABLE ({ UNSIGNED2 wi , REAL8 score }) —

RESULT DATASET(Silhouette_Result) The silhouette coefficient per work item

SEE ML_Core.Types.SampleSilhouette_Result, ML_Core.Analysis.SampleSilhouetteScore

AppendID

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DESCRIPTIONS

APPENDID AppendID

/ EXPORT	AppendID
(dIn,idfield,dOut)	

Macro takes any structured dataset, and appends a unique 1-based record ID column to it. Values will not be sequential and values will not be dense because of data skew. Gaps will appear when data ends on each node. If dense and sequential values are required, use AppendSeqID.

Note that, as a macro, nothing is returned, but attribute named in dOut will be defined to contain the resulting dataset.

Example:

```
ML\_Core.AppendID(dOrig, recID, dOrigWithId);
```

PARAMETER dIn ||| INTEGER8 — The name of the input dataset.

PARAMETER idfield ||| INTEGER8 — The name of the field to be appended containing the id for each row.

PARAMETER dOut ||| INTEGER8 — The name of the resulting dataset.

RETURN —

AppendSeqID

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DESCRIPTIONS

APPENDSEQID AppendSeqID

- EXPORT	AppendSeqID
(dIn,idfield,dOut)	

Macro takes any structured dataset, and appends a unique 1-based record ID column to it. Values will be in data sequence. Note: implemented as a count project, each node processes the data in series instead of parallel. For better cluster performance, use AppendID as long as dense, sequential ids are not needed.

Note that, as a macro, nothing is returned, but attribute named in dOut will be defined to contain the resulting dataset.

Example:

```
ML\_Core.AppendSeqID(dOrig, recID, dOrigWithId);
```

PARAMETER dIn ||| INTEGER8 — The name of the input dataset.

PARAMETER idfield ||| INTEGER8 — The name of the field to be appended containing the id for each row.

PARAMETER dOut ||| INTEGER8 — The name of the resulting dataset.

RETURN —

Config

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DESCRIPTIONS

CONFIG Config

	Config
--	--------

Global configuration constants that can be modified if needed.

Children

1. [MaxLookup](#) : The maximum amount of data to use in a LOOKUP JOIN
 2. [Discrete](#) : The default number of groups to use when discretizing data
 3. [RoundingError](#) : The tolerance for rounding error
-

MAXLOOKUP MaxLookup

[Config](#) \

	MaxLookup
--	-----------

The maximum amount of data to use in a LOOKUP JOIN.

RETURN INTEGER8 —

DISCRETE Discrete

[Config](#) \

	Discrete
--	----------

The default number of groups to use when discretizing data.

RETURN INTEGER8 —

ROUNDINGERROR RoundingError

[Config](#) \

	RoundingError
--	---------------

The tolerance for rounding error.

RETURN REAL8 —

Constants

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DESCRIPTIONS

CONSTANTS

 Constants

	Constants
--	-----------

Useful constants used in ML.

Children

- 1. [Pi](#) : Constant PI
- 2. [Root_2](#) : Constant square root of 2

PI

 Pi

[Constants](#) \

	Pi
--	----

Constant PI

RETURN

 REAL8 —

ROOT_2 Root_2

Constants \

	Root_2
--	--------

Constant square root of 2

RETURN REAL8 —

CrossValidation

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IMPORTS

```
__versions.ML_Core.V3_2_2.ML_Core |  
__versions.ML_Core.V3_2_2.ML_Core.Types |
```

DESCRIPTIONS

CROSSVALIDATION CrossValidation

	CrossValidation
--	-----------------

This module is a container for any cross-validation methods

Children

1. [NFoldCV](#) :

N-Fold Cross Validation is a way to validate the effectiveness of a regression or classification without having to segregate test data from training data

NFOLD CV NFoldCV

[CrossValidation](#) \

NFoldCV
(LearnerName, IndepDS, DepDS, NumFolds)

N-Fold Cross Validation is a way to validate the effectiveness of a regression or classification without having to segregate test data from training data.

The results of the N-Fold Cross Validation approximate the expected result of training on all of the data samples and testing those results on other data from the same distribution.

This allows a model that is built on all available labeled data to be effectively assessed. Note that this process does not produce the target model, but only estimates the 'out-of-sample' error statistics that such a model would produce.

The method is as follows:

- Randomly split independent and dependent data into N (e.g. 10) 'folds'.
- Train N separate models, using N-1 of the folds as training data (e.g. 9).
- Test each model using the 1 fold that was not in the training set.
- Aggregate the test results across the N tests.

Any of the HPCC Machine Learning methods may be used with N-Fold Cross Validation The ML module to be used is passed as a parameter.

N-Fold Cross Validation can be used for regression or classification. If the dependent data is in NumericField format, it is treated as a regression and regression analytics are returned. If it is in DiscreteField format, then it is treated as a Classification, and Classification analytics are return.

Using the wrong dependent data type for the given learner will result in un- handled errors.

The returned MODULE exports the following attributes:

For Classification:

- ClassStats - Assesses Classes Contained in the Training Data (see Types.Class_Stats).
- Accuracy Overall Accuracy of the classification (see Types.Classification_Accuracy).
- AccuracyByClass Precision and Recall for each class (see Types.Class_Accuracy).
- ConfusionMatrix Frequency of predicted / actual class pairings (see Types.Consusion_Detail).

For Regression:

- Accuracy (see Types.Regression_Accuracy).

PARAMETER LearnerName ||| INTEGER8 — The attribute that holds the instantiated ML module.

PARAMETER IndepDS ||| INTEGER8 — The independent data to be used for training and testing.

PARAMETER DepDS ||| INTEGER8 — The dependent data to be used for training and testing.

PARAMETER NumFolds ||| INTEGER8 — The number of folds to use. Ten is typically considered adequate.

RETURN **BOOLEAN** — Result **MODULE** with attributes for assessing the strength of the model.

Discretize

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IMPORTS

`__versions.ML_Core.V3_2_2.ML_Core.Types |`

DESCRIPTIONS

DISCRETIZE Discretize

	Discretize
--	------------

This module is used to turn a dataset of NumericFields into a dataset of DiscreteFields. This is not quite as trivial as it seems as there are a number of different ways to make the underlying data discrete; and even within one method there may be different parameters. Further - it is quite probable that different methods are going to be desired for each field.

There are two methods of interfacing:

- Call a discretization method directly to apply to all fields.
- Build a set of instructions on how to discretize each field and then call 'Do'.

The record format 'r_Method is used to build the set of instructions in the latter case.

For each discretization method (e.g. ByRounding), there is a corresponding attribute preceded by 'i_' that is used to build the r_Method instruction for using that method (e.g. i_ByRounding).

Three methods are currently provided:

- ByRounding – Numerically round the number to the nearest integer.

- ByBucketing – Split the range of each variable into a number of evenly spaced buckets.
- ByTiling – Splits the datapoints into an ordered set of equal-sized groups.

Children

1. [c_Method](#) : Enumerate the available discretization methods
2. [r_Method](#) : This format is used to construct an 'instruction stream' to allow a dataset to be discretized according to a set of instructions which are in (meta)data
3. [i_ByRounding](#) : Construct an instruction (rMethod) that will cause certain fields to be discretized by rounding
4. [ByRounding](#) : Round the values passed in to create a discrete element Scale is applied (by multiplication) first and can be used to bring the data into a desired range (rParam1), Delta is applied (by addition) second and can be used to re-base a range OR to cause truncation or roundup as required (rParam2)
5. [i_ByBucketing](#) : Construct an instruction (rMethod) that will cause certain fields to be discretized by bucketing
6. [ByBucketing](#) : Allocates a continuous variable into one of N buckets based upon an equal division of the RANGE of the variable
7. [i_ByTiling](#) : Construct an instruction (rMethod) that will cause certain fields to be discretized by tiling
8. [ByTiling](#) : Allocate a continuous variable into one of N groups such that each group (tile) contains roughly the same number of entries and that all of the elements of group 2 have a higher value than group 1, etc
9. [Do](#) : Execute a set of discretization instructions in order to discretize all of the fields of the dataset using the appropriate methods

C_METHOD c_Method

Discretize \

c_Method

Enumerate the available discretization methods.

RETURN UNSIGNED4 —

VALUE Rounding = 1

VALUE Bucketing = 2

VALUE Tiling = 3

R_METHOD **r_Method**

Discretize \

r_Method

This format is used to construct an 'instruction stream' to allow a dataset to be discretized according to a set of instructions which are in (meta)data. It can be created directly, though the preferred method is to call `i_ByRounding(...)`, `i_ByBucketing(...)`, or `i_ByTiling(...)` to create each record.

FIELD method ||| UNSIGNED4 — Indicator of the method to use (see `c_method`).

FIELD iParam1 ||| INTEGER8 — The first integer parameter to the discretization method.

FIELD rParam1 ||| REAL8 — The first real parameter.

FIELD rParam2 ||| REAL8 — The second real parameter.

FIELD fields ||| SET (UNSIGNED4) — No Doc

I_BYROUNDING **i_ByRounding**

Discretize \

i_ByRounding
(SET OF Types.t_FieldNumber f, REAL Scale=1.0,REAL Delta=0.0)

Construct an instruction (`rMethod`) that will cause certain fields to be discretized by rounding. See `ByRounding` below.

PARAMETER f ||| SET (UNSIGNED4) — A set of field numbers to which to apply this method.

PARAMETER Scale ||| REAL8 — (Optional) A number by which to multiply each field before rounding.

PARAMETER Delta ||| REAL8 — (Optional) An offset that is applied after scaling but before rounding.

RETURN TABLE (r_Method) — DATASET(r_Method) containing one record.

BYROUNDING ByRounding

Discretize \

ByRounding
(DATASET(Types.NumericField) d, REAL Scale=1.0, REAL Delta=0.0)

Round the values passed in to create a discrete element Scale is applied (by multiplication) first and can be used to bring the data into a desired range (rParam1), Delta is applied (by addition) second and can be used to re-base a range OR to cause truncation or roundup as required (rParam2).

