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<td>Version</td>
<td>3.0.0</td>
</tr>
<tr>
<td>Description</td>
<td>Logistic Regression implementation</td>
</tr>
<tr>
<td>License</td>
<td><a href="http://www.apache.org/licenses/LICENSE-2.0">http://www.apache.org/licenses/LICENSE-2.0</a></td>
</tr>
<tr>
<td>Copyright</td>
<td>Copyright (C) 2017 HPCC Systems®</td>
</tr>
<tr>
<td>Authors</td>
<td>HPCCSystems</td>
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<tr>
<td>DependsOn</td>
<td>ML_Core 3.2.1, PBblas</td>
</tr>
<tr>
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<td>6.2.0</td>
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BinomialConfusion

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IMPORTS

ML_Core.Types | Types |

DESCRIPTIONS

FUNCTION BinomialConfusion

| DATASET(Types.Binomial_Confusion_Summary) | BinomialConfusion |
| (DATASET(Core_Types.Confusion_Detail) d) |

Calculate the binomial confusion matrix. Work items with multinomial responses are ignored by this function. The higher value lexically is considered to be the positive indication.

PARAMETER d ||| TABLE ( Confusion_Detail ) — confusion detail for the work item and classifier.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 true_positive , UNSIGNED8 true_negative , UNSIGNED8 false_positive , UNSIGNED8 false_negative , UNSIGNED8 cond_pos , UNSIGNED8 pred_pos , UNSIGNED8 cond_neg , UNSIGNED8 pred_neg , REAL8 prevalence , REAL8 accuracy , REAL8 true_pos_rate , REAL8 false_neg_rate , REAL8 false_pos_rate , REAL8 true_neg_rate , REAL8 pos_pred_val , REAL8 false_disc_rate , REAL8 false_omit_rate , REAL8 neg_pred_val } ) — confusion matrix for a binomial classifier in Binomial_Confusion_Summary format.

SEE Types.Binomial_Confusion_Summary
BinomialLogisticRegression

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IMPORTS

Constants | ML_Core.Interfaces | ML_Core.Types |

DESCRIPTIONS

MODULE BinomialLogisticRegression

<table>
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<th>BinomialLogisticRegression</th>
</tr>
</thead>
<tbody>
<tr>
<td>(UNSIGNED max_iter=200, REAL8 epsilon=Constants.default_epsilon, REAL8 ridge=Constants.default_ridge)</td>
</tr>
</tbody>
</table>

Binomial logistic regression using iteratively re-weighted least squares.

PARAMETER max_iter ||| UNSIGNED8 — (Optional) The maximum number of iterations to try. Default = 200.

PARAMETER epsilon continue |
| REAL8 — (Optional) The minimum change in the Beta value estimate to continue |

PARAMETER ridge |
| REAL8 — (Optional) A value to populate a diagonal matrix that is added to a matrix to help assure that the matrix is invertible. |

PARENT ML_Core.Interfaces.IClassify

</home/tetrapod/pcsource/ML_Core/Interfaces/IClassify.ecl>

Children
1. **GetModel** : Calculate the model to fit the observation data to the observed classes
2. **Classify** : Classify the observations using a model as previously returned from GetModel
3. **Report** : Report the confusion matrix for the classifier and training data

---

**FUNCTION** GetModel

BinomialLogisticRegression \[

<table>
<thead>
<tr>
<th>DATASET(Types.Layout_Model)</th>
<th>GetModel</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Types.NumericField) observations, DATASET(Types.DiscreteField) classifications)</td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

**RETURN** TABLE ( \{ UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 value \} ) — the encoded model in Layout_Model format.

**OVERRIDE**

SEE ML_Core.Types.NumericField
SEE ML_Core.Types.DiscreteField
SEE ML_Core.Types.Layout_Model

---

**FUNCTION** Classify

BinomialLogisticRegression \[


Classify the observations using a model as previously returned from GetModel.

**PARAMETER** `new_observations` ||| TABLE ( NumericField ) — observations to be classified in NumericField format.

**PARAMETER** `model` ||| TABLE ( Layout_Model ) — The model in Layout_Model format.

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

**OVERRIDE**

SEE ML_Core.Types.Layout_Model
SEE ML_Core.Types.NumericField
SEE ML_Core.Types.Classify_Result

---

**FUNCTION Report**

Binomial Logistic Regression \ 

**DATASET(Types.Confusion_Detail) Report**

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

Report the confusion matrix for the classifier and training data.

**PARAMETER** `classifications` ||| TABLE ( DiscreteField ) — the actual classifications associated with the observations (i.e. ground truth) in DiscreteField format.

**PARAMETER** `model` ||| TABLE ( Layout_Model ) — the encoded model as returned from GetModel.
PARAMETER observations ||| TABLE ( NumericField ) — the explanatory values in NumericField format.

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 in Confusion_Detail format.

OVERRIDE

SEE ML_Core.Types.NumericField
SEE ML_Core.Types.DiscreteField
SEE ML_Core.Types.ConfusionDetail
FUNCTION Confusion

<table>
<thead>
<tr>
<th>DATASET(Confusion_Detail)</th>
<th>Confusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(DiscreteField) dependents, DATASET(DiscreteField) predicts)</td>
<td></td>
</tr>
</tbody>
</table>

Generate the confusion matrix, to compare actual versus predicted response variable values.

PARAMETER predicts ||| TABLE ( DiscreteField ) — the predicted responses.

PARAMETER dependents ||| TABLE ( DiscreteField ) — the original response values.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 classifier , INTEGER4 actual_class , INTEGER4 predict_class , UNSIGNED4 occurs , BOOLEAN correct , REAL8 pctActual , REAL8 pctPred } ) — confusion matrix in Confusion_Detail format.

