
toad

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CHAPTER 1

Installation

via pip

```
pip install toad
```

via anaconda

```
conda install toad --channel conda-forge
```

via source code

```
python setup.py install
```


CHAPTER 2

Tutorial

A [basic tutorial](#) is provided.

3.1 toad package

3.2 Submodules

3.2.1 toad.detector module

Command line tools for detecting csv data

Team: ESC

Examples

```
python detector.py -i xxx.csv -o report.csv
```

```
toad.detector.getTopValues (series, top=5, reverse=False)
```

Get top/bottom n values

Parameters

- **series** (*Series*) – data series
- **top** (*number*) – number of top/bottom n values
- **reverse** (*bool*) – it will return bottom n values if True is given

Returns Series of top/bottom n values and percentage. ['value:percent', None]

Return type Series

```
toad.detector.getDescribe (series, percentiles=[0.25, 0.5, 0.75])
```

Get describe of series

Parameters

- **series** (*Series*) – data series

- **percentiles** – the percentiles to include in the output

Returns the describe of data include mean, std, min, max and percentiles

Return type Series

`toad.detector.countBlank(series, blanks=[])`

Count number and percentage of blank values in series

Parameters

- **series** (*Series*) – data series
- **blanks** (*list*) – list of blank values

Returns number of blanks str: the percentage of blank values

Return type number

`toad.detector.isNumeric(series)`

Check if the series's type is numeric

Parameters **series** (*Series*) – data series

Returns bool

`toad.detector.detect(dataframe)`

Detect data

Parameters **dataframe** (*DataFrame*) – data that will be detected

Returns report of detecting

Return type DataFrame

3.2.2 toad.merge module

`toad.merge.ChiMerge()`

Chi-Merge

Parameters

- **feature** (*array-like*) – feature to be merged
- **target** (*array-like*) – a array of target classes
- **n_bins** (*int*) – n bins will be merged into
- **min_samples** (*number*) – min sample in each group, if float, it will be the percentage of samples
- **min_threshold** (*number*) – min threshold of chi-square

Returns array of split points

Return type array

`toad.merge.DTMerge()`

Merge by Decision Tree

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) – target will be used to fit decision tree
- **nan** (*number*) – value will be used to fill nan

- **n_bins** (*int*) – n groups that will be merged into
- **min_samples** (*int*) – min number of samples in each leaf nodes

Returns array of split points

Return type array

`toad.merge.KMeansMerge()`
Merge by KMeans

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) – target will be used to fit kmeans model
- **nan** (*number*) – value will be used to fill nan
- **n_bins** (*int*) – n groups that will be merged into
- **random_state** (*int*) – random state will be used for kmeans model

Returns split points of feature

Return type array

`toad.merge.QuantileMerge()`
Merge by quantile

Parameters

- **feature** (*array-like*) –
- **nan** (*number*) – value will be used to fill nan
- **n_bins** (*int*) – n groups that will be merged into
- **q** (*array-like*) – list of percentage split points

Returns split points of feature

Return type array

`toad.merge.StepMerge()`
Merge by step

Parameters

- **feature** (*array-like*) –
- **nan** (*number*) – value will be used to fill nan
- **n_bins** (*int*) – n groups that will be merged into
- **clip_v** (*number | tuple*) – min/max value of clipping
- **clip_std** (*number | tuple*) – min/max std of clipping
- **clip_q** (*number | tuple*) – min/max quantile of clipping

Returns split points of feature

Return type array

`toad.merge.merge`
merge feature into groups

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) –
- **method** (*str*) – ‘dt’, ‘chi’, ‘quantile’, ‘step’, ‘kmeans’ - the strategy to be used to merge feature
- **return_splits** (*bool*) – if needs to return splits
- **n_bins** (*int*) – n groups that will be merged into

Returns a array of merged label with the same size of feature array: list of split points

Return type array

3.2.3 toad.metrics module

`toad.metrics.KS(score, target)`
calculate ks value

Parameters

- **score** (*array-like*) – list of score or probability that the model predict
- **target** (*array-like*) – list of real target

Returns the max KS value

Return type float

`toad.metrics.KS_bucket(score, target, bucket=10, method='quantile', return_splits=False, **kwargs)`
calculate ks value by bucket

Parameters

- **score** (*array-like*) – list of score or probability that the model predict
- **target** (*array-like*) – list of real target
- **bucket** (*int*) – n groups that will bin into
- **method** (*str*) – method to bin score. *quantile* (default), *step*
- **return_splits** (*bool*) – if need to return splits of bucket