PARAMETER d ||| TABLE (NumericField) — The NumericField dataset to be discretized.

PARAMETER Scale ||| REAL8 — (Optional) A number by which to multiply each field before rounding.

PARAMETER Delta ||| REAL8 — (Optional) An offset that is applied after scaling but before rounding.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , INTEGER4 value }) — DATASET(DiscreteField) containing the discretized dataset.

I_BYBUCKETING i_ByBucketing

Discretize \

i_ByBucketing
(SET OF Types.t_FieldNumber f, Types.t_Discrete N=ML_Core.Config.Discrete)

Construct an instruction (rMethod) that will cause certain fields to be discretized by bucketing. See ByBucketing below.

PARAMETER f ||| SET (UNSIGNED4) — A set of field numbers to which to apply this method.

PARAMETER N ||| INTEGER4 — (Optional) The number of buckets into which to split the range. The default is to use the ML_Core. Config.Discrete configuration parameter.

RETURN TABLE (r_Method) — DATASET(r_Method) containing one record.

BYBUCKETING ByBucketing

[Discretize \](#)

	ByBucketing
	(DATASET(Types.NumericField) d, Types.t_Discrete N=ML_Core.Config.Discrete)

Allocates a continuous variable into one of N buckets based upon an equal division of the RANGE of the variable.

The buckets will NOT have an even number of elements unless the underlying distribution of the variable is uniform.

PARAMETER d ||| TABLE (NumericField) — The NumericField dataset to be discretized.

PARAMETER N ||| INTEGER4 — (Optional) The number of buckets into which to split the range. The default is to use the ML_Core. Config.Discrete configuration parameter.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , INTEGER4 value }) — DATASET(DiscreteField) containing the discretized dataset.

I_BYTILING i_ByTiling

[Discretize \](#)

i_ByTiling
(SET OF Types.t_FieldNumber f, Types.t_Discrete N=ML_Core.Config.Discrete)

Construct an instruction (rMethod) that will cause certain fields to be discretized by tiling. See ByTiling below.

PARAMETER **f** ||| SET (UNSIGNED4) — A set of field numbers to which to apply this method.

PARAMETER **N** ||| INTEGER4 — (Optional) The number of tiles into which to split the data. The default is to use the ML_Core. Config.Discrete configuration parameter.

RETURN TABLE (r_Method) — DATASET(r_Method) containing one record.

BYTILING ByTiling

Discretize \

ByTiling
(DATASET(Types.NumericField) d, Types.t_Discrete N=ML_Core.Config.Discrete)

Allocate a continuous variable into one of N groups such that each group (tile) contains roughly the same number of entries and that all of the elements of group 2 have a higher value than group 1, etc.

PARAMETER **d** ||| TABLE (NumericField) — The NumericField dataset to be discretized.

PARAMETER **N** ||| INTEGER4 — (Optional) The number of tiles to create. The default is to use the ML_Core. Config.Discrete configuration parameter.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , INTEGER4 value }) — DATASET(DiscreteField) containing the discretized dataset.

DO Do

Discretize \

Do
<code>(DATASET(Types.NumericField) d, DATASET(r_Method) to_do)</code>

Execute a set of discretization instructions in order to discretize all of the fields of the dataset using the appropriate methods.

Note that the file `d` is read once for each instruction - so it is much better to combine the instructions for multiple fields into one (provided the parameters and method are the same).

PARAMETER `d` ||| TABLE (NumericField) — The NumericField dataset to be discretized.

PARAMETER `to_do` ||| TABLE (r_Method) — The DATASET(`r_Method`) that contains the discretization instructions.

RETURN TABLE (DiscreteField) — DATASET(DiscreteField) containing the discretized dataset.

FieldAggregates

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IMPORTS

```
__versions.ML_Core.V3_2_2.ML_Core.Types |  
__versions.ML_Core.V3_2_2.ML_Core.Utils | std.system.ThorLib |
```

DESCRIPTIONS

FIELDAGGREGATES FieldAggregates

	FieldAggregates
(DATASET(Types.NumericField) d)	

Calculate various statistical aggregations of the fields in a NumericField dataset.

PARAMETER **d** ||| TABLE (NumericField) — The dataset to be aggregated.

Children

1. [Simple](#) : Calculate basic statistics about each field
2. [SimpleRanked](#) : Calculate the rank (order) of each cell for each field
3. [Medians](#) : Calculate the median value of each field
4. [MinMedNext](#) : No Documentation Found
5. [Buckets](#) : Bucketize the datapoints into N buckets for each field
6. [BucketRanges](#) : Return the ranges associated with each of N buckets as computed by 'Buckets' above

7. [Modes](#) : Calculate the mode (i.e
8. [Cardinality](#) : Returns the cardinality of each field
9. [RankedInput](#) : No Documentation Found
10. [NTiles](#) : Calculate the N-tile of each datapoint within its field
11. [NTileRanges](#) : Return the ranges associated with each of N-tiles as computed by 'Ntiles' above
12. [HistBins](#) : No Documentation Found
13. [HistBinRanges](#) : No Documentation Found
14. [PearsonCorr](#) : No Documentation Found
15. [SpearmanCorr](#) : No Documentation Found
16. [KendallCorr](#) : No Documentation Found
17. [GenSpearman2Corr](#) : No Documentation Found

SIMPLE Simple

[FieldAggregates](#) \

Simple

Calculate basic statistics about each field.

Calculates: min, max, sum, count, mean, variance, and standard deviation for each field.

There are no parameters.

Example:

```
myAggs := FieldAggregates(myDS).simple;
```

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , REAL8 minval , REAL8 maxval , REAL8 sumval , REAL8 countval , REAL8 mean , REAL8 var , REAL8 sd }) —

SIMPLERANKED SimpleRanked

[FieldAggregates](#) \

SimpleRanked

Calculate the rank (order) of each cell for each field.

The returned data adds a 'Pos' field to each cell, indicating its rank within it's field number.

There are no parameters.

Example:

```
myRankedDS := FieldAggregates(myDS).SimpleRanked;
```

MEDIANS Medians

[FieldAggregates](#) \

Medians

Calculate the median value of each field.

There are no parameters.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , REAL8 median }) —
DATASET({wi, number, median}), one record per work-item and field number. <p>Example:
</p><pre>myFieldMedians := FieldAggregates(myDS).Medians;</pre>

MINMEDNEXT MinMedNext

[FieldAggregates](#) \

MinMedNext

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , REAL8 median , REAL8 nextval , REAL8 minval , REAL8 maxval , REAL8 sumval , REAL8 countval , REAL8 mean , REAL8 var , REAL8 sd }) —

BUCKETS Buckets

[FieldAggregates](#) \

	Buckets
	(Types.t_Discrete n)

Bucketize the datapoints into N buckets for each field.

Bucketization splits the range of the data into N equal size range buckets. The data will not normally be evenly split among buckets unless it is uniformly distributed. Contrast this with N-tile, where the data is split nearly evenly.

PARAMETER n ||| INTEGER4 — The number of buckets to use.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value , UNSIGNED8 Pos , INTEGER4 bucket }) — DATASET OF {wi, id, number, value, pos, bucket}, where pos is the rank within each field, and bucket is the bucket number.

BUCKETRANGES BucketRanges

[FieldAggregates](#) \

	BucketRanges
	(Types.t_Discrete n)

Return the ranges associated with each of N buckets as computed by 'Buckets' above.

PARAMETER n ||| INTEGER4 — The number of buckets.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , INTEGER4 bucket , REAL8 Min , REAL8 Max , UNSIGNED8 cnt }) — DATASET OF {wi, number, bucket, Min, and Max}, one for each bucket for each field.

MODES Modes

[FieldAggregates](#) \

	Modes
--	-------

Calculate the mode (i.e. the most common value) for each field

There are no parameters.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , REAL8 mode , UNSIGNED8 cnt }) — DATASET OF {wi, number, mode, cnt}, one per field. 'cnt' is the number of times the mode value occurred.

CARDINALITY Cardinality

[FieldAggregates](#) \

	Cardinality
--	-------------

Returns the cardinality of each field. That is the number of different values occurring in each field.

There are no parameters.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , UNSIGNED8 cardinality }) — DATASET OF {wi, number, cardinality}, one per field.

RANKEDINPUT RankedInput

[FieldAggregates](#) \

	RankedInput
--	-------------

No Documentation Found

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value , REAL8 Pos }) —

NTILES NTiles

[FieldAggregates](#) \

	NTiles
(Types.t_Discrete n)	

Calculate the N-tile of each datapoint within its field. For example, if N is 100, we calculate percentiles.

PARAMETER n ||| INTEGER4 — The number of groups into which to balance the data

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value , REAL8 Pos , INTEGER4 ntile }) — DATASET OF {wi, id, number, value, pos, ntile}, where pos is the rank within each field.

NTILERANGES NTileRanges

[FieldAggregates](#) \

	NTileRanges
(Types.t_Discrete n)	

Return the ranges associated with each of N-tiles as computed by 'Ntiles' above.

PARAMETER **n** ||| INTEGER4 — The number of N-tile groups.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , INTEGER4 ntile ,
REAL8 Min , REAL8 Max , UNSIGNED8 cnt }) — DATASET OF {wi, number, bucket,
Min, and Max}, one for each N-tile group for each field.