SEE ML_Core.Types.Confusion_Detail
Constants

DESCRIPTIONS

MODULE Constants

<table>
<thead>
<tr>
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</thead>
</table>

Constants used by Logistic Regression. Most of these are the nominal values used by the Model data set. A few are used to control behavior.

Children

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2. default_epsilon : No Documentation Found
3. default_ridge : No Documentation Found
4. local_cap : No Documentation Found
5. id_base : No Documentation Found
6. id_iters : No Documentation Found
7. id_delta : No Documentation Found
8. id_correct : No Documentation Found
9. id_incorrect : No Documentation Found
10. id_stat_set : No Documentation Found
11. id_betas : No Documentation Found
12. id_betas_coef : No Documentation Found
13. id_betas_SE : No Documentation Found
14. base_builder : No Documentation Found
15. base_max_iter : No Documentation Found
16. base_epsilon : No Documentation Found
17. base_ind_vars : No Documentation Found
18. base_dep_vars : No Documentation Found
19. base_obs : No Documentation Found
20. builder_irls_local : No Documentation Found
21. builder_irls_global : No Documentation Found
22. builder_softmax : No Documentation Found

ATTRIBUTE limit_card

Constants \n
UNSIGNED2 limit_card

No Documentation Found

RETURN UNSIGNED2 —

ATTRIBUTE default_epsilon

Constants \n
REAL8 default_epsilon

No Documentation Found

RETURN REAL8 —
**ATTRIBUTE** default_ridge

Constants

| REAL8 | default_ridge |

No Documentation Found

**RETURN** REAL8 —

**ATTRIBUTE** local_cap

Constants

| UNSIGNED4 | local_cap |

No Documentation Found

**RETURN** UNSIGNED4 —

**ATTRIBUTE** id_base

Constants

| id_base |

No Documentation Found

**RETURN** INTEGER8 —
**ATTRIBUTE** id_iters

Constants

| id_iters |

No Documentation Found

**RETURN** INTEGER8

---

**ATTRIBUTE** id_delta

Constants

| id_delta |

No Documentation Found

**RETURN** INTEGER8

---

**ATTRIBUTE** id_correct

Constants

| id_correct |

No Documentation Found

**RETURN** INTEGER8
ATTRIBUTE id_incorrect

Constants \n
| id_incorrect |

No Documentation Found

RETURN INTEGER8 —

ATTRIBUTE id_stat_set

Constants \n
| id_stat_set |

No Documentation Found

RETURN SET ( INTEGER8 ) —

ATTRIBUTE id_betas

Constants \n
| id_betas |

No Documentation Found

RETURN INTEGER8 —
### ATTRIBUTE `id_betas_coef`

Constants

<table>
<thead>
<tr>
<th><code>id_betas_coef</code></th>
</tr>
</thead>
</table>

No Documentation Found

**RETURN INTEGER8 —**

### ATTRIBUTE `id_betas_SE`

Constants

<table>
<thead>
<tr>
<th><code>id_betas_SE</code></th>
</tr>
</thead>
</table>

No Documentation Found

**RETURN INTEGER8 —**

### ATTRIBUTE `base_builder`

Constants

<table>
<thead>
<tr>
<th><code>base_builder</code></th>
</tr>
</thead>
</table>

No Documentation Found

**RETURN INTEGER8 —**
ATTRIBUTE base_max_iter

Constants

base_max_iter

No Documentation Found

RETURN INTEGER8 —

ATTRIBUTE base_epsilon

Constants

base_epsilon

No Documentation Found

RETURN INTEGER8 —

ATTRIBUTE base_ind_vars

Constants

base_ind_vars

No Documentation Found

RETURN INTEGER8 —
**ATTRIBUTE** base_dep_vars

Constants

```
base_dep_vars
```

No Documentation Found

**RETURN** INTEGER8 —

---

**ATTRIBUTE** base_obs

Constants

```
base_obs
```

No Documentation Found

**RETURN** INTEGER8 —

---

**ATTRIBUTE** builder_irls_local

Constants

```
builder_irls_local
```

No Documentation Found

**RETURN** INTEGER8 —
**ATTRIBUTE** builder_irls_global

Constants \\

| builder_irls_global |

No Documentation Found

**RETURN** INTEGER8 —

---

**ATTRIBUTE** builder_softmax

Constants \\

| builder_softmax |

No Documentation Found

**RETURN** INTEGER8 —

---
FUNCTION DataStats

<table>
<thead>
<tr>
<th>DATASET(Types.Data_Info)</th>
<th>DataStats</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core_Types.NumericField) indep, DATASET(Core_Types.DiscreteField) dep, BOOLEAN field_details=FALSE)</td>
<td></td>
</tr>
</tbody>
</table>

Produce summary information about the datasets.

When field_details = FALSE, indicates the range for the x and y (independent and dependent) columns.

When field_details = TRUE, the cardinality, minimum, and maximum values are returned. A zero cardinality is returned when the field cardinality exceeds the Constants.limit_card value.

Note that a column of all zero values cannot be distinguished from a missing column.

PARAMETER indep ||| TABLE ( NumericField ) — data set of independent variables.

PARAMETER dep ||| TABLE ( DiscreteField ) — data set of dependent variables.

PARAMETER field_details ||| BOOLEAN — Boolean directive to provide field level info.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 dependent_fields , UNSIGNED4 dependent_records , UNSIGNED4 independent_fields , UNSIGNED4 }
independent_records, UNSIGNED4 dependent_count, UNSIGNED4 independent_count, TABLE (Field_Desc) dependent_stats, TABLE (Field_Desc) independent_stats} — a data set of information on each work item in Data_Info format.