Returns DataFrame

`toad.metrics.KS_by_col(df, by='feature', score='score', target='target')`

`toad.metrics.SSE(y_pred, y)`
sum of squares due to error

`toad.metrics.MSE(y_pred, y)`
mean of squares due to error

`toad.metrics.AIC(y_pred, y, k, llf=None)`
Akaike Information Criterion

Parameters

- **y_pred** (*array-like*) –
- **y** (*array-like*) –
- **k** (*int*) – number of featuers

- **llf** (*float*) – result of log-likelihood function

`toad.metrics.BIC(y_pred, y, k, llf=None)`

Bayesian Information Criterion

Parameters

- **y_pred** (*array-like*) –
- **y** (*array-like*) –
- **k** (*int*) – number of features
- **llf** (*float*) – result of log-likelihood function

`toad.metrics.F1(score, target, split='best', return_split=False)`

calculate f1 value

Parameters

- **score** (*array-like*) –
- **target** (*array-like*) –

Returns best f1 score float: best splitter

Return type float

`toad.metrics.AUC(score, target, return_curve=False)`

AUC Score

Parameters

- **score** (*array-like*) – list of score or probability that the model predict
- **target** (*array-like*) – list of real target
- **return_curve** (*bool*) – if need return curve data for ROC plot

Returns auc score

Return type float

`toad.metrics.PSI(test, base, combiner=None, return_frame=False)`

calculate PSI

Parameters

- **test** (*array-like*) – data to test PSI
- **base** (*array-like*) – base data for calculate PSI
- **combiner** (*Combiner|list|dict*) – combiner to combine data
- **return_frame** (*bool*) – if need to return frame of proportion

Returns float|Series

`toad.metrics.matrix(y_pred, y, splits=None)`

confusion matrix of target

Parameters

- **y_pred** (*array-like*) –
- **y** (*array-like*) –
- **splits** (*float|list*) – split points of y_pred

Returns confusion matrix with true labels in rows and predicted labels in columns

Return type DataFrame

3.2.4 toad.plot module

`toad.plot.badrates_plot` (*frame*, *x=None*, *target='target'*, *by=None*, *freq=None*, *format=None*, *return_counts=False*, *return_proportion=False*, *return_frame=False*)

plot for badrate

Parameters

- **frame** (*DataFrame*) –
- **x** (*str*) – column in frame that will be used as x axis
- **target** (*str*) – target column in frame
- **by** (*str*) – column in frame that will be calculated badrate by it
- **freq** (*str*) – offset aliases string by pandas <http://pandas.pydata.org/pandas-docs/stable/timeseries.html#offset-aliases>
- **format** (*str*) – format string for time
- **return_counts** (*bool*) – if need return counts plot
- **return_frame** (*bool*) – if need return frame

Returns badrate plot Axes: counts plot Axes: proportion plot Dataframe: grouping detail data

Return type Axes

`toad.plot.corr_plot` (*frame*, *figure_size=(20, 15)*)

plot for correlation

Parameters **frame** (*DataFrame*) – frame to draw plot

Returns Axes

`toad.plot.proportion_plot` (*x=None*, *keys=None*)

plot for comparing proportion in different dataset

Parameters

- **x** (*Series/list*) – series or list of series data for plot
- **keys** (*str/list*) – keys for each data

Returns Axes

`toad.plot.roc_plot` (*score*, *target*, *compare=None*, *figsize=(14, 10)*)

plot for roc

Parameters

- **score** (*array-like*) – predicted score
- **target** (*array-like*) – true target
- **compare** (*array-like*) – another score for comparing with score

Returns Axes

`toad.plot.ks_plot` (*score*, *target*, *figsize=(14, 10)*)

plot for ks

Parameters

- **score** (*array-like*) – predicted score
- **target** (*array-like*) – true target
- **compare** (*array-like*) – another score for comparing with score

Returns Axes

`toad.plot.bin_plot` (*frame*, *x=None*, *target='target'*, *iv=True*, *annotate_format='.2f'*, *return_frame=False*)
 plot for bins

Parameters

- **frame** (*DataFrame*) –
- **x** (*str*) – column in frame that will be used as x axis
- **target** (*str*) – target column in frame
- **iv** (*bool*) – if need to show iv in plot
- **annotate_format** (*str*) – format str for axis annotation of chart
- **return_frame** (*bool*) – if need return bin frame

Returns contains good, bad, badrate, prop, y_prop, n_prop, woe, iv

Return type Dataframe

3.2.5 toad.scorecard module

class `toad.scorecard.ScoreCard` (*pdo=60*, *rate=2*, *base_odds=35*, *base_score=750*, *card=None*, *combiner={}*, *transer=None*, ***kwargs*)