HISTBINS HistBins

[FieldAggregates](#) \

HistBins
(Types.t_Discrete n)

No Documentation Found

PARAMETER **n** ||| INTEGER4 — No Doc

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8
value , INTEGER4 hbin }) —

HISTBINRANGES HistBinRanges

[FieldAggregates](#) \

HistBinRanges
(Types.t_Discrete n)

No Documentation Found

PARAMETER **n** ||| INTEGER4 — No Doc

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 number , INTEGER4 hbin ,
REAL8 Min , REAL8 Max , UNSIGNED8 cnt }) —

PEARSONCORR PearsonCorr

[FieldAggregates](#) \

	PearsonCorr
--	-------------

No Documentation Found

RETURN TABLE ({ UNSIGNED2 wi , INTEGER4 number1 , INTEGER4 number2 ,
REAL8 Correl }) —

SPEARMANCORR SpearmanCorr

[FieldAggregates](#) \

	SpearmanCorr
--	--------------

No Documentation Found

RETURN TABLE ({ UNSIGNED2 wi , INTEGER4 number1 , INTEGER4 number2 ,
REAL8 Correl }) —

KENDALLCORR KendallCorr

[FieldAggregates](#) \

	KendallCorr
--	-------------

No Documentation Found

RETURN TABLE ({ UNSIGNED2 wi , INTEGER4 number1 , INTEGER4 number2 ,
REAL8 Correl }) —

GENSPEARMAN2CORR GenSpearman2Corr

[FieldAggregates](#) \

	GenSpearman2Corr
(dep = 1)	

No Documentation Found

PARAMETER dep ||| INTEGER8 — No Doc

RETURN TABLE ({ UNSIGNED2 wi , INTEGER4 number1 , INTEGER4 number2 ,
REAL8 Correl }) —

FromField

[Go Up](#)

DESCRIPTIONS

FROMFIELD FromField

/ EXPORT	FromField
(dIn,lOut,dOut,dMap=)	

Macro to convert a NumericField formatted, cell-based dataset to a Record formatted dataset. Typically used to return converted NumericField data back to its original layout.

Note that as a Macro, nothing is returned, but new attributes are created in-line for use in subsequent definitions.

In the simplest case, the assumption is that the field order of the resulting table is in line with the field number in the input dataset, with the ID field as the first field.

For example:

```
myRec := RECORD
  UNSIGNED recordId;
  REAL height;
  REAL weight;
END;
Value of NumericField records with field number = 1 would go to height.
Value of NumericField records with field number = 2 would go to weight.
The id field of the NumericField record would be mapped to the recordId
field of the result.
```

If the field orders have been changed (e.g. by customizing the ToField process, a field-mapping should be specified (See dMap below). Usage Examples:

```
ML.FromField(myNFData, myRecordLayout, myRecordData);  
// Datamap to reorder the weight and height fields in the example above  
dataMap := DATASET([\{'weight', '1'\},  
                    \{'height', '2'\}], Types.Field\_Mapping);  
ML.FromField(nyNFData, myRecordLayout, myRecordData, dataMap);
```

PARAMETER dIn ||| INTEGER8 — The name of the input dataset in NumericField format.

PARAMETER lOut ||| INTEGER8 — The name of the layout record defining the records of the result dataset.

PARAMETER dOut ||| INTEGER8 — The name of the result dataset.

PARAMETER dMap ||| INTEGER8 — [OPTIONAL] A Field_Mapping dataset as produced by ToField that describes the mapping between field name and field number. The format of this map is defined by Types.Field_Mapping.

RETURN — Nothing. The MACRO creates new attributes in-line as described above.

SEE Types.NumericField

SEE Types.Field_Mapping

SEE ToField

Generate

[Go Up](#)

IMPORTS

`__versions.ML_Core.V3_2_2.ML_Core.Types |`

DESCRIPTIONS

GENERATE Generate

	Generate
--	----------

Increase dimensionality by adding polynomial transforms of the data to create new feature columns. This can be useful, for example, when building a linear model against data that may not have linear relationships.

Children

1. [tp_Method](#) : Enumeration of polynomial methods
2. [MethodName](#) : Convert a column number into a descriptive label
3. [ToPoly](#) : Generate up to seven, successively higher order, features from a single given feature

TP_METHOD [tp_Method](#)

[Generate](#) \

	<code>tp_Method</code>
--	------------------------

Enumeration of polynomial methods.

RETURN **UNSIGNED1** —

VALUE $\text{LogX} = 1$

VALUE $X = 2$

VALUE $X\text{LogX} = 3$

VALUE $XX = 4 - X \text{ squared}$

VALUE $XX\text{LogX} = 5$

VALUE $XXX = 6 - X \text{ cubed}$

VALUE $XXX\text{LogX} = 7$

METHODNAME **MethodName**

[Generate \](#)

	<code>MethodName</code>
	<code>(tp_Method x)</code>

Convert a column number into a descriptive label.

PARAMETER **x** ||| **UNSIGNED1** — The column number to describe.

RETURN **STRING7** — The descriptive label.

TOPOLY ToPoly

Generate \

	ToPoly
	<code>(DATASET(Types.NumericField) seedCol, UNSIGNED maxN=7)</code>

Generate up to seven, successively higher order, features from a single given feature.

The generated features are:

1. LogX (logs are base 10)
2. X
3. XLogX
4. X²
5. X²LogX
6. X³
7. X³LogX

Note that the returned fields will be numbered 1-7, as above.

PARAMETER seedCol ||| TABLE (NumericField) — A single column of NumericField data. The number field is ignored.

PARAMETER maxN ||| UNSIGNED8 — (Optional) The number of new columns to generate. For example: If 1, then one feature, LogX is generated. If 3, then LogX, X, and X² features are generated. The default is 7, in which case, all features are generated.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — DATASET(NumericField) with numOriginalRecs * maxN records.

SEE Types.NumericField

ModelOps2

[Go Up](#)

IMPORTS

`__versions.ML_Core.V3_2_2.ML_Core.Types |`

DESCRIPTIONS

MODELOPS2 ModelOps2

	ModelOps2
--	-----------

This module provides a set of operations to provide manipulation of machine learning models (version 2) in the `Types.Layout_Model2` format.

`Layout_Model2` defines a flexible structure that allows storage of model information for any Machine Learning algorithm.

The model is based on a "Naming Tree" paradigm.

The naming tree is a data structure that allows a hierarchical name (e.g. object-id) to be attached to each data-cell. Examples of naming-trees are OID trees such as those used in various network identifiers such as MIBs.

This structure is used within ML to store model information. It is a useful format for several reasons:

- It has the flexibility to store complex sets of data in a generic way.
- It easily stores scalar as well as matrix oriented data.
- It allows a model to contain data elements within scopes that are defined at different level. For example, part of the model may be defined globally, another may be common for a bundle, while another section is specific to a given module.

- It readily allows composite models to be created by encapsulating entire complex models (or sets of models) within branches of another model. The individual models can then be extracted from the composite model, and passed to the modules that created them.

Theory of Operation

The naming tree (NT) is conceptually simple. Each cell is identified by a hierarchical numbering scheme of arbitrary depth. Take, for example, the following NT:

```

1
  1.1
    1.1.1
    1.1.2
  1.2
    1.2.1
    1.2.2
2

```

This tree defines the following leaf (scalar) elements: 1.1.1, 1.1.2, 1.2.1, 1.2.2, 2.

Note that the deepest node on any branch is considered a leaf, and branches can be of variable depth. Note also that there is no explicit creation of branch nodes. The branches are implicitly defined by the ids of the leafs.

In this example, node 1.1 can be thought as representing an array, though it could also be thought of as a structure of two distinct scalars, depending on whether the user expects a variable length list under 1.1 (i.e. 1.1.1 - 1.1.N) or a fixed set of cells.

Likewise node 1 can be thought of as a matrix (1.r.c, where r is the row index and c is the column index), in cases where r and c are of variable size.

This naming tree also supports the myriad interface, allowing multiple independent work-items to be represented, each of which may duplicate the same structure.

The id is represented by an ECL SET of Unsigned identifiers (e.g. [1,2,1] represents the OID 1.2.1).

Each cell is defined by three fields: wi (work-item-id), value (the cell contents) and indexes (the id).

A naming tree can be constructed as an inline dataset. For example, the following creates the tree in the example above:

```

DATASET([\{1, 3.2, [1,1,1]\},
        \{1, .0297, [1,1,2]\},
        \{1, 2.0, [1,2,1]\},
        \{1, 1550, [1,2,2]\},

```

```
\{1, 8.1, [2]\}], Layout\_Model2);
```

There are attributes in this module to assist with manipulation of naming trees:

- Creating a NT from a NumericField matrix.
- Extracting a NumericField matrix from an NT branch.
- Inserting an NT onto a branch of another NT.
- Extracting an NT from a branch of an NT.

SEE Types.Layout_Model2

Children

1. [Extract](#) : Extract an inner sub-tree from an existing model
2. [ExtendIndices](#) : Extend the indices of a model to fit within a deeper model
3. [Insert](#) : Insert a model into a sub-tree of an existing model
4. [ToNumericField](#) : Convert a two-level model or model sub-tree into a NumericField dataset
5. [FromNumericField](#) : Convert a NumericField dataset to a 2 level model (or model subtree)
6. [GetItem](#) : Get a single record (cell) from a model by index
7. [SetItem](#) : Add a single record (cell) to an model at a given set of coordinates

EXTRACT Extract

[ModelOps2](#) \

<code>DATASET(Layout_Model2)</code>	Extract
<code>(DATASET(Layout_Model2) mod, t_indexes fromIndx, t_work_item fromWi=0)</code>	

Extract an inner sub-tree from an existing model.

Work-item = 0 (default) will extract all work-items

This is the opposite of Insert. For example:

If I have a tree:

```
1
2
3
  3.1
  3.2
```

and I extract from index 3, it will return the Naming Tree:

```
1
2
```

containing the two sub-cells of the original index 3

PARAMETER mod ||| TABLE (Layout_Model2) — The model from which to extract the sub-tree.

PARAMETER fromIndx ||| SET (UNSIGNED4) — The index from which to extract the subtree.

PARAMETER fromWi ||| UNSIGNED2 — The work-item to extract or 0 to extract the same sub-tree from all work-items.

RETURN TABLE ({ UNSIGNED2 wi , REAL8 value , SET (UNSIGNED4) indexes })
— A model containing all of the sub-cells below fromIndx with the indexes adjusted to the top of the tree.

EXTENDINDICES ExtendIndices

ModelOps2 \

DATASET(Layout_Model2)	ExtendIndices
(DATASET(Layout_Model2) mod, t_indexes atIndex)	

Extend the indices of a model to fit within a deeper model.

For example, a cell with index [1,2] could be moved to index [1,2,3,1,2] by using atIndex := [1,2,3].