SEE Types.Data_Info

SEE Constants.limit_card
DESCRIPTIONS

FUNCTION Deviance_Analysis

<table>
<thead>
<tr>
<th>DATASET(Types.AOD_Record)</th>
<th>Deviance_Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Types.Deviance_Record) proposed, DATASET(Types.Deviance_Record) base)</td>
<td></td>
</tr>
</tbody>
</table>

Analysis of Deviance Report.

Compare deviance information between two models, a base and a proposed model.

Analysis of Deviance is analogous to the Analysis of Variance (ANOVA) used in least-squares modeling, but adapted to the general linear model (GLM). In this case it is adapted specifically to the logistic model.

The inputs are the deviance records for each model as obtained from a call to Model_Deviance.

PARAMETER base || TABLE ( Deviance_Record ) — deviance records of the base model for comparison.

PARAMETER proposed || TABLE ( Deviance_Record ) — deviance records of the proposed model.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 residual_df , UNSIGNED8 df , REAL8 residual_dev , REAL8 deviance , REAL8 p_value } ) — the comparison of the deviance between the models in AOD_Record format.
SEE Model_Deviance
SEE Types.Deviance_Record
SEE Types.AOD_Record
**Deviance_Detail**

**DESCRIPTIONS**

**FUNCTION** Deviance_Detail

<table>
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<tr>
<th>DATASET(Types.Observation_Deviance)</th>
<th>Deviance_Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core_Types.DiscreteField) dependents, DATASET(Types.Raw_Prediction) predicts)</td>
<td></td>
</tr>
</tbody>
</table>

Deviance detail report.

Provides deviance information for each observation.

Analysis of Deviance is analogous to the Analysis of Variance (ANOVA) used in least-squares modeling, but adapted to the general linear model (GLM). In this case it is adapted specifically to the logistic model.

**PARAMETER**

- **predicts** ||| TABLE ( Raw_Prediction ) — the predicted values of the response variable
- **dependents** ||| TABLE ( DiscreteField ) — original dependent records for the model

**RETURN**

TABLE ( { UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 classifier , INTEGER4 actual , INTEGER4 predicted , REAL8 mod_ll , REAL8 mod_dev_component , REAL8 mod_dev_residual , REAL8 nil_ll , REAL8 nil_dev_component , REAL8 nil_dev_residual } ) — the deviance information by observation and the log likelihood of the predicted result in Observation_Deviance format.
SEE Types.Observation_Deviance
Matrix multiply when either A or B is a diagonal and is passed as a vector.

Computes: \( \alpha \cdot \text{op}(A) \cdot \text{op}(B) + \beta \cdot C \) where \( \text{op}() \) is transpose.

**PARAMETER**

- **A** ||| SET ( REAL8 ) — matrix A.
- **k** ||| UNSIGNED4 — number of columns/rows for the multiplier/multiplicand.
- **alpha** ||| REAL8 — scalar used on A.
- **n** ||| UNSIGNED4 — number of columns in product.
- **transposeA** ||| BOOLEAN — true when transpose of A is used.
- **beta** ||| REAL8 — scalar for matrix C.
- **C** ||| SET ( REAL8 ) — matrix C or empty.
PARAMETER \textbf{m} ||| UNSIGNED4 — number of rows in product.

PARAMETER \textbf{diagonalB} ||| BOOLEAN — true when B is the diagonal matrix.

PARAMETER \textbf{B} ||| SET ( REAL8 ) — matrix B.

PARAMETER \textbf{diagonalA} ||| BOOLEAN — true when A is the diagonal matrix.

PARAMETER \textbf{transposeB} ||| BOOLEAN — true when transpose of B is used.

RETURN SET ( REAL8 ) — result matrix in matrix\_t format.

SEE Std.BLAS.Types.matrix\_t
**enum_workitems**

Create an enumeration of string contents to be used as work items.

This macro produces 2 external symbols, dsOut and dsOut_Map.

The dsOut extends the input dataset with a numeric work-item number.

The dsOut_Map dataset captures the relationship between the strings that name the work items and the nominal assigned in Workitem_Mapping format.

**PARAMETER**

- **dsOut** — the symbol to use for the appended data.
- **wi_name** — the field name for the work item value assigned.
- **src_field** — a field name to use to discriminate work-items.
- **dsIn** — the input recordset.

**RETURN** — Nothing. The macro creates the symbols 'dsOut' and 'dsOut_Map' inline.

**SEE** Types.Workitem_Mapping
FUNCTION ExtractBeta

<table>
<thead>
<tr>
<th>ExtractBeta</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core_Types.Layout_Model) mod_ds)</td>
</tr>
</tbody>
</table>

Extract the beta values form the model dataset.

PARAMETER mod_ds  ||| TABLE ( Layout_Model ) — the model as returned from GetModel.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 ind_col , UNSIGNED4 dep_nom , REAL8 w , REAL8 SE } ) — the beta values as Model_Coef records, with zero as the constant term.

SEE Types.Model_Coef
FUNCTION ExtractBeta_CI

<table>
<thead>
<tr>
<th>DATASET(ML_Core.Types.Confidence_Model_Coef)</th>
<th>ExtractBeta_CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core.Types.Layout_Model) mod_ds, REAL8 level)</td>
<td></td>
</tr>
</tbody>
</table>

Extract the beta values and confidence intervals from the model dataset.

PARAMETER mod_ds ||| TABLE (Layout_Model) — the model as returned from GetModel.

PARAMETER level ||| REAL8 — the significance value for the intervals.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 ind_col , UNSIGNED4 dep_nom , REAL8 w , REAL8 SE , REAL8 upper , REAL8 lower } ) — the beta values with confidence intervals in Confidence_Model_Coef format, with zero as the constant term.