Bases: `sklearn.base.BaseEstimator`, `toad.utils.mixin.RulesMixin`, `toad.utils.mixin.BinsMixin`

__init__ (*pdo=60*, *rate=2*, *base_odds=35*, *base_score=750*, *card=None*, *combiner={}*, *transer=None*, ***kwargs*)

Parameters

- **combiner** (*toad.Combiner*) –
- **transer** (*toad.WOETransformer*) –

coef_
 coef of LR model

fit (*X*, *y*)

Parameters

- **X** (*2D DataFrame*) –
- **Y** (*array-like*) –

predict (*X*, ***kwargs*)

predict score :param X: X to predict :type X: 2D-DataFrame
 dict :param return_sub: if need to return sub score of each feature :type return_sub: Bool
 :param default: default sub score for unknown feature, *min* (default), *max* :type default: str
 number

Returns predicted score DataFrameDict: sub score for each feature

Return type array-like

get_reason (*X*, *base_effect*=None, *threshold_score*=None, *keep*=3)
calculate top-effect-of-features as reasons

Parameters

- **X** (*2D DataFrame*) – X to find reason
- **base_effect** (*Series*) – base effect score of each feature
- **threshold_score** (*float*) – threshold to find top k most important features, show the highest top k features when prediction score > threshold and show the lowest top k when prediction score <= threshold default is the sum of *base_effect* score
- **keep** (*int*) – top k most important reasons to keep, default 3

Returns top k most important reasons for each feature

Return type DataFrame

bin_to_score (*bins*, *return_sub*=False, *default*='min')
predict score from bins

predict_proba (*X*)
predict probability

Parameters **X** (*2D array-like*) – X to predict

Returns probability of all classes

Return type 2d array

proba_to_score (*prob*)
covert probability to score
 $\text{odds} = (1 - \text{prob}) / \text{prob}$ score = factor * log(odds) * offset

score_to_proba (*score*)
covert score to probability

Returns the probability of 1

Return type array-like/float

woe_to_score (*woe*, *weight*=None)
calculate score by woe

after_load (*rules*)
after load card

after_export (*card*, *to_frame*=False, *to_json*=None, *to_csv*=None, ****kwargs**)
generate a scorecard object

Parameters

- **to_frame** (*bool*) – return DataFrame of card
- **to_json** (*str* | *IOBase*) – io to write json file
- **to_csv** (*filepath* | *IOBase*) – file to write csv

Returns dict

testing_frame (****kwargs**)
get testing frame with score

Returns testing frame with score

Return type DataFrame

3.2.6 toad.selection module

```
toad.selection.stepwise (frame, target='target', estimator='ols', direction='both', criterion='aic',
                        p_enter=0.01, p_remove=0.01, p_value_enter=0.2, intercept=False,
                        max_iter=None, return_drop=False, exclude=None)
```

stepwise to select features

Parameters

- **frame** (*DataFrame*) – dataframe that will be use to select
- **target** (*str*) – target name in frame
- **estimator** (*str*) – model to use for stats
- **direction** (*str*) – direction of stepwise, support ‘forward’, ‘backward’ and ‘both’, suggest ‘both’
- **criterion** (*str*) – criterion to statistic model, support ‘aic’, ‘bic’
- **p_enter** (*float*) – threshold that will be used in ‘forward’ and ‘both’ to keep features
- **p_remove** (*float*) – threshold that will be used in ‘backward’ to remove features
- **intercept** (*bool*) – if have intercept
- **p_value_enter** (*float*) – threshold that will be used in ‘both’ to remove features
- **max_iter** (*int*) – maximum number of iterate
- **return_drop** (*bool*) – if need to return features’ name who has been dropped
- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped

Return type *DataFrame*

```
toad.selection.drop_empty (frame, threshold=0.9, nan=None, return_drop=False, exclude=None)
```

drop columns by empty

Parameters

- **frame** (*DataFrame*) – dataframe that will be used
- **threshold** (*number*) – drop the features whose empty num is greater than threshold. if threshold is float, it will be use as percentage
- **nan** (*any*) – values will be look like empty
- **return_drop** (*bool*) – if need to return features’ name who has been dropped
- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped

Return type *DataFrame*

```
toad.selection.drop_var (frame, threshold=0, return_drop=False, exclude=None)
```

drop columns by variance

Parameters

- **frame** (*DataFrame*) – dataframe that will be used
- **threshold** (*float*) – drop features whose variance is less than threshold
- **return_drop** (*bool*) – if need to return features’ name who has been dropped

- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped

Return type DataFrame

```
toad.selection.drop_corr(frame, target=None, threshold=0.7, by='IV', return_drop=False, exclude=None)
```

drop columns by correlation

Parameters

- **frame** (*DataFrame*) – dataframe that will be used
- **target** (*str*) – target name in dataframe
- **threshold** (*float*) – drop features that has the smallest weight in each groups whose correlation is greater than threshold
- **by** (*array-like*) – weight of features that will be used to drop the features
- **return_drop** (*bool*) – if need to return features' name who has been dropped
- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped

Return type DataFrame

```
toad.selection.drop_iv(frame, target='target', threshold=0.02, return_drop=False, return_iv=False, exclude=None)
```

drop columns by IV

Parameters

- **frame** (*DataFrame*) – dataframe that will be used
- **target** (*str*) – target name in dataframe
- **threshold** (*float*) – drop the features whose IV is less than threshold
- **return_drop** (*bool*) – if need to return features' name who has been dropped
- **return_iv** (*bool*) – if need to return features' IV
- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped Series: list of features' IV

Return type DataFrame

```
toad.selection.drop_vif(frame, threshold=3, return_drop=False, exclude=None)
```

variance inflation factor

Parameters

- **frame** (*DataFrame*) –
- **threshold** (*float*) – drop features until all vif is less than threshold
- **return_drop** (*bool*) – if need to return features' name who has been dropped
- **exclude** (*array-like*) – list of feature names that will not be dropped

Returns selected dataframe array: list of feature names that has been dropped

Return type DataFrame

`toad.selection.select` (*frame*, *target*='target', *empty*=0.9, *iv*=0.02, *corr*=0.7, *return_drop*=False, *exclude*=None)
 select features by rate of empty, iv and correlation

Parameters

- **frame** (*DataFrame*) –
- **target** (*str*) – target's name in dataframe
- **empty** (*number*) – drop the features which empty num is greater than threshold. if threshold is less than 1, it will be use as percentage
- **iv** (*float*) – drop the features whose IV is less than threshold
- **corr** (*float*) – drop features that has the smallest IV in each groups which correlation is greater than threshold
- **return_drop** (*bool*) – if need to return features' name who has been dropped
- **exclude** (*array-like*) – list of feature name that will not be dropped

Returns selected dataframe dict: list of dropped feature names in each step

Return type DataFrame

3.2.7 toad.stats module

`toad.stats.gini` (*target*)
 get gini index of a feature

Parameters **target** (*array-like*) – list of target that will be calculate gini

Returns gini value

Return type number

`toad.stats.gini_cond`
 get conditional gini index of a feature

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) –

Returns conditional gini value. If feature is continuous, it will return the best gini value when the feature bins into two groups

Return type number

`toad.stats.entropy` (*target*)
 get information entropy of a feature

Parameters **target** (*array-like*) –

Returns information entropy

Return type number

`toad.stats.entropy_cond`
 get conditional entropy of a feature

Parameters

- **feature** (*array-like*) –

- **target** (*array-like*) –

Returns conditional information entropy. If feature is continuous, it will return the best entropy when the feature bins into two groups

Return type number

`toad.stats.probability(target, mask=None)`
get probability of target by mask

`toad.stats.WOE(y_prob, n_prob)`
get WOE of a group

Parameters

- **y_prob** – the probability of grouped y in total y
- **n_prob** – the probability of grouped n in total n

Returns woe value

Return type number

`toad.stats.IV`
get the IV of a feature

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) –
- **return_sub** (*bool*) – if need return IV of each groups
- **n_bins** (*int*) – n groups that the feature will bin into
- **method** (*str*) – the strategy to be used to merge feature, default is 'dt'
- **()** (***kwargs*) – other options for merge function

`toad.stats.badrate(target)`
calculate badrate

Parameters **target** (*array-like*) – target array which 1 is bad

Returns float

`toad.stats.VIF(frame)`
calculate vif

Parameters **frame** (*ndarray/DataFrame*) –

Returns Series

class `toad.stats.indicator(*args, is_class=False, **kwargs)`
Bases: `toad.utils.decorator.Decorator`
indicator decorator

`toad.stats.column_quality(feature, target, name='feature', indicators=[], need_merge=False, **kwargs)`
calculate quality of a feature

Parameters

- **feature** (*array-like*) –
- **target** (*array-like*) –

- **name** (*str*) – feature’s name that will be setted in the returned Series
- **indicators** (*list*) – list of indicator functions
- **need_merge** (*bool*) – if need merge feature

Returns a list of quality with the feature’s name

Return type Series

```
toad.stats.quality(dataframe, target='target', cpu_cores=0, iv_only=False, indicators=['iv', 'gini',
                                             'entropy', 'unique'], **kwargs)
```

get quality of features in data

Parameters

- **dataframe** (*DataFrame*) – dataframe that will be calculate quality
- **target** (*str*) – the target’s name in dataframe
- **iv_only** (*bool*) – *deprecated*. if only calculate IV
- **cpu_cores** (*int*) – the maximun number of CPU cores will be used, 0 means all CPUs will be used, -1 means all CPUs but one will be used.