PARAMETER mod ||| TABLE (Layout_Model2) — The model whose indexes are to be extended.

PARAMETER atIndex ||| SET (UNSIGNED4) — The prefix indexes to be prepended to the indexes of each cell in mod.

RETURN TABLE ({ UNSIGNED2 wi , REAL8 value , SET (UNSIGNED4) indexes })
— A model with extended indexes.

INSERT Insert

ModelOps2 \

<code>DATASET(Layout_Model2)</code>	Insert
<code>(DATASET(Layout_Model2) mod1, DATASET(Layout_Model2) mod2, t_indexes atIndex)</code>	

Insert a model into a sub-tree of an existing model.

Extends the indexes of the provided model to fit onto a branch of another model, and concatenates the two models. This is the opposite of extract. For example:

If I have a model:

1
2

and a second model:

1
2
3

That I would like to insert into the first tree at index 3, I would end up with the tree:

1
2
3
 3.1
 3.2
 3.3

Example code:

```
mod3 := Insert(mod1, mod2, [3]);
```


PARAMETER mod1 ||| TABLE (Layout_Model2) — The first (base) model.

PARAMETER mod2 ||| TABLE (Layout_Model2) — The sub-model that is to be inserted into mod1.

PARAMETER atIndx ||| SET (UNSIGNED4) — The index prefix (in mod1) that will contain the cells from mod2.

RETURN TABLE (Layout_Model2) — a new model containing the cells from both models.

TONUMERICFIELD ToNumericField

ModelOps2 \

DATASET(NumericField)	ToNumericField
(DATASET(Layout_Model2) mod, t_indexes fromIndx = [])	

Convert a two-level model or model sub-tree into a NumericField dataset.

The last two indexes of the model subtree are used as the indexes for the NumericField matrix. The second to last index corresponds to the NF's id field and the last index corresponds to the NF's number field.

PARAMETER mod ||| TABLE (Layout_Model2) — The model from which to extract the NumericField matrix.

PARAMETER fromIndx ||| SET (UNSIGNED4) — The index from which to extract the matrix. Example: [3,1,5]. The default is from the top of the tree i.e. [].

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — NumericField matrix in DATASET(NumericField) format.

FROMNUMERICFIELD FromNumericField

ModelOps2 \

DATASET(Layout_Model2)	FromNumericField
(DATASET(NumericField) nf, t_indexes atIndex=[])	

Convert a NumericField dataset to a 2 level model (or model subtree).

A two level model is created and appended to atIndex.

The first new index will contain the value of the NumericField's id field, and the second will contain the value of the NumericField's number field.

Example: If I have a NumericField with id=1 and number=3, and I use atIndex = [3,1,5], it will create a Naming Tree cell with indexes: [3,1,5,1,3].

PARAMETER nf ||| TABLE (NumericField) — A NumericField dataset to be converted.

PARAMETER atIndex ||| SET (UNSIGNED4) — The index at which to place the new subtree e.g., [3,1,5].

RETURN TABLE ({ UNSIGNED2 wi , REAL8 value , SET (UNSIGNED4) indexes })
— DATASET(ntNumeric) Naming Tree.

GETITEM GetItem

ModelOps2 \

Layout_Model2	GetItem
(DATASET(Layout_Model2) mod, t_indexes indxs, wi_num=1)	

Get a single record (cell) from a model by index.

PARAMETER mod ||| TABLE (Layout_Model2) — The model (DATASET(layout_model2)) from which to extract the cell.

PARAMETER indxs ||| SET (UNSIGNED4) — The id of the cell to extract (e.g. [3,1,5]).

PARAMETER wi_num ||| INTEGER8 — The work-item number to extract the cell from, default = 1.

RETURN ROW (Layout_Model2) — The model cell (Layout_Model2) or an empty cell (wi=0) if not found.

SETITEM SetItem

ModelOps2 \

DATASET(Layout_Model2)	SetItem
(DATASET(Layout_Model2) mod, t_work_item wi, t_indexes indexes, t_fieldReal value)	

Add a single record (cell) to an model at a given set of coordinates.

PARAMETER mod ||| TABLE (Layout_Model2) — The model to which to add a cell.

PARAMETER wi ||| UNSIGNED2 — The work-item associated with the cell.

PARAMETER indexes ||| SET (UNSIGNED4) — The indices for the cell.

PARAMETER value ||| REAL8 — The value of the cell.

RETURN TABLE (Layout_Model2) — Model with the added cell.

ToField

[Go Up](#)

DESCRIPTIONS

TOFIELD ToField

/ EXPORT	ToField
<code>(dIn, dOut, idfield=", wifield=", wivalue=", datafields=)</code>	

Convert a record-oriented dataset to a cell-oriented NumericField dataset for use with Machine Learning mechanisms.

ToField Macro takes a record-oriented dataset, with each row containing an ID and one or more numeric fields, and expands it into the NumericField format used by ML.

Note that as a Macro, nothing is returned, but new attributes are created in-line for use in subsequent definitions.

Along with creating the NumericField table, this macro produces two simple functions to assist the user in mapping the field names to their corresponding numbers. These are "STRING dOut_ToName(UNSIGNED)" and "UNSIGNED dOut_ToNumber(STRING)", where the "dOut" portion of the function name is the name passed into that parameter of the macro.

The macro also produces a mapping table named "dOut_Map", again where "dOut" refers to the parameter, that contains a table of the field mappings. See Types.Field_Mapping for the layout of this mapping dataset. Examples:

```
ML.ToField(dOrig,dMatrix);
ML.ToField(dOrig,dMatrix,myid,'field5,field7,field10');
dMatrix\_ToName(2);    // returns 'field7'
dMatrix\_ToNumber('field10'); // returns 3
dMatrix\_Map;  // returns the mapping table of field name to number see
               // Types.Field\_Mapping
```

PARAMETER dIn ||| INTEGER8 — The name of the input dataset.

PARAMETER dOut ||| INTEGER8 — The name of the resulting dataset.

PARAMETER idfield ||| INTEGER8 — [OPTIONAL] The name of the field that contains the UID for each row. If omitted, it is assumed to be the first field.

PARAMETER wifield ||| INTEGER8 — [OPTIONAL] The name of the field that contains the work item value. A constant is used if the field name is not supplied (as provided by wivalue below).

PARAMETER wivalue ||| INTEGER8 — [OPTIONAL] The constant value to use for work item. The value 1 is used if not supplied.

PARAMETER datafields ||| INTEGER8 — [OPTIONAL] A STRING containing a comma-delimited list of the fields to be treated as axes. If omitted, all numeric fields that are not the idfield or wifield will be treated as axes. NOTE: idfield defaults to the first field in the table, so if that field is specified as an axis field, then the user should be sure to specify a value in the idfield param.

RETURN — Nothing. The MACRO creates new attributes in-line as described above.

SEE Types.NumericField

SEE Types.Field_Mapping

Types

[Go Up](#)

DESCRIPTIONS

TYPES Types

	Types
--	-------

This module provides the major data type definitions for use with the various ML Bundles

Children

1. [t_RecordID](#) : No Documentation Found
2. [t_FieldNumber](#) : No Documentation Found
3. [t_FieldReal](#) : No Documentation Found
4. [t_FieldSign](#) : No Documentation Found
5. [t_Discrete](#) : No Documentation Found
6. [t_Item](#) : No Documentation Found
7. [t_Count](#) : No Documentation Found
8. [t_Work_Item](#) : No Documentation Found
9. [t_index](#) : No Documentation Found
10. [t_indexes](#) : No Documentation Found
11. [AnyField](#) : No Documentation Found
12. [NumericField](#) : The NumericField layout defines a matrix of Real valued data-points
13. [DiscreteField](#) : The Discrete Field layout defines a matrix of Integer valued data-points
14. [Layout_Model2](#) : Layout for Model dataset (version 2) Generic Layout describing the model 'learned' by a Machine Learning algorithm

15. [Layout_Model](#) : No Documentation Found
 16. [Classify_Result](#) : No Documentation Found
 17. [l_result](#) : No Documentation Found
 18. [Class_Stats](#) : Class_Stats
 19. [Confusion_Detail](#) : Confusion_Detail
 20. [Classification_Accuracy](#) : Classification_Accuracy
 21. [Class_Accuracy](#) : Class_Accuracy Results layout for Analysis.Classification.AccuracyByClass See https://en.wikipedia.org/wiki/Precision_and_recall for a more detailed explanation
 22. [AUC_Result](#) : AUC_Result Result layout for Analysis.Classification.AUC
 23. [Regression_Accuracy](#) : Regression_Accuracy
 24. [Contingency_Table](#) : Contingency_Table Contains the contingency table for every combination of feature and classifier
 25. [Chi2_Result](#) : Chi2_Result Result layout for Analysis.FeatureSelection.Chi2 Contains chi2 value for every combination of feature and classifier per work item, and its corresponding p value
 26. [ARI_Result](#) : ARI_Result Result layout for Analysis.Clustering.ARI Contains the Adjusted Rand Index for each work item
 27. [SampleSilhouette_Result](#) : SampleSilhouette_Result Result layout for Analysis.Clustering.SampleSilhouetteScore Contains the silhouette score for each sample datapoint
 28. [Silhouette_Result](#) : Silhouette_Result Result layout for Analysis.Clustering.SilhouetteScore Contains the silhouette score for each work item
 29. [ClusterLabels](#) : ClusterLabels format defines the distance space where each cluster defined by a center and its closest samples
 30. [Data_Diagnostic](#) : No Documentation Found
 31. [Field_Mapping](#) : Field_Mapping is the format produced by ToField for field-name mapping
 32. [LUCI_Rec](#) : LUCI Record – A dataset of lines each containing a string This is the DATASET format in which ML algorithm export LUCI files
 33. [Classification_Scores](#) : Classification_Scores The probability or confidence, per class, that a sample belongs to that class
-