SEE Types.Confidence_Model_Coef
**FUNCTION** ExtractBeta_full

<table>
<thead>
<tr>
<th>DATASET(Types.Full_Model_Coef)</th>
<th>ExtractBeta_full</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core_Types.Layout_Model) mod_ds, REAL8 level=0.05)</td>
<td></td>
</tr>
</tbody>
</table>

Extract the coefficient information including confidence intervals, z and p values.

**PARAMETER**

- mod_ds ||| TABLE ( Layout_Model ) — the model as returned from GetModel.
- level ||| REAL8 — the significance value for the intervals.

**RETURN**

TABLE ( { UNSIGNED2 wi , UNSIGNED4 ind_col , UNSIGNED4 dep_nom , REAL8 w , REAL8 SE , REAL8 z , REAL8 p_value , REAL8 upper , REAL8 lower } ) — the coefficient information for the model in Full_Model_Coef format, with zero as the constant term.

**SEE**

Types.Full_Model_Coef
**FUNCTION** ExtractBeta_pval

| DATASET(Types.pval_Model_Coef) | ExtractBeta_pval | (DATASET(Core_Types.Layout_Model) mod_ds) |

Extract the beta values including z and p value from the model.

**PARAMETER** mod_ds ||| TABLE ( Layout_Model ) — the model as returned from GetModel.

**RETURN** TABLE ( { UNSIGNED2 wi, UNSIGNED4 ind_col, UNSIGNED4 dep_nom, REAL8 w, REAL8 SE, REAL8 z, REAL8 p_value } ) — the beta values with p-values in pval_Model_Coef format, with zero as the constant term.

**SEE** Types.pval_Model_Coef
**FUNCTION** ExtractReport

<table>
<thead>
<tr>
<th>DATASET(Types.Model_Report)</th>
<th>ExtractReport</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Core_Types.Layout_Model) mod_ds)</td>
<td></td>
</tr>
</tbody>
</table>

Create a model report from a model.

**PARAMETER** mod_ds || TABLE ( Layout_Model ) — the model as returned from GetModel.

**RETURN** TABLE ( { UNSIGNED2 wi , UNSIGNED4 max_iterations , REAL8 epsilon , UNSIGNED4 dep_vars , UNSIGNED4 ind_vars , UNSIGNED8 obs , UNSIGNED2 builder , TABLE ( Classifier_Stats ) stats } ) — the model report in Model_Report format.

**SEE** Types.Model_Report
LogitPredict

FUNCTION LogitPredict

<table>
<thead>
<tr>
<th>DATASET(Classify_Result)</th>
<th>LogitPredict</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Model_Coef) coef, DATASET(NumericField) independents)</td>
<td></td>
</tr>
</tbody>
</table>

Predict the category values with the logit function and the supplied beta coefficients.

**PARAMETER** independents | TABLE ( NumericField ) — the observations.

**PARAMETER** coef | TABLE ( Model_Coef ) — the model beta coefficients as returned from ExtractBeta.

**RETURN** TABLE ( { UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , INTEGER4 value , REAL8 conf } ) — the predicted category values and a confidence score in Classify_Result format.

SEE ExtractBeta

SEE ML_Core.Types.Classify_Result
FUNCTION LogitScore

<table>
<thead>
<tr>
<th>DATASET(Raw_Prediction)</th>
<th>LogitScore</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Model_Coef) coef, DATASET(NumericField) independents)</td>
<td></td>
</tr>
</tbody>
</table>

Calculate the score using the logit function and the the supplied beta coefficients.

PARAMETER independents ||| TABLE ( NumericField ) — the observations.
PARAMETER coef ||| TABLE ( Model_Coef ) — the model beta coefficients as returned from ExtractBetas.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED8 id , UNSIGNED4 number , REAL8 raw } ) — the raw prediction value in Raw_Prediction format.

SEE ExtractBetas
SEE Types.Raw_Prediction
FUNCTION LUCI_Model

CREATE

DATASET(Types.LUCI_Rec) LUCI_Model

(DATASET(Types.LUCI_Model_Rqst) rqst,
 DATASET(Types.External_Model) mod, STRING
 wi_field='work_item')

Create a LUCI model file description of the model(s) from the external version of the model.

LUCI is a proprietary format used within LexisNexis.

The multi-score card per model case assumes that the score card selection is based solely upon the work item field. If this is not the case, the L1SE records will need to be patched.

The model id and name may have a "$" character that is updated to match the work item when there are multiple models applied. If the strings do not have a "$" character, the work item string is appended.

The score card name may have a "$" character which is updated to match the work item. If the name is blank, the score card is named for the work item.

LUCI data fields may not contain comma characters. This function requires that the work item identification strings do not contain characters that need special handling for CSV data.

PARAMETER wi_field ||| STRING — the field name holding the work item identification string.
PARAMETER `rqst` ||| TABLE ( LUCI_Model_Rqst ) — the information to map work items to models in LUCI_Model_Rqst format.

PARAMETER `mod` ||| TABLE ( External_Model ) — the model with the external field names applied in External_Model format as returned from Named_Model.

RETURN TABLE ( { STRING line } ) — The lines of the LUCI file in LUCI_Rec format.

SEE Types.External_Model
SEE Named_Model
SEE Types.LUCI_Model_Rqst
SEE Types.LUCI_Rec
FUNCTION Model_Deviance

<table>
<thead>
<tr>
<th>DATASET(Types.Deviance_Record)</th>
<th>Model_Deviance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Types.Observation_Deviance) od,</td>
<td></td>
</tr>
<tr>
<td>DATASET(Types.Model_Coef) mod)</td>
<td></td>
</tr>
</tbody>
</table>

Model Deviance Report.

Create a report of deviance information for a model.

Analysis of Deviance is analogous to the Analysis of Variance (ANOVA) used in least-squares modeling, but adapted to the general linear model (GLM). In this case it is adapted specifically to the logistic model.