Returns quality of features with the features’ name as row name

Return type DataFrame

```
toad.stats.feature_bin_stats(df_bin, feature, target)
```

calculate the detail info of a feature after bin

Parameters

- **df_bin** (*dataframe has featute and target columns*) –
- **feature** (*str*) –
- **target** (*str*) –

Returns contains good, bad, badrate, prop, y_prop, n_prop, woe, iv

Return type DataFrame

3.2.8 toad.transform module

```
class toad.transform.Transformer
```

Bases: sklearn.base.TransformerMixin, toad.utils.mixin.RulesMixin

Base class for transformers

```
fit(X, *args, update=False, **kwargs)
```

fit method, see details in *fit_* method

```
transform(X, *args, **kwargs)
```

transform method, see details in *transform_* method

```
__init__
```

Initialize self. See help(type(self)) for accurate signature.

```
export(**kwargs)
```

export rules to dict or a json file

Parameters **to_json** (*str* | *IOBase*) – json file to save rules

Returns dictionary of rules

Return type dict

fit_transform (*X*, *y=None*, ***fit_params*)

Fit to data, then transform it.

Fits transformer to *X* and *y* with optional parameters *fit_params* and returns a transformed version of *X*.

Parameters

- **X** (*array-like of shape (n_samples, n_features)*) – Input samples.
- **y** (*array-like of shape (n_samples,) or (n_samples, n_outputs), default=None*) – Target values (None for unsupervised transformations).
- ****fit_params** (*dict*) – Additional fit parameters.

Returns **X_new** – Transformed array.

Return type ndarray array of shape (n_samples, n_features_new)

load (*rules*, *update=False*, ***kwargs*)

load rules from dict or json file

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str/IOBase*) – json file of rules
- **update** (*bool*) – if need to use updating instead of replacing rules

set_output (**, transform=None*)

Set output container.

See sphx_glr_auto_examples_miscellaneous_plot_set_output.py for an example on how to use the API.

Parameters **transform** (*{"default", "pandas"}, default=None*) – Configure output of *transform* and *fit_transform*.

- **"default"**: Default output format of a transformer
- **"pandas"**: DataFrame output
- **None**: Transform configuration is unchanged

Returns **self** – Estimator instance.

Return type estimator instance

update (**args, **kwargs*)

update rules

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str/IOBase*) – json file of rules

class toad.transform.WOETransformer

Bases: *toad.transform.Transformer*

WOE transformer

fit_ (*X*, *y*)

fit WOE transformer

Parameters

- **X** (*DataFrame/array-like*) –
- **y** (*str/array-like*) –
- **select_dtypes** (*str/numpy.dtypes*) – ‘object’, ‘number’ etc. only selected dtypes will be transform

transform_ (*rule, X, default='min'*)
transform function for single feature

Parameters

- **X** (*array-like*) –
- **default** (*str*) – ‘min’(default), ‘max’ - the strategy to be used for unknown group

Returns array-like

__init__
Initialize self. See help(type(self)) for accurate signature.

export (***kwargs*)
export rules to dict or a json file

Parameters **to_json** (*str/IOBase*) – json file to save rules

Returns dictionary of rules

Return type dict

fit (*X, *args, update=False, **kwargs*)
fit method, see details in *fit_* method

fit_transform (*X, y=None, **fit_params*)
Fit to data, then transform it.

Fits transformer to *X* and *y* with optional parameters *fit_params* and returns a transformed version of *X*.

Parameters

- **X** (*array-like of shape (n_samples, n_features)*) – Input samples.
- **y** (*array-like of shape (n_samples,) or (n_samples, n_outputs), default=None*) – Target values (None for unsupervised transformations).
- ****fit_params** (*dict*) – Additional fit parameters.

Returns **X_new** – Transformed array.

Return type ndarray array of shape (n_samples, n_features_new)

load (*rules, update=False, **kwargs*)
load rules from dict or json file

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str/IOBase*) – json file of rules
- **update** (*bool*) – if need to use updating instead of replacing rules

set_output (**, transform=None*)
Set output container.

See sphx_glr_auto_examples_misellaneous_plot_set_output.py for an example on how to use the API.