T_RECORDID t_RecordID

[Types \](#)

	t_RecordID
--	------------

No Documentation Found

RETURN UNSIGNED8 —

T_FIELDNUMBER t_FieldNumber

[Types \](#)

	t_FieldNumber
--	---------------

No Documentation Found

RETURN UNSIGNED4 —

T_FIELDREAL t_FieldReal

[Types \](#)

	t_FieldReal
--	-------------

No Documentation Found

RETURN REAL8 —

T_FIELDSIGN t_FieldSign

[Types \](#)

	t_FieldSign
--	-------------

No Documentation Found

RETURN INTEGER1 —

T_DISCRETE t_Discrete

[Types \](#)

	t_Discrete
--	------------

No Documentation Found

RETURN INTEGER4 —

T_ITEM t_Item

[Types \](#)

	t_Item
--	--------

No Documentation Found

RETURN UNSIGNED4 —

T_COUNT t_Count

[Types \](#)

	t_Count
--	---------

No Documentation Found

RETURN UNSIGNED8 —

T_WORK_ITEM t_Work_Item

[Types \](#)

	t_Work_Item
--	-------------

No Documentation Found

RETURN UNSIGNED2 —

T_INDEX t_index

[Types \](#)

	t_index
--	---------

No Documentation Found

RETURN UNSIGNED4 —

T_INDEXES t_indexes

[Types \](#)

	t_indexes
--	-----------

No Documentation Found

RETURN SET (UNSIGNED4) —

ANYFIELD AnyField

[Types \](#)

	AnyField
--	----------

No Documentation Found

FIELD wi ||| UNSIGNED2 — No Doc

FIELD id ||| UNSIGNED8 — No Doc

FIELD number ||| UNSIGNED4 — No Doc

NUMERICFIELD NumericField

[Types \](#)

	NumericField
--	--------------

The NumericField layout defines a matrix of Real valued data-points. It acts as the primary Dataset layout for interacting with most ML Functions. Each record represents a single cell in a matrix. It is most often used to represent a set of data-samples or observations, with the 'id' field representing the data-sample or observation, and the 'number' field representing the various fields within the observation.

FIELD wi ||| UNSIGNED2 — The work-item id, supporting the Myriad style interface. This allows multiple independent matrixes to be contained within a single dataset, supporting independent ML activities to be processed in parallel.

FIELD id ||| UNSIGNED8 — This field represents the row-number of this cell of the matrix. It is also considered the record-id for observations / data-samples.

FIELD number ||| UNSIGNED4 — This field represents the matrix column number for this cell. It is also considered the field number of the observation

FIELD value ||| REAL8 — The value of this cell in the matrix.

DISCRETEFIELD DiscreteField

Types \

	DiscreteField
--	---------------

The Discrete Field layout defines a matrix of Integer valued data-points. It is similar to the NumericField layout above, except for only containing discrete (integer) values. It is typically used to convey the class-labels for classification algorithms.

FIELD wi ||| UNSIGNED2 — The work-item id, supporting the Myriad style interface. This allows multiple independent matrixes to be contained within a single dataset, supporting independent ML activities to be processed in parallel.

FIELD id ||| UNSIGNED8 — This field represents the row-number of this cell of the matrix. It is also considered the record-id for observations / data-samples.

FIELD number ||| UNSIGNED4 — This field represents the matrix column number for this cell. It is also considered the field number of the observation

FIELD value ||| INTEGER4 — The value of this cell in the matrix.

LAYOUT_MODEL2 Layout_Model2

Types \

	Layout_Model2
--	---------------

Layout for Model dataset (version 2) Generic Layout describing the model 'learned' by a Machine Learning algorithm. Models for all new ML bundles are stored in this format. Some older bundles may still use the Layout_Model (version 1) layout. Models are thought of as opaque data structures. They are not designed to be understandable except to the bundle that produced them. Most bundles contain mechanisms to extract useful information from the model. This version of the model is based on a Naming-Tree paradigm. This provides a flexible generic mechanism for storage and manipulation of models. For bundle developers (or the curious), the file modelOps2 provides a detailed description of the theory and usage of this model layout as well as a set of functions to manipulate models for use by bundle developers.

FIELD wi ||| UNSIGNED2 — The work-item-id

FIELD value ||| REAL8 — The value of the cell

FIELD indexes ||| SET (UNSIGNED4) — The identifier for the cell – a set of unsigned integers e.g., [1,2,1,3]

LAYOUT_MODEL Layout_Model

Types \

Layout_Model

No Documentation Found

FIELD wi ||| UNSIGNED2 — No Doc

FIELD id ||| UNSIGNED8 — No Doc

FIELD number ||| UNSIGNED4 — No Doc

FIELD value ||| REAL8 — No Doc

CLASSIFY_RESULT Classify_Result

Types \

Classify_Result

No Documentation Found

FIELD wi ||| UNSIGNED2 — No Doc

FIELD id ||| UNSIGNED8 — No Doc

FIELD number ||| UNSIGNED4 — No Doc

FIELD value ||| INTEGER4 — No Doc

FIELD conf ||| REAL8 — No Doc

L_RESULT l_result

Types \

	l_result
--	----------

No Documentation Found

CLASS_STATS Class_Stats

Types \

	Class_Stats
--	-------------

Class_Stats Layout for data returned from Analysis.Regression.ClassStats

FIELD wi ||| UNSIGNED2 — Work-item identifier

FIELD classifier ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate classification. Otherwise 1.

FIELD class ||| INTEGER4 — The class label associated with this record

FIELD classCount ||| INTEGER4 — The number of times the class was seen in the data

FIELD classPct ||| REAL8 — The percent of records with this class.

CONFUSION_DETAIL Confusion_Detail

Types \

	Confusion_Detail
--	------------------

Confusion_Detail Layout for storage of the confusion matrix for ML Classifiers Each row represents a pairing of a predicted class and an actual class

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD classifier ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD actual_class ||| INTEGER4 — The target class number – the expected result.

FIELD predict_class ||| INTEGER4 — The class number predicted by the ML algorithm

FIELD occurs ||| UNSIGNED4 — The number of times this pairing of (actual / predicted) classes occurred

FIELD correct ||| BOOLEAN — Boolean indicating if this represents a correct prediction (i.e. predicted = actual)

FIELD pctActual ||| REAL8 — The percent of items that were actually of <actual_class> that were predicted as <predict_class>.</predict_class></actual_class>

FIELD pctPred ||| REAL8 — Indicates the percent of items that were predicted as <predict_class> that were actually of <actual_class>.</actual_class></predict_class>

CLASSIFICATION_ACCURACY Classification_Accuracy

Types \

	Classification_Accuracy
--	-------------------------

Classification_Accuracy Results layout for Analysis.Classification/Accuracy

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD classifier ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD errCnt ||| UNSIGNED8 — The number of errors (i.e. predicted <> actual)

FIELD recCnt ||| UNSIGNED8 — The total number or records in the test set

FIELD Raw_Accuracy ||| REAL8 — The percentage of samples properly classified (0.0 - 1.0)

FIELD PoD ||| REAL8 — Power of Discrimination. Indicates how this classification performed relative to a random guess of class. Zero or negative indicates that the classification was no better than a random guess. 1.0 indicates a perfect classification. For example if there are two equi-probable classes, then a random guess would be right about 50% of the time. If this classification had a Raw Accuracy of 75%, then its PoD would be .5 (half way between a random guess and perfection).

FIELD PoDE ||| REAL8 — Power of Discrimination Extended. Indicates how this classification performed relative to guessing the most frequent class (i.e. the trivial solution). Zero or negative indicates that this classification is no better than the trivial solution. 1.0 indicates perfect classification. For example, if 95% of the samples were of class 1, then the trivial solution would be right 95% of the time. If this classification had a raw accuracy of 97.5%, its PoDE would be .5 (i.e. half way between trivial solution and perfection).

FIELD Hamming_Loss ||| REAL8 — Hamming loss. The percentage of records misclassified. Useful for multilabel classification. It is equal to 1 - Raw_Accuracy.

CLASS_ACCURACY **Class_Accuracy**

Types \

Class_Accuracy

Class_Accuracy Results layout for Analysis.Classification.AccuracyByClass See https://en.wikipedia.org/wiki/Precision_and_recall for a more detailed explanation.

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD classifier ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD class ||| INTEGER4 — The class to which the analytics apply

FIELD precision ||| REAL8 — The precision of the classification for this class (i.e. True Positives / (True Positives + FalsePositives)). What percentage of the items that we predicted as being in this class are actually of this class?

FIELD recall ||| REAL8 — The completeness of recall for this class (i.e. True Positives / (True Positives + False Negatives)) What percentage of the items that are actually in this class did we correctly predict as this class?

FIELD **FPR** ||| REAL8 — The false positive rate for this class (i.e. False Positives / (False Positives + True Negatives)) What percentage of the items not in this class did we falsely predict as this class?

FIELD **f_score** ||| REAL8 — The balanced F-score for this class (i.e. $2 * (\text{precision} * \text{recall}) / (\text{precision} + \text{recall})$) The harmonic mean of precision and recall. Higher values are better.

AUC_RESULT AUC_Result

Types \

	AUC_Result
--	------------

AUC_Result Result layout for Analysis.Classification.AUC. Provides the area under the Receiver Operating Characteristic curve for the given data. This area is a measure of the classifier's ability to distinguish between classes.

FIELD **wi** ||| UNSIGNED2 — Work item identifier

FIELD **classifier** ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD **class** ||| INTEGER4 — The class to which the analytics apply.

FIELD **AUC** ||| REAL8 — The value of the Area Under the Receiver Operating Characteristic curve for this class. This value ranges between 0 and 1. A higher value is an indication of a better classifier.

REGRESSION_ACCURACY Regression_Accuracy

Types \

	Regression_Accuracy
--	---------------------

Regression_Accuracy Results layout for Analysis.Reggression.Accuracy

FIELD **wi** ||| UNSIGNED2 — Work item identifier

FIELD regressor ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD R2 ||| REAL8 — The R-Squared value (Coefficient of Determination) for the regression. R-squared of zero or negative indicates that the regression has no predictive value. R2 of 1 would indicate a perfect regression.