PARAMETER od || TABLE ( Observation_Deviance ) — observation-deviance records, as obtained from a call to Deviance_Detail.

PARAMETER mod || TABLE ( Model_Coef ) — model co-efficients records, as obtained from a call to ExtractBeta.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 df , REAL8 deviance , REAL8 AIC } ) — model deviance in Deviance_Record format.
SEE Deviance_Detail
SEE ExtractBeta
SEE Types.Deviance_Record
IMPORTS

Types |

DESCRIPTIONS

FUNCTION Named_Model

<table>
<thead>
<tr>
<th>DATASET(Types.External_Model)</th>
<th>Named_Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Types.Layout_Model) mod_ds, DATASET(Types.FieldName_Mapping) expl_map, DATASET(Types.FieldName_Mapping) resp_map, DATASET(Types.WorkItem_mapping) wi_map=empty, REAL8 level=0.05)</td>
<td></td>
</tr>
</tbody>
</table>

Apply external labels for work items and field names to a model.

Returns an expanded model that includes:

- coefficients
- z and p-values
- independent variable field names
- dependent variable field names
- work-item names

PARAMETER wi_map ||| TABLE ( WorkItem_Mapping ) — (optional) mapping of workitem strings to workitem nominals in FieldName_Mapping format.
PARAMETER expl_map |\|| TABLE ( FieldName_Mapping ) — the relation of the explanatory or 
independent variables to the field names for those variables in FieldName_Mapping format.

PARAMETER mod_ds |\|| TABLE ( Layout_Model ) — the model as returned from GetModel.

PARAMETER level |\|| REAL8 — (optional) value for confidence intervals. Default = 0.05.

PARAMETER resp_map |\|| TABLE ( FieldName_Mapping ) — the relation of the response variable 
column numbers to the field names in FieldName_Mapping format.

RETURN TABLE ( { STRING work_item , STRING response_field , UNSIGNED2 wi , 
UNSIGNED4 dep_nom , TABLE ( External_Coef ) coef } ) — an expanded model in 
External_Model format.

SEE Types.FieldName_Mapping

SEE Types.External_Model
Go Up

IMPORTS

Types |

DESCRIPTIONS

FUNCTION Null_Deviance

<table>
<thead>
<tr>
<th>DATASET(Types.Deviance_Record)</th>
<th>Null_Deviance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATASET(Types.Observation_Deviance) od)</td>
<td></td>
</tr>
</tbody>
</table>

Return Deviance information for the null model, that is, a model with only an intercept.

Analysis of Deviance is analogous to the Analysis of Variance (ANOVA) used in least-squares modeling, but adapted to the general linear model (GLM). In this case it is adapted specifically to the logistic model.

PARAMETER od || TABLE ( Observation_Deviance ) — Observation Deviance record set as returned from Deviance_Detail.

RETURN TABLE ( { UNSIGNED2 wi , UNSIGNED4 classifier , UNSIGNED8 df , REAL8 deviance , REAL8 AIC } ) — a data set of the null model deviances for each work item and classifier in Deviance_Record format.

SEE Types.Observation_Deviance

SEE Types.Deviance_Record

SEE Deviance_Detail
Types

IMPORTS

ML_Core.Types |

DESCRIPTIONS

MODULE Types

| Types |

Type definitions for LogisticRegression bundle

Children

1. AnyField : No Documentation Found
2. NumericField : The NumericField layout defines a matrix of Real valued data-points
3. DiscreteField : The Discrete Field layout defines a matrix of Integer valued data-points
4. Layout_Model : No Documentation Found
5. t_work_item : No Documentation Found
6. t_RecordID : No Documentation Found
7. t_FieldNumber : No Documentation Found
8. t_FieldReal : No Documentation Found
9. t_Discrete : No Documentation Found
10. t_Universe : No Documentation Found
11. Field_Desc : Describe information about each field in a training set

12. Data_Info : Describes information about a training dataset composed of independent and dependent columns

13. NumericField_U : Record structure to add a 'Universe Number' to a NumericField allowing multiple independent NumericField matrixes within a work-item

14. DiscreteField_U : Record structure to add a 'Universe Number' to a DiscreteField allowing multiple independent DiscreteField matrixes within a work-item

15. Layout_Column_Map : Layout for a column map record that is used to remap column numbers

16. Classifier_Stats : Statistics about the effectiveness of each classifier in a model

17. Model_Report : Statistical information about a model

18. Binomial_Confusion_Summary : Accuracy stats for binomial classifications

19. Model_Coef : Model Coefficients

20. Confidence_Model_Coef : Model Coefficients with confidence intervals

21. pval_Model_Coef : Model coefficients with z and p-value

22. Full_Model_Coef : Model coefficients with confidence intervals and p-value

23. External_Coef : Model coefficients, confidence intervals, and p-value, plus independent field names, for each coefficient

24. External_Model : Expanded version of a model with statistics and field names

25. Raw_Prediction : Record for raw prediction without confidence information

26. Observation_Deviance : Record to contain deviance information about each observation

27. Deviance_Record : Record to hold deviance summary information about a model

28. AOD_Record : Record to hold Analysis of Deviance (AOD) information for a model

29. FieldName_Mapping : Layout used to hold the mapping between a field’s number and its name

30. WorkItem_Mapping : Layout used to hold the mapping between a work-item number and a textual name for that work-item

31. LUCI_Rec : Layout to store the lines of a generated LUCI model file

32. LUCI_Model_Rqst : Format for information to guide the generation of a LUCI file
**RECORD** AnyField

Types

| AnyField |

No Documentation Found

**FIELD** number ||| UNSIGNED4 — No Doc

**FIELD** id ||| UNSIGNED8 — No Doc

**FIELD** wi ||| UNSIGNED2 — No Doc

---

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

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

**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** 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.
**RECORD** DiscreteField