Parameters **transform** (`{ "default", "pandas" }, default=None`) – Configure output of *transform* and *fit_transform*.

- `"default"`: Default output format of a transformer
- `"pandas"`: DataFrame output
- `None`: Transform configuration is unchanged

Returns **self** – Estimator instance.

Return type estimator instance

transform (*X*, **args*, ***kwargs*)
transform method, see details in *transform_* method

update (**args*, ***kwargs*)
update rules

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str* | *IOBase*) – json file of rules

class toad.transform.Combiner

Bases: *toad.transform.Transformer*, *toad.utils.mixin.BinsMixin*

Combiner for merge data

fit_ (*X*, *y=None*, *method='chi'*, *empty_separate=False*, ***kwargs*)
fit combiner

Parameters

- **X** (*DataFrame* | *array-like*) – features to be combined
- **y** (*str* | *array-like*) – target data or name of target in *X*
- **method** (*str*) – the strategy to be used to merge *X*, same as *.merge*, default is *chi*
- **n_bins** (*int*) – counts of bins will be combined
- **empty_separate** (*bool*) – if need to combine empty values into a separate group

transform_ (*rule*, *X*, *labels=False*, *ellipsis=16*, ***kwargs*)
transform *X* by combiner

Parameters

- **X** (*DataFrame* | *array-like*) – features to be transformed
- **labels** (*bool*) – if need to use labels for resulting bins, *False* by default
- **ellipsis** (*int*) – max length threshold that labels will not be ellipsis, *None* for skipping ellipsis

Returns array-like

set_rules (*map*, *reset=False*)
set rules for combiner

Parameters

- **map** (*dict* | *array-like*) – map of splits
- **reset** (*bool*) – if need to reset combiner

Returns **self**

__init__
Initialize self. See help(type(self)) for accurate signature.

export (***kwargs*)
export rules to dict or a json file

Parameters **to_json** (*str* | *IOBase*) – json file to save rules

Returns dictionary of rules

Return type dict

fit (*X*, **args*, *update=False*, ***kwargs*)
fit method, see details in *fit*_method

fit_transform (*X*, *y=None*, ***fit_params*)
Fit to data, then transform it.

Fits transformer to *X* and *y* with optional parameters *fit_params* and returns a transformed version of *X*.

Parameters

- **X** (*array-like* of shape (*n_samples*, *n_features*)) – Input samples.
- **y** (*array-like* of shape (*n_samples*,) or (*n_samples*, *n_outputs*), *default=None*) – Target values (None for unsupervised transformations).
- ****fit_params** (*dict*) – Additional fit parameters.

Returns **X_new** – Transformed array.

Return type ndarray array of shape (*n_samples*, *n_features_new*)

classmethod format_bins (*bins*, *index=False*, *ellipsis=None*)
format bins to label

Parameters

- **bins** (*ndarray*) – bins to format
- **index** (*bool*) – if need index prefix
- **ellipsis** (*int*) – max length threshold that labels will not be ellipsis, *None* for skipping ellipsis

Returns array of labels

Return type ndarray

load (*rules*, *update=False*, ***kwargs*)
load rules from dict or json file

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str* | *IOBase*) – json file of rules
- **update** (*bool*) – if need to use updating instead of replacing rules

classmethod parse_bins (*bins*)
parse labeled bins to array

set_output (***, *transform=None*)
Set output container.

See sphx_glr_auto_examples_misellaneous_plot_set_output.py for an example on how to use the API.

Parameters `transform` (`{ "default", "pandas" }`, `default=None`) – Configure output of `transform` and `fit_transform`.

- `"default"`: Default output format of a transformer
- `"pandas"`: DataFrame output
- `None`: Transform configuration is unchanged

Returns `self` – Estimator instance.

Return type estimator instance

transform (`X`, `*args`, `**kwargs`)
transform method, see details in `transform_` method

update (`*args`, `**kwargs`)
update rules

Parameters

- **rules** (`dict`) – dictionary of rules
- **from_json** (`str` | `IOBase`) – json file of rules

class `toad.transform.GBDTTransformer`

Bases: `toad.transform.Transformer`

GBDT transformer

__init__ ()
Initialize self. See `help(type(self))` for accurate signature.

fit_ (`X`, `y`, `**kwargs`)
fit GBDT transformer

Parameters

- **X** (`DataFrame` | `array-like`) –
- **y** (`str` | `array-like`) –
- **select_dtypes** (`str` | `numpy.dtypes`) – `'object'`, `'number'` etc. only selected dtypes will be transform,

transform_ (`rules`, `X`)
transform woe

Parameters **X** (`DataFrame` | `array-like`) –

Returns array-like

export (`**kwargs`)
export rules to dict or a json file

Parameters **to_json** (`str` | `IOBase`) – json file to save rules

Returns dictionary of rules

Return type dict

fit (`X`, `*args`, `update=False`, `**kwargs`)
fit method, see details in `fit_` method

fit_transform (`X`, `y=None`, `**fit_params`)
Fit to data, then transform it.