FIELD MSE ||| REAL8 — Mean Squared Error = $\text{SUM}((\text{predicted} - \text{actual})^2) / N$ (number of datapoints)

FIELD RMSE ||| REAL8 — Root Mean Squared Error = $\text{MSE}^{.5}$ (Square root of MSE)

CONTINGENCY_TABLE Contingency_Table

Types \

Contingency_Table

Contingency_Table Contains the contingency table for every combination of feature and classifier. Result layout for Analysis.FeatureSelection.Contingency

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD fnumber ||| UNSIGNED4 — The feature number

FIELD snumber ||| UNSIGNED4 — The sample number or the classifier number

FIELD fclass ||| INTEGER4 — The feature label / class

FIELD sclass ||| INTEGER4 — The sample (classifier) label / class

FIELD cnt ||| INTEGER8 — The number of samples with feature label fclass and classifier label sclass
Does not contain entries for combinations with no members.

CHI2_RESULT Chi2_Result

Types \

Chi2_Result

Chi2_Result Result layout for Analysis.FeatureSelection.Chi2 Contains chi2 value for every combination of feature and classifier per work item, and its corresponding p value.

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD fnumber ||| UNSIGNED4 — Feature number

FIELD snumber ||| UNSIGNED4 — Sample number / number of classifier

FIELD dof ||| INTEGER8 — The number of degrees of freedom

FIELD x2 ||| REAL8 — The chi2 value for this combination. Higher values indicate more closely related variables

FIELD p ||| REAL8 — The p-value, which is the area under the chi-square probability density function curve to the right of the specified x2 value. The probability that the variables are not closely related

ARI_RESULT ARI_Result

Types \

	ARI_Result
--	------------

ARI_Result Result layout for Analysis.Clustering.ARI Contains the Adjusted Rand Index for each work item.

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD value ||| REAL8 — The ARI for the model

SAMPLESILHOUETTE_RESULT SampleSilhouette_Result

Types \

	SampleSilhouette_Result
--	-------------------------

SampleSilhouette_Result Result layout for Analysis.Clustering.SampleSilhouetteScore Contains the silhouette score for each sample datapoint.

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD id ||| UNSIGNED8 — Sample datapoint identifier

FIELD value ||| REAL8 — Silhouette score

SILHOUETTE_RESULT Silhouette_Result

Types \

	Silhouette_Result
--	--------------------------

Silhouette_Result Result layout for Analysis.Clustering.SilhouetteScore Contains the silhouette score for each work item.

FIELD wi ||| UNSIGNED2 — Work item identifier

FIELD score ||| REAL8 — Silhouette score

CLUSTERLABELS ClusterLabels

Types \

	ClusterLabels
--	----------------------

ClusterLabels format defines the distance space where each cluster defined by a center and its closest samples. It is the same as KMeans.Types.KMeans_Model.Labels.

FIELD wi ||| UNSIGNED2 — The model identifier.

FIELD id ||| UNSIGNED8 — The sample identifier.

FIELD label ||| UNSIGNED8 — The identifier of the closest center to the sample.

DATA_DIAGNOSTIC Data_Diagnostic

[Types \](#)

	Data_Diagnostic
--	-----------------

No Documentation Found

FIELD wi ||| UNSIGNED2 — No Doc

FIELD valid ||| BOOLEAN — No Doc

FIELD message_text ||| SET (VARSTRING) — No Doc

FIELD_MAPPING Field_Mapping

[Types \](#)

	Field_Mapping
--	---------------

Field_Mapping is the format produced by ToField for field-name mapping.

FIELD orig_name ||| STRING — The name of the field in the original layout

FIELD assigned_name ||| STRING — The integer field number used in the ML algorithm stored as a STRING

LUCI_REC LUCI_Rec

[Types \](#)

	LUCI_Rec
--	----------

LUCI Record – A dataset of lines each containing a string This is the DATASET format in which ML algorithm export LUCI files.

FIELD line ||| STRING — A single line in the LUCI csv file

CLASSIFICATION_SCORES Classification_Scores

Types \

	Classification_Scores
--	-----------------------

Classification_Scores The probability or confidence, per class, that a sample belongs to that class.

FIELD wi ||| UNSIGNED2 — The work-item identifier.

FIELD id ||| UNSIGNED8 — The record-id of the sample.

FIELD classifier ||| UNSIGNED4 — The field number associated with this dependent variable, for multi-variate. Otherwise 1.

FIELD class ||| INTEGER4 — The class label.

FIELD prob ||| REAL8 — The percentage of trees that assigned this class label, which is a rough stand-in for the probability that the label is correct.

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ICLASSIFY IClassify

	IClassify
--	-----------

DEPRECATED Interface Definition for Classification Modules (version 1). This interface is being deprecated and should not be used for new bundles or bundles undergoing substantial revision. Please use IClassify2 going forward. Interface definition for Classification. Actual implementation modules will probably take parameters.

Children

1. [GetModel](#) : Calculate the model to fit the observation data to the observed classes
 2. [Classify](#) : Classify the observations using a model
 3. [Report](#) : Report the confusion matrix for the classifier and training data
-

GETMODEL GetModel

IClassify \

DATASET (Types.Layout_Model)	GetModel
(DATASET(Types.NumericField) observations, DATASET(Types.DiscreteField) classifications)	

Calculate the model to fit the observation data to the observed classes.

PARAMETER observations ||| TABLE (NumericField) — the observed explanatory values.

PARAMETER classifications ||| TABLE (DiscreteField) — the observed classification used to build.
the model

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8
value }) — the encoded model

CLASSIFY Classify

IClassify \

DATASET (Types.Classify_Result)	Classify
(DATASET(Types.Layout_Model) model, DATASET(Types.NumericField) new_observations)	

Classify the observations using a model.

PARAMETER model ||| TABLE (Layout_Model) — The model, which must be produced by a
corresponding getModel function.

PARAMETER new_observations ||| TABLE (NumericField) — observations to be classified.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number ,
INTEGER4 value , REAL8 conf }) — Classification with a confidence value.

REPORT Report

IClassify \

<code>DATASET(Types.Confusion_Detail)</code>	Report
<code>(DATASET(Types.Layout_Model) model, DATASET(Types.NumericField) observations, DATASET(Types.DiscreteField) classifications)</code>	

Report the confusion matrix for the classifier and training data.

PARAMETER model ||| TABLE (Layout_Model) — the encoded model.

PARAMETER observations ||| TABLE (NumericField) — the explanatory values.

PARAMETER classifications ||| TABLE (DiscreteField) — the classifications associated with the observations.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 actual_class , INTEGER4 predict_class , UNSIGNED4 occurs , BOOLEAN correct , REAL8 pctActual , REAL8 pctPred }) — the confusion matrix showing correct and incorrect results.

Interfaces/ IClassify2

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IMPORTS

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DESCRIPTIONS

ICLASSIFY2 IClassify2

	IClassify2
--	-------------------

Interface definition for Classification (Version 2). Classification learns a function that maps a set of input data to one or more output class-label (i.e. Discrete) variables. The resulting learned function is known as the model. That model can then be used repetitively to predict the class(es) for each sample when presented with new input data. Actual implementation modules will probably take configuration parameters to control the classification process. The Classification modules also expose attributes for assessing the effectiveness of the classification.

Children

1. [GetModel](#) : Calculate the model to fit the independent data to the observed classes (i.e
2. [Classify](#) : Classify the observations using a model
3. [Accuracy](#) : Return accuracy metrics for the given set of test data
This is equivalent to calling Predict followed by Analysis.Classification.Accuracy(...)
4. [AccuracyByClass](#) : Return class-level accuracy by class metrics for the given set of test data
5. [ConfusionMatrix](#) : Return the confusion matrix for a set of test data

GETMODEL GetModel

[IClassify2](#) \

DATASET(Layout_Model2)	GetModel
(DATASET(NumericField) <u>independents</u> , DATASET(DiscreteField) <u>dependents</u>)	

Calculate the model to fit the independent data to the observed classes (i.e. dependent data).

PARAMETER independents ||| — The observed independent (explanatory) values.

PARAMETER dependents ||| TABLE (DiscreteField) — The observed dependent(class label) values.

PARAMETER independents ||| TABLE (NumericField) — No Doc

RETURN TABLE ({ UNSIGNED2 wi , REAL8 value , SET (UNSIGNED4) indexes })
— The encoded model.

SEE Types.Layout_Model2

SEE Types.NumericField

SEE Types.DiscreteField

CLASSIFY Classify

[IClassify2](#) \

DATASET(DiscreteField)	Classify
(DATASET(Layout_Model2) <u>model</u> , DATASET(NumericField) <u>observations</u>)	

Classify the observations using a model.

PARAMETER model ||| TABLE (Layout_Model2) — The model, which must be produced by a corresponding getModel function.

PARAMETER observations ||| TABLE (NumericField) — New observations (independent data) to be classified.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , INTEGER4 value }) — Predicted class values.

ACCURACY Accuracy

IClassify2 \

<code>DATASET(Classification_Accuracy)</code>	Accuracy
<code>(DATASET(Layout_Model2) model, DATASET(DiscreteField) actuals, DATASET(NumericField) observations)</code>	

Return accuracy metrics for the given set of test data

This is equivalent to calling Predict followed by Analysis.Classification.Accuracy(...).

Provides accuracy statistics as follows:

- `errCount` – The number of misclassified samples.
- `errPct` – The percentage of samples that were misclassified (0.0 - 1.0).
- `RawAccuracy` – The percentage of samples properly classified (0.0 - 1.0).
- `PoD` – Power of Discrimination. Indicates how this classification performed relative to a random guess of class. Zero or negative indicates that the classification was no better than a random guess. 1.0 indicates a perfect classification. For example if there are two equiprobable classes, then a random guess would be right about 50% of the time. If this classification had a Raw Accuracy of 75%, then its PoD would be .5 (half way between a random guess and perfection).
- `PoDE` – Power of Discrimination Extended. Indicates how this classification performed relative to guessing the most frequent class (i.e. the trivial solution). Zero or negative indicates that this classification is no better than the trivial solution. 1.0 indicates perfect classification. For example, if 95% of the samples were of class 1, then the trivial solution would be right 95% of the time. If this classification had a raw accuracy of 97.5%, its PoDE would be .5 (i.e. half way between trivial solution and perfection).