<table>
<thead>
<tr>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiscreteField</td>
</tr>
</tbody>
</table>

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 | value || INTEGER4 — The value of this cell in the matrix. |
|-------|-------|
| FIELD | number || UNSIGNED4 — This field represents the matrix column number for this cell. It is also considered the field number of the observation |
| 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 | 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. |

---

**RECORD** Layout_Model

<table>
<thead>
<tr>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout_Model</td>
</tr>
</tbody>
</table>

No Documentation Found

| FIELD | value || REAL8 — No Doc |
|-------|-------|
| FIELD | number || UNSIGNED4 — No Doc |
| FIELD | id || UNSIGNED8 — No Doc |
| FIELD | wi || UNSIGNED2 — No Doc |
**ATTRIBUTE** t_work_item

Types

- t_work_item

No Documentation Found

**RETURN** UNSIGNED2

**ATTRIBUTE** t_RecordID

Types

- t_RecordID

No Documentation Found

**RETURN** UNSIGNED8

**ATTRIBUTE** t_FieldNumber

Types

- t_FieldNumber

No Documentation Found

**RETURN** UNSIGNED4
ATTRIBUTE t_FieldReal

Types

| t_FieldReal |

No Documentation Found

RETURN REAL8 —

ATTRIBUTE t_Discrete

Types

| t_Discrete |

No Documentation Found

RETURN INTEGER4 —

ATTRIBUTE t_Universe

Types

| t_Universe |

No Documentation Found

RETURN UNSIGNED1 —
**RECORD Field_Desc**

Describe information about each field in a training set.

**FIELD**  
- **min_value** ||| REAL8 — the minimum value for the field.  
- **number** ||| UNSIGNED4 — the column (feature) number.  
- **cardinality** ||| UNSIGNED4 — the number of unique values in the field.  
- **max_value** ||| REAL8 — the maximum value for the field.

**RECORD Data_Info**

Describes information about a training dataset composed of independent and dependent columns.

**FIELD**  
- **dependent_records** ||| UNSIGNED4 — the number of records in the dependent data.  
- **wi** ||| UNSIGNED2 — the work-item number.  
- **independent_fields** ||| UNSIGNED4 — the number of fields in the independent data.  
- **dependent_stats** ||| TABLE (Field_Desc) — dataset of Field_Desc records describing each of the fields of the dependent data.  
- **independent_records** ||| UNSIGNED4 — the number of records in the independent data.  
- **independent_stats** ||| TABLE (Field_Desc) — dataset of Field_Desc records describing each of the fields of the independent data.  
- **dependent_fields** ||| UNSIGNED4 — the number of fields in the dependent data.  
- **dependent_count** ||| UNSIGNED4 — No Doc.  
- **independent_count** ||| UNSIGNED4 — No Doc.
FIELD u \|\|\| UNSIGNED1 — the ‘universe’ number identifying a distinct matrix within a NumericField dataset and work-item.

FIELD value \|\|\| REAL8 — No Doc

FIELD number \|\|\| UNSIGNED4 — No Doc

FIELD id \|\|\| UNSIGNED8 — No Doc

FIELD wi \|\|\| UNSIGNED2 — No Doc
**FIELD** wi ||| UNSIGNED2 — No Doc

---

**RECORD** Layout_Column_Map

**Types**

| Layout_Column_Map |

Layout for a column map record that is used to remap column numbers.

**FIELD** remap_number ||| UNSIGNED4 — the mapped-to field number.

**FIELD** orig_number ||| UNSIGNED4 — the original field number.

**FIELD** wi ||| UNSIGNED2 — the work-item number.

---

**RECORD** Classifier_Stats

**Types**

| Classifier_Stats |

Statistics about the effectiveness of each classifier in a model.

**FIELD** incorrect ||| UNSIGNED4 — the number of classes predicted incorrectly in the training data.

**FIELD** correct ||| UNSIGNED4 — the number of classes predicted correctly in the training data.

**FIELD** max_delta ||| REAL8 — the max_delta value for the classifier.

**FIELD** column ||| UNSIGNED4 — the classifier field number.

**FIELD** iterations ||| UNSIGNED4 — the number of iterations used to train the classifier.
**RECORD** Model_Report

Statistical information about a model.

One record is generated per work-item.

**FIELD**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ind_vars</td>
<td>UNSIGNED4 — the number of independent variables (i.e. features).</td>
</tr>
<tr>
<td>stats</td>
<td>TABLE ( Classifier_Stats ) — child dataset of Classifier_Stats, one for each classifier in the work-item.</td>
</tr>
<tr>
<td>dep_vars</td>
<td>UNSIGNED4 — the number of dependent variables (i.e. classifiers).</td>
</tr>
<tr>
<td>builder</td>
<td>UNSIGNED2 — the identifier for the builder used to train the model.</td>
</tr>
<tr>
<td>max_iterations</td>
<td>UNSIGNED4 — the maximum iterations use to train the model.</td>
</tr>
<tr>
<td>obs</td>
<td>UNSIGNED8 — the number of observations (i.e. records) in the training data.</td>
</tr>
<tr>
<td>epsilon</td>
<td>REAL8 — the 'epsilon' value used within the model.</td>
</tr>
<tr>
<td>wi</td>
<td>UNSIGNED2 — the work-item</td>
</tr>
</tbody>
</table>

**SEE** Classifier_Stats

---

**RECORD** Binomial_Confusion_Summary

Accuracy stats for binomial classifications.

One record per work-item and classifier.

**FIELD**

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>classifier</td>
<td>UNSIGNED4 — the classifier field number (i.e. dependent field number).</td>
</tr>
</tbody>
</table>
**FIELD**  
**true_positive** ||| UNSIGNED8 — the count of true positive results (i.e. predicted = TRUE, actual = TRUE).