Fits transformer to `X` and `y` with optional parameters `fit_params` and returns a transformed version of `X`.

Parameters

- **X** (*array-like of shape (n_samples, n_features)*) – Input samples.
- **y** (*array-like of shape (n_samples,) or (n_samples, n_outputs), default=None*) – Target values (None for unsupervised transformations).
- ****fit_params** (*dict*) – Additional fit parameters.

Returns **X_new** – Transformed array.

Return type ndarray array of shape (n_samples, n_features_new)

load (*rules, update=False, **kwargs*)
load rules from dict or json file

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str / IOBase*) – json file of rules
- **update** (*bool*) – if need to use updating instead of replacing rules

set_output (**, transform=None*)
Set output container.

See sphx_glr_auto_examples_miscellaneous_plot_set_output.py for an example on how to use the API.

Parameters transform (*{"default", "pandas"}, default=None*) – Configure output of *transform* and *fit_transform*.

- *"default"*: Default output format of a transformer
- *"pandas"*: DataFrame output
- *None*: Transform configuration is unchanged

Returns **self** – Estimator instance.

Return type estimator instance

transform (*X, *args, **kwargs*)
transform method, see details in *transform_* method

update (**args, **kwargs*)
update rules

Parameters

- **rules** (*dict*) – dictionary of rules
- **from_json** (*str / IOBase*) – json file of rules

3.2.9 toad.preprocessing module

toad.preprocessing.process module

class toad.preprocessing.process.**Processing** (*data*)
Bases: object
Examples:

```

>>> (Processing(data)
...   .groupby('id')
...   .partitionby(TimePartition(
...       'base_time',
...       'filter_time',
...       ['30d', '60d', '180d', '365d', 'all']
...   ))
...   .apply({'A': ['max', 'min', 'mean']})
...   .apply({'B': ['max', 'min', 'mean']})
...   .apply({'C': 'nunique'})
...   .apply({'D': {
...       'f': len,
...       'name': 'normal_count',
...       'mask': Mask('D').isin(['normal']),
...   }})
...   .apply({'id': 'count'})
...   .exec()
... )

```

__init__ (*data*)

Initialize self. See help(type(self)) for accurate signature.

groupby (*name*)

group data by name

Parameters **name** (*str*) – column name in data

apply (*f*)

apply functions to data

Parameters **f** (*dict/function*) – a config dict that keys are the column names and values are the functions, it will take the column series as the functions argument. if *f* is a function, it will take the whole dataframe as the argument.

partitionby (*p*)

partition data to multiple pieces, processing will process to all the pieces

Parameters **p** (*Partition*) –

class toad.preprocessing.process.**Mask** (*column=None*)

Bases: object

a placeholder to select dataframe

__init__ (*column=None*)

Initialize self. See help(type(self)) for accurate signature.

class toad.preprocessing.process.**F** (*f, name=None, mask=None*)

Bases: object

function class for processing

__init__ (*f, name=None, mask=None*)

Initialize self. See help(type(self)) for accurate signature.

toad.preprocessing.partition module

class toad.preprocessing.partition.**TimePartition** (*base, filter, times*)

Bases: toad.preprocessing.partition.Partition

partition data by time delta

Parameters

- **base** (*str*) – column name of base time
- **filter** (*str*) – column name of target time to be compared
- **times** (*list*) – list of time delta

Example:

```
>>> TimePartition('apply_time', 'query_time', ['30d', '90d', 'all'])
```

__init__ (*base, filter, times*)

Initialize self. See help(type(self)) for accurate signature.

partition (*data*)

partition data

Parameters **data** (*DataFrame*) – dataframe

Returns mask of partition data iterator -> str: suffix string of current partition

Return type iterator -> ndarray[bool]

class toad.preprocessing.partition.**ValuePartition** (*column*)

Bases: toad.preprocessing.partition.Partition

partition data by column values

Parameters **column** (*str*) – column name which will be used as partition

Example:

```
>>> ValuePartition('status')
```

__init__ (*column*)

Initialize self. See help(type(self)) for accurate signature.

partition (*data*)

partition data

Parameters **data** (*DataFrame*) – dataframe

Returns mask of partition data iterator -> str: suffix string of current partition

Return type iterator -> ndarray[bool]