Normally, this should be called using data samples that were not included in the training set. In that case, these statistics are considered Out-of-Sample error statistics. If it is called with the X and Y from the training set, it provides In-Sample error statistics, which should never be used to rate the classification model.

PARAMETER model ||| TABLE (Layout_Model2) — The encoded model as returned from GetModel.

PARAMETER actuals ||| TABLE (DiscreteField) — The actual class values associated with the observations.

PARAMETER observations ||| TABLE (NumericField) — The independent (explanatory) values on which to base the test.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 recCnt , UNSIGNED8 errCnt , REAL8 Raw_Accuracy , REAL8 PoD , REAL8 PoDE , REAL8 Hamming_Loss }) — DATASET(Classification_Accuracy), one record per work-item.

SEE Types.Classification_Accuracy

ACCURACYBYCLASS AccuracyByClass

IClassify2 \

DATASET(Class_Accuracy)	AccuracyByClass
(DATASET(Layout_Model2) model, DATASET(DiscreteField) actuals, DATASET(NumericField) observations)	

Return class-level accuracy by class metrics for the given set of test data.

This is equivalent to calling Predict followed by Analysis.Classification.AccuracyByClass(...).

PARAMETER model ||| TABLE (Layout_Model2) — The encoded model as returned from GetModel.

PARAMETER actuals ||| TABLE (DiscreteField) — The actual class values associated with the observations.

PARAMETER observations ||| TABLE (NumericField) — The independent (explanatory) values on which to base the test

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 class , REAL8 precision , REAL8 recall , REAL8 FPR , REAL8 f_score }) — DATASET(Class_Accuracy), one record per work-item per class.

SEE Types.Class_Accuracy.

CONFUSIONMATRIX ConfusionMatrix

IClassify2 \

<code>DATASET(Confusion_Detail)</code>	<code>ConfusionMatrix</code>
<code>(DATASET(Layout_Model2) model, DATASET(DiscreteField) actuals, DATASET(NumericField) observations)</code>	

Return the confusion matrix for a set of test data. This is equivalent to calling Predict followed by Analysis.Classification.ConfusionMatrix(...).

The confusion matrix indicates the number of datapoints that were classified correctly or incorrectly for each class label.

The matrix is provided as a matrix of size numClasses x numClasses with fields as follows:

- 'wi' – The work item id
- 'pred' – the predicted class label (from Classify).
- 'actual' – the actual (target) class label.
- 'samples' – the count of samples that were predicted as 'pred', but should have been 'actual'.
- 'totSamples' – the total number of samples that were predicted as 'pred'.
- 'pctSamples' – the percentage of all samples that were predicted as 'pred', that should have been 'actual' (i.e. samples / totSamples)

This is a useful tool for understanding how the algorithm achieved the overall accuracy. For example: were the common classes mostly correct, while less common classes often misclassified? Which classes were most often confused? This should be called with test data that is independent of the training data in order to understand the out-of-sample (i.e. generalization) performance.

PARAMETER model ||| TABLE (Layout_Model2) — The encoded model as returned from GetModel.

PARAMETER actuals ||| TABLE (DiscreteField) — The actual class values.

PARAMETER observations ||| TABLE (NumericField) — The independent (explanatory) values.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 actual_class , INTEGER4 predict_class , UNSIGNED4 occurs , BOOLEAN correct , REAL8 pctActual , REAL8 pctPred }) — DATASET(Confusion_Detail), one record per cell of the confusion matrix.

SEE Types.Confusion_Detail.

Interfaces/ IRegression

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DESCRIPTIONS

IRegression IRegression

/ EXPORT	IRegression
(DATASET(NumericField) X=empty_data, DATASET(NumericField) Y=empty_data)	

DEPRECATED Interface Definition for Regression Modules (version 1). This interface is being deprecated and should not be used for new bundles or bundles undergoing substantial revision. Please use IRegression2 going forward. Regression learns a function that maps a set of input data to one or more output variables. The resulting learned function is known as the model. That model can then be used repetitively to predict (i.e. estimate) the output value(s) based on new input data.

PARAMETER X ||| TABLE (NumericField) — The independent data in DATASET(NumericField) format. Each statistical unit (e.g. record) is identified by 'id', and each feature is identified by field number (i.e. 'number').

PARAMETER Y ||| TABLE (NumericField) — The dependent variable(s) in DATASET(NumericField) format. Each statistical unit (e.g. record) is identified by 'id', and each feature is identified by field number (i.e. 'number').

Children

1. [GetModel](#) : Calculate and return the 'learned' model
2. [Predict](#) : Predict the output variable(s) based on a previously learned model

GETMODEL GetModel

[IRegression](#) \

DATASET(Layout_Model)	GetModel
---------------------------------------	-----------------

Calculate and return the 'learned' model. The model may be persisted and later used to make predictions using 'Predict' below.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — DATASET(LayoutModel) describing the learned model parameters.

PREDICT Predict

[IRegression](#) \

DATASET(NumericField)	Predict
(DATASET(NumericField) newX, DATASET(Layout_Model) model)	

Predict the output variable(s) based on a previously learned model.

PARAMETER newX ||| TABLE (NumericField) — DATASET(NumericField) containing the X values to b predicted.

PARAMETER model ||| TABLE (Layout_Model) — No Doc

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — DATASET(NumericField) containing one entry per observation (i.e. id) in newX. This represents the predicted values for Y.

Interfaces/ IRegression2

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DESCRIPTIONS

IRegression2 IRegression2

IRegression2

Interface Definition for Regression Modules (Version 2). Regression learns a function that maps a set of input data to one or more continuous output variables. The resulting learned function is known as the model. That model can then be used repetitively to predict (i.e. estimate) the output value(s) based on new input data. Actual implementation modules will probably take configuration parameters to control the regression process. The regression modules also expose attributes for assessing the effectiveness of the regression.

Children

1. [GetModel](#) : Calculate and return the 'learned' model
 2. [Predict](#) : Predict the output variable(s) based on a previously learned model
 3. [Accuracy](#) : Assess the accuracy of a set of predictions
-

GETMODEL GetModel

[IRegression2](#) \

<code>DATASET(Layout_Model2)</code>	GetModel
<code>(DATASET(NumericField) independents, DATASET(NumericField) dependents)</code>	

Calculate and return the 'learned' model.

The model may be persisted and later used to make predictions using 'Predict' below.

PARAMETER **`independents`** ||| `TABLE (NumericField)` — The independent data in `DATASET(NumericField)` format. Each statistical unit (e.g. record) is identified by 'id', and each feature is identified by field number (i.e. 'number').

PARAMETER **`dependents`** ||| `TABLE (NumericField)` — The dependent variable(s) in `DATASET(NumericField)` format. Each statistical unit (e.g. record) is identified by 'id', and each feature is identified by field number (i.e. 'number').

RETURN `TABLE ({ UNSIGNED2 wi , REAL8 value , SET (UNSIGNED4) indexes })`
— The encoded model.

SEE `Types.NumericField`

SEE `Types.Layout_Model2`

PREDICT Predict

[IRegression2](#) \

<code>DATASET(NumericField)</code>	Predict
<code>(DATASET(Layout_Model2) model, DATASET(NumericField) observations)</code>	

Predict the output variable(s) based on a previously learned model

PARAMETER **`independents`** ||| — the observations upon which to predict.

PARAMETER model ||| TABLE (Layout_Model2) — No Doc

PARAMETER observations ||| TABLE (NumericField) — No Doc

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — one entry per observation (i.e. id) in observations. This represents the predicted values for the dependent variable(s).

ACCURACY Accuracy

[IRegression2](#) \

<code>DATASET(Regression_Accuracy)</code>	Accuracy
<code>(DATASET(Layout_Model2) model, DATASET(NumericField) actuals, DATASET(NumericField) observations)</code>	

Assess the accuracy of a set of predictions. This is equivalent to calling predict and then Analysis.Regression.Accuracy.

PARAMETER model ||| TABLE (Layout_Model2) — The model as returned from GetModel

PARAMETER actuals ||| TABLE (NumericField) — The actual values of the dependent variable to compare with the predictions.

PARAMETER observations ||| TABLE (NumericField) — The independent data upon which the accuracy assessment is to be based.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED4 regressor , REAL8 R2 , REAL8 MSE , REAL8 RMSE }) — Accuracy statistics (see Types.Regression_Accuracy for details)

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Math |

DESCRIPTIONS

BETA Beta

/ EXPORT	Beta
(REAL8 <u>x</u> , REAL8 <u>y</u>)	

Compute the beta value of two positive real numbers, x and y.

PARAMETER x ||| REAL8 — the value of the first number

PARAMETER y ||| REAL8 — the value of the second number

RETURN REAL8 — the beta value

Math/ Distributions

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IMPORTS

Constants | Math |

DESCRIPTIONS

DISTRIBUTIONS Distributions

	Distributions
--	---------------

Compute PDF, CDF, and PPF values for various Probability Distributions.

The Probability Density Function(PDF(x)) of a distribution is the relative likelihood of a sample drawn from that distribution being of value x.

The Cumulative Distribution Function (CDF(x)) of a distribution is the probability of a sample drawn from that distribution to be less than or equal to x.

The Percentage Point Function (PPF(x)) of a distribution is the inverse of the CDF. Given a probability, it returns the value at which the probability of occurrence is less than or equal to the given probability.