**FIELD**  
**cond_neg** ||| UNSIGNED8 — the count of results where actual = FALSE.

**FIELD**  
**false_disc_rate** ||| REAL8 — false_positive / pred_pos.

**FIELD**  
**true_neg_rate** ||| REAL8 — true_negative / cond_neg.

**FIELD**  
**accuracy** ||| REAL8 — (true_positive + true_negative) / total.

**FIELD**  
**false_negative** ||| UNSIGNED8 — the count of false_negative results (i.e. predicted = FALSE, actual = TRUE).

**FIELD**  
**true_pos_rate** ||| REAL8 — true_positive / cond_pos.

**FIELD**  
**true_negative** ||| UNSIGNED8 — the count of true negative results (i.e. predicted = FALSE, actual = FALSE).

**FIELD**  
**neg_pred_val** ||| REAL8 — true_negative / pred_neg.

**FIELD**  
**pred_neg** ||| UNSIGNED8 — the count of results where predicted = FALSE.

**FIELD**  
**false_pos_rate** ||| REAL8 — false_positive / cond_neg.

**FIELD**  
**cond_pos** ||| UNSIGNED8 — the count of results where actual = TRUE.

**FIELD**  
**prevalence** ||| REAL8 — cond_pos / total.

**FIELD**  
**wi** ||| UNSIGNED2 — the work-item number.

**FIELD**  
**false_omit_rate** ||| REAL8 — false_negative / pred_neg.

**FIELD**  
**false_positive** ||| UNSIGNED8 — the count of false_positive results (i.e. predicted = TRUE, actual = FALSE).

**FIELD**  
**pred_pos** ||| UNSIGNED8 — the count of results where predicted = TRUE.

**FIELD**  
**pos_pred_val** ||| REAL8 — true_positive / pred_pos.

**FIELD**  
**false_neg_rate** ||| REAL8 — No Doc

---

**RECORD**  
**Model_Coef**

**Types**

| Model_Coef |

Model Coefficients.
### Confidence_Model_Coef

Model Coefficients with confidence intervals.

<table>
<thead>
<tr>
<th>FIELD</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>dep_nom</td>
<td>the dependent column number (i.e. classifier number)</td>
<td>UNSIGNED4</td>
</tr>
<tr>
<td>ind_col</td>
<td>the independent column number (i.e feature number)</td>
<td>UNSIGNED4</td>
</tr>
<tr>
<td>SE</td>
<td>the Standard Error of the coefficient</td>
<td>REAL8</td>
</tr>
<tr>
<td>w</td>
<td>the learned weight (i.e. coefficient)</td>
<td>REAL8</td>
</tr>
<tr>
<td>wi</td>
<td>the work-item number</td>
<td>UNSIGNED2</td>
</tr>
</tbody>
</table>

### pval_Model_Coef

Model coefficients with z and p-value.

<table>
<thead>
<tr>
<th>FIELD</th>
<th>Description</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>lower</td>
<td>the lower range of the confidence interval</td>
<td>REAL8</td>
</tr>
<tr>
<td>upper</td>
<td>the upper range of the confidence interval</td>
<td>REAL8</td>
</tr>
<tr>
<td>se</td>
<td>No Doc</td>
<td>REAL8</td>
</tr>
<tr>
<td>wi</td>
<td>No Doc</td>
<td>UNSIGNED2</td>
</tr>
<tr>
<td>dep_nom</td>
<td>No Doc</td>
<td>UNSIGNED4</td>
</tr>
<tr>
<td>w</td>
<td>No Doc</td>
<td>REAL8</td>
</tr>
<tr>
<td>ind_col</td>
<td>No Doc</td>
<td>UNSIGNED4</td>
</tr>
</tbody>
</table>
**FIELD**  p_value ||| REAL8 — the p_value of the coefficient.

**FIELD**  z ||| REAL8 — the z value.

**FIELD**  se ||| REAL8 — No Doc

**FIELD**  wi ||| UNSIGNED2 — No Doc

**FIELD**  dep_nom ||| UNSIGNED4 — No Doc

**FIELD**  w ||| REAL8 — No Doc

**FIELD**  ind_col ||| UNSIGNED4 — No Doc

---

**RECORD** Full_Model_Coef

Types \

```
| Full_Model_Coef |
```

Model coefficients with confidence intervals and p-value

**FIELD**  p_value ||| REAL8 — the p_value of the coefficient.

**FIELD**  lower ||| REAL8 — the lower range of the confidence interval

**FIELD**  upper ||| REAL8 — the upper range of the confidence interval

**FIELD**  z ||| REAL8 — the z value.

**FIELD**  se ||| REAL8 — No Doc

**FIELD**  wi ||| UNSIGNED2 — No Doc

**FIELD**  dep_nom ||| UNSIGNED4 — No Doc

**FIELD**  w ||| REAL8 — No Doc

**FIELD**  ind_col ||| UNSIGNED4 — No Doc

---
**RECORD** External_Coef

Types \\

| External_Coef |

Model coefficients, confidence intervals, and p-value, plus independent field names, for each coefficient.

**FIELD** lower ||| REAL8 — the lower bound of the confidence interval.

**FIELD** ind_col ||| UNSIGNED4 — the field number of the independent field for this coefficient.

**FIELD** upper ||| REAL8 — the upper bound of the confidence interval.

**FIELD** z ||| REAL8 — the z value.

**FIELD** p_value ||| REAL8 — the p-value.

**FIELD** field_name ||| STRING — the name of the independent field for this coefficient.

**FIELD** isIntercept ||| BOOLEAN — Boolean field is TRUE if this is the intercept coefficient, otherwise FALSE.

**FIELD** w ||| REAL8 — the coefficient value (weight)

**FIELD** SE ||| REAL8 — the Standard Error of the coefficient

---

**RECORD** External_Model

Types \\

| External_Model |

Expanded version of a model with statistics and field names.