Children

1. [Normal_CDF](#) : Cumulative Distribution Function (CDF) of the standard normal distribution
2. [Normal_PPF](#) : Percentage Point Function (PPF) for the Normal Distribution
3. [T_CDF](#) : Cumulative Distribution Function (CDF) for Students t distribution

4. [T_PPF](#) : Percentage point function (PPF) for the T distribution
5. [Chi2_CDF](#) : The Cumulative Distribution Function (CDF) for the Chi Square distribution for the specified degrees of freedom
6. [Chi2_PPF](#) : Probability Point Function (PPF) for the Chi Squared distribution

NORMAL_CDF Normal_CDF

[Distributions](#) \

REAL8	Normal_CDF
(REAL8 x)	

Cumulative Distribution Function (CDF) of the standard normal distribution. The probability that a normal random variable will be smaller than or equal to x standard deviations above or below the mean.

Taken from C/C++ Mathematical Algorithms for Scientists and Engineers, n. Shamma, McGraw-Hill, 1995.

PARAMETER x ||| REAL8 — the number of standard deviations.

RETURN REAL8 — probability of exceeding x.

NORMAL_PPF Normal_PPF

[Distributions](#) \

REAL8	Normal_PPF
(REAL8 x)	

Percentage Point Function (PPF) for the Normal Distribution.

Translated from C/C++ Mathematical Algorithms for Scientists and Engineers, N. Shamma, McGraw-Hill, 1995.

PARAMETER x ||| REAL8 — probability.

RETURN REAL8 — number of standard deviations from the mean.

T_CDF T_CDF

[Distributions \](#)

REAL8	T_CDF
(REAL8 x, REAL8 df)	

Cumulative Distribution Function (CDF) for Students t distribution.

The integral evaluated between negative infinity and x.

Translated from NIST SEL DATAPAC Fortran TCDF.f source.

PARAMETER x ||| REAL8 — value of the evaluation.

PARAMETER df ||| REAL8 — degrees of freedom.

RETURN REAL8 — the probability that a value will be less than or equal to the specified value.

T_PPF T_PPF

[Distributions \](#)

REAL8	T_PPF
(REAL8 x, REAL8 df)	

Percentage point function (PPF) for the T distribution.

Translated from NIST SEL DATAPAC Fortran TPPF.f source.

PARAMETER x ||| REAL8 — the probability.

PARAMETER df ||| REAL8 — degrees of freedom of the distribution.

RETURN REAL8 — the value with that probability.

CHI2_CDF Chi2_CDF

[Distributions](#) \

REAL8	Chi2_CDF
(REAL8 x, REAL8 df)	

The Cumulative Distribution Function (CDF) for the Chi Square distribution for the specified degrees of freedom.

Translated from the NIST SEL DATAPAC Fortran subroutine CHSCDF.

PARAMETER x ||| REAL8 — the value at which to compute.

PARAMETER df ||| REAL8 — the degrees of freedom of the distribution.

RETURN REAL8 — the cumulative probability.

CHI2_PPF Chi2_PPF

[Distributions](#) \

REAL8	Chi2_PPF
(REAL8 x, REAL8 df)	

Probability Point Function (PPF) for the Chi Squared distribution.

Translated from the NIST SEL DATAPAC Fortran subroutine CHSPPF.

PARAMETER x ||| REAL8 — the probability value.

PARAMETER df ||| REAL8 — the degrees of freedom of the distribution.

RETURN REAL8 — the value with that probability.

Math/ DoubleFac

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DESCRIPTIONS

DOUBLEFAC DoubleFac

/ EXPORT REAL8	DoubleFac
(INTEGER2 i)	

Compute the double factorial. The double factorial is defined for odd n as the product of all the odd numbers up to and including that number.

For even numbers it is the product of the even numbers up to and including that number.

Thus $\text{DoubleFac}(8) = 8*6*4*2$.

IF $i < 2$, the value 1 is returned.

PARAMETER i ||| INTEGER2 — the input value.

RETURN REAL8 — the numeric result.

Math/ Fac

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DESCRIPTIONS

FAC Fac

/ EXPORT REAL8	Fac
(UNSIGNED2 i)	

Factorial function, $(i)(i-1)(i-2)\dots(2)$

PARAMETER *i* ||| UNSIGNED2 — the input value.

RETURN REAL8 — the factorial $i!$.

Math/ gamma

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DESCRIPTIONS

GAMMA gamma

/ EXPORT REAL8	gamma
(REAL8 x)	

Compute the value of gamma function of real number x.

This is a wrapper for the standard C tgamma function.

PARAMETER \underline{x} ||| REAL8 — the input value.

RETURN REAL8 — the value of GAMMA evaluated at x.

Math/ log_gamma

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DESCRIPTIONS

LOG_GAMMA log_gamma

/ EXPORT REAL8	log_gamma
(REAL8 x)	

Compute the value of the log gamma function of the absolute value of X.

This is wrapper for the standard C lgamma function. Avoids the race condition found on some platforms by taking the absolute value of the input argument.

PARAMETER x ||| REAL8 — the input x.

RETURN REAL8 — the value of the log of the GAMMA evaluated at ABS(x).

Math/ lowerGamma

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DESCRIPTIONS

LOWERGAMMA lowerGamma

/ EXPORT REAL8	lowerGamma
(REAL8 x, REAL8 y)	

Compute the lower incomplete gamma value of two real numbers, x and y.

PARAMETER x ||| REAL8 — the value of the first number.

PARAMETER y ||| REAL8 — the value of the second number.

RETURN REAL8 — the lower incomplete gamma value.

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Math |

DESCRIPTIONS

NCK NCK

	NCK
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N Choose K – finds the number of combinations of K elements out of a possible N.

PARAMETER N ||| — the number of items in the population.

PARAMETER K ||| — the number of items to choose.

RETURN — the number of combinations.

Children

1. [NCK1](#) : No Documentation Found

NCK1 NCK1

NCK \

	NCK1
(INTEGER N, INTEGER K)	

No Documentation Found

PARAMETER n ||| INTEGER8 — No Doc

PARAMETER k ||| INTEGER8 — No Doc

RETURN REAL8 —

Math/ Poly

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DESCRIPTIONS

POLY Poly

/ EXPORT REAL8	Poly
(REAL8 x, SET OF REAL8 Coeffs)	

Evaluate a polynomial from a set of coefficients.

Coeffs 1 is assumed to be the HIGH order of the equation.

Thus for ax^2+bx+c - the set would need to be $\text{Coef} := [a,b,c]$;

PARAMETER x ||| REAL8 — the value of x in the polynomial.

PARAMETER Coeffs ||| SET (REAL8) — a set of coefficients for the polynomial. The ALL set is considered to be all zero values.

RETURN REAL8 — value of the polynomial at x.

Math/ StirlingFormula

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IMPORTS

Math | Constants |

DESCRIPTIONS

STIRLINGFORMULA StirlingFormula

/ EXPORT	StirlingFormula
(REAL x)	

Stirling's formula.

PARAMETER x ||| REAL8 — the point of evaluation.

RETURN REAL8 — evaluation result.

Math/ upperGamma

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DESCRIPTIONS

UPPERGAMMA upperGamma

/ EXPORT REAL8	upperGamma
(REAL8 x, REAL8 y)	

Compute the upper incomplete gamma value of two real numbers, x and y.

PARAMETER x ||| REAL8 — the value of the first number.

PARAMETER y ||| REAL8 — the value of the second number.

RETURN REAL8 — the upper incomplete gamma value.

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<code>; EXPORT</code>	<code>test__discrete</code>
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RETURN —

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SequenceInField.ecl
Assign sequence numbers within groups for a dataset

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Types |

DESCRIPTIONS

FAT Fat

<code>/ EXPORT DATASET(Types.NumericField)</code>	Fat
<code>(DATASET(Types.NumericField) d0, Types.t_FieldReal v=0)</code>	

Make a sparse NumericField dataset dense by filling in missing values. All empty cells are set to the designated value.

PARAMETER d0 ||| TABLE (NumericField) — They NumericField dataset to be filled.

PARAMETER v ||| REAL8 — The value to assign missing records.

RETURN TABLE ({ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value }) — A full NumericField dataset with every field populated.

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IMPORTS

Types |

DESCRIPTIONS

FATD FatD

<code>/ EXPORT DATASET(Types.DiscreteField)</code>	FatD
<code>(DATASET(Types.DiscreteField) d0, Types.t_Discrete v=0)</code>	

Make a sparse DiscreteField dataset dense by filling in missing values. All empty cells are set to the designated value.

PARAMETER **d0** ||| TABLE (DiscreteField) — The DiscreteField dataset to be filled.

PARAMETER **v** ||| INTEGER4 — The value to assign missing records.

RETURN TABLE ({ UNSIGNED2 **wi** , UNSIGNED8 **id** , UNSIGNED4 **number** ,
INTEGER4 **value** }) — A full DiscreteField dataset with every field populated.

Utils/ Gini

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DESCRIPTIONS

GINI Gini

<code>/ EXPORT</code>	Gini
<code>(infile, pivot, target, wi_name='wi')</code>	

Create a file of pivot/target pairs with a Gini impurity value.

PARAMETER infile ||| INTEGER8 — the input file, any type with a work item field.

PARAMETER pivot ||| INTEGER8 — the name of the pivot field.

PARAMETER target ||| INTEGER8 — the name of the field used as the target.

PARAMETER wi_name ||| INTEGER8 — the name of the work item field, default is "wi".

RETURN **BOOLEAN** — A table by Work Item and Pivot value giving count and Gini impurity value.

Utils/ SequenceInField

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DESCRIPTIONS

SEQUENCEINFIELD SequenceInField

/ EXPORT	SequenceInField
(infile,infield,seq,wi_name='wi')	

Assign sequence numbers within groups for a dataset. Given a file (dataset) which is sorted by the work item identifier and INFIELD (and possibly other values), add sequence numbers within the range of each infield. Slightly elaborate code is to avoid having to partition the data to one value of infield per node and to work with very large numbers of records where a global count project would be inappropriate. This is useful for assigning rank positions with the groupings.

PARAMETER infile ||| INTEGER8 — the input file, any type.

PARAMETER infield ||| INTEGER8 — field name of grouping field.

PARAMETER seq ||| INTEGER8 — name of the field to receive the sequence number.

PARAMETER wi_name ||| INTEGER8 — work item field name, default is wi.

RETURN BOOLEAN — a file of the same type with sequence numbers applied.