Field names include independent data field names, dependent data field names and work-item names.

**FIELD** dep_nom ||| UNSIGNED4 — the field number of the classifier (i.e. dependent field number).

**FIELD** work_item ||| STRING — the work-item’s name.

**FIELD** wi ||| UNSIGNED2 — the work-item number.
FIELD coef ||| TABLE (External_Coef) — child dataset of External_Coef format. One record per model coefficient.

FIELD response_field ||| STRING — the name of the classifier field (i.e. dependent field name).

SEE External_Coef

RECORD Raw_Prediction

Types

| Raw_Prediction |

Record for raw prediction without confidence information.

FIELD raw ||| REAL8 — the raw prediction value.
FIELD number ||| UNSIGNED4 — No Doc
FIELD id ||| UNSIGNED8 — No Doc
FIELD wi ||| UNSIGNED2 — No Doc

RECORD Observation_Deviance

Types

| Observation_Deviance |

Record to contain deviance information about each observation.

FIELD nil ||| — ll log likelihood of the nil model (i.e. model with only a constant term).
FIELD mod_ll ||| REAL8 — log likelihood of the model
FIELD classifier ||| UNSIGNED4 — the dependent field number.
<table>
<thead>
<tr>
<th>FIELD</th>
<th>actual</th>
<th>INTEGER4 — the actual (i.e. ground truth value).</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIELD</td>
<td>nil_dev_residual</td>
<td>REAL8 — the deviance not explained by the null model (i.e. the residual)</td>
</tr>
<tr>
<td>FIELD</td>
<td>wi</td>
<td>UNSIGNED2 — the work-item number.</td>
</tr>
<tr>
<td>FIELD</td>
<td>predicted</td>
<td>INTEGER4 — the value predicted by the model.</td>
</tr>
<tr>
<td>FIELD</td>
<td>mod_dev_residual</td>
<td>REAL8 — the deviance not explained by the model (i.e. the residual)</td>
</tr>
<tr>
<td>FIELD</td>
<td>mod_dev_component</td>
<td>REAL8 — the deviance explained by the model</td>
</tr>
<tr>
<td>FIELD</td>
<td>nil_dev_component</td>
<td>REAL8 — the deviance explained by the null model</td>
</tr>
<tr>
<td>FIELD</td>
<td>id</td>
<td>UNSIGNED8 — the record id (i.e. observation number).</td>
</tr>
<tr>
<td>FIELD</td>
<td>nil_ll</td>
<td>REAL8 — No Doc</td>
</tr>
</tbody>
</table>

---

**RECORD Deviance_Record**

**Types \**

| Deviance_Record |

Record to hold deviance summary information about a model.

<table>
<thead>
<tr>
<th>FIELD</th>
<th>AIC</th>
<th>REAL8 — the Akaike Information Criteria value.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIELD</td>
<td>classifier</td>
<td>UNSIGNED4 — the classifier number (i.e. field number of the dependent variable).</td>
</tr>
<tr>
<td>FIELD</td>
<td>df</td>
<td>UNSIGNED8 — degrees-of-freedom of the chi squared distribution.</td>
</tr>
<tr>
<td>FIELD</td>
<td>deviance</td>
<td>REAL8 — the total deviance for this classifier.</td>
</tr>
<tr>
<td>FIELD</td>
<td>wi</td>
<td>UNSIGNED2 — the work-item number</td>
</tr>
</tbody>
</table>

---
**RECORD** AOD_Record

Record to hold Analysis of Deviance (AOD) information for a model.

**FIELD**
- **classifier** ||| UNSIGNED4 — the classifier number (i.e. field number of the dependent variable).
- **deviance** ||| REAL8 — the total deviance.
- **residual_dev** ||| REAL8 — the deviance not explained by the model.
- **wi** ||| UNSIGNED2 — the work-item number.
- **p** ||| — value the probability that the null hypothesis is correct.
- **df** ||| UNSIGNED8 — degrees of freedom of the chi squared distribution.
- **residual_df** ||| UNSIGNED8 — No Doc
- **p_value** ||| REAL8 — No Doc

---

**RECORD** FieldName_Mapping

Layout used to hold the mapping between a field’s number and its name.

**FIELD**
- **assigned_name** ||| STRING — the textual name of the field (e.g. 'age').
- **orig_name** ||| STRING — typically the field number as a text string (e.g. '2').
**RECORD** WorkItem_Mapping

Types \n
| WorkItem_Mapping |

Layout used to hold the mapping between a work-item number and a textual name for that work-item.

**FIELD** orig_wi ||| STRING — the work-item name.

**FIELD** wi ||| UNSIGNED2 — the work-item number.

---

**RECORD** LUCI_Rec

Types \n
| LUCI_Rec |

Layout to store the lines of a generated LUCI model file.

**FIELD** line ||| STRING — the text for a single line for the LUCI file.

---

**RECORD** LUCI_Model_Rqst

Types \n
| LUCI_Model_Rqst |

Format for information to guide the generation of a LUCI file.

**FIELD** model_name ||| STRING — an expanded name for the model as used in the LUCI L1MD format.

**FIELD** model_id ||| STRING — a short textual name for the model as used in the LUCI L1MD format.
**FIELD** wi_list ||| SET ( STRING ) — can be set to ['ALL'], or can be a list of work-item names.

**FIELD** score_card_name ||| STRING — the score card name pattern (see LUCI_Model.ecl for details).

**FIELD** response_field ||| STRING — name of the dependent field (aka classifier name).