3.2.10 toad.nn module

toad.nn.module module

class toad.nn.module.**Module**

Bases: torch.nn.modules.module.Module

base module for every model

Examples

```

>>> from toad.nn import Module
... from torch import nn
...
... class Net(Module):
...     def __init__(self, inputs, hidden, outputs):
...         super().__init__()
...         self.model = nn.Sequential(
...             nn.Linear(inputs, hidden),
...             nn.ReLU(),
...             nn.Linear(hidden, outputs),
...             nn.Sigmoid(),
...         )
...
...     def forward(self, x):
...         return self.model(x)
...
...     def fit_step(self, batch):
...         x, y = batch
...         y_hat = self(x)
...
...         # log into history
...         self.log('y', y)
...         self.log('y_hat', y_hat)
...
...         return nn.functional.mse_loss(y_hat, y)
...
... model = Net(10, 4, 1)
...
... model.fit(train_loader)

```

__init__()
define model struct

device
device of model

fit (*loader*, *trainer=None*, *optimizer=None*, *loss=None*, *early_stopping=None*, ***kwargs*)
train model

Parameters

- **loader** (*DataLoader*) – loader for training model
- **trainer** (*Trainer*) – trainer for training model
- **optimizer** (*torch.Optimier*) – the default optimizer is *Adam(lr = 1e-3)*
- **loss** (*Callable*) – could be called as ‘loss(y_hat, y)’
- **early_stopping** (*earlystopping*) – the default value is *loss_earlystopping*, you can set it to *False* to disable early stopping
- **epoch** (*int*) – number of epoch for training loop
- **callback** (*callable*) – callable function will be called every epoch

evaluate (*loader*, *trainer=None*)
evaluate model

Parameters

- **loader** (*DataLoader*) – loader for evaluate model

- **trainer** (*Trainer*) – trainer for evaluate model

fit_step (*batch*, *loss=None*, **args*, ***kwargs*)
step for fitting

Parameters

- **batch** (*Any*) – batch data from dataloader
- **loss** (*Callable*) – could be called as 'loss(y_hat, y)'

Returns loss of this step

Return type Tensor

save (*path*)
save model

load (*path*)
load model

log (*key*, *value*)
log values to history

Parameters

- **key** (*str*) – name of message
- **value** (*Tensor*) – tensor of values

distributed (*backend=None*, ***kwargs*)
get distributed model

class toad.nn.module.**DistModule** (*module*, *device_ids=None*, *output_device=None*,
dim=0, *broadcast_buffers=True*, *process_group=None*,
bucket_cap_mb=25, *find_unused_parameters=False*,
check_reduction=False, *gradient_as_bucket_view=False*,
static_graph=False)

Bases: torch.nn.parallel.distributed.DistributedDataParallel

distributed module class

toad.nn.functional module

toad.nn.functional.**flooding** (*loss*, *b*)
flooding loss

toad.nn.functional.**focal_loss**
focal loss

Parameters

- **input** (*Tensor*) – N x C, C is the number of classes
- **target** (*Tensor*) – N, each value is the index of classes
- **alpha** (*Variable*) – balaced variant of focal loss, range is in [0, 1]
- **gamma** (*float*) – focal loss parameter
- **reduction** (*str*) – *mean*, *sum*, *none* for reduce the loss of each classes

toad.nn.functional.**binary_focal_loss**
binary focal loss

```
toad.nn.functional.focal_loss_for_numpy(input, target, alpha=1.0, gamma=2.0, reduction='mean')
    focal loss for numpy array

toad.nn.functional.label_smoothing(labels, smoothing=0.1)
    label smoothing
```

toad.nn.trainer module

```
class toad.nn.trainer.History
    Bases: object
    model history
    __init__()
        Initialize self. See help(type(self)) for accurate signature.
    log(key, value)
        log message to history

    Parameters
    • key (str) – name of message
    • value (Tensor) – tensor of values
```

```
class toad.nn.trainer.callback(*args, **kwargs)
    Bases: toad.utils.decorator.Decorator
    callback for trainer
```

Examples

```
>>> @callback
... def savemodel(model):
...     model.save("path_to_file")
...
... trainer.train(model, callback = savemodel)
```

```
__init__(*args, **kwargs)
    Initialize self. See help(type(self)) for accurate signature.
```

```
class toad.nn.trainer.earlystopping(*args, **kwargs)
    Bases: toad.nn.trainer.callback.callback
```

Examples

```
>>> @earlystopping(delta = 1e-3, patience = 5)
... def auc(history):
...     return AUC(history['y_hat'], history['y'])
```

```
setup(delta=-0.001, patience=10, skip=0)
```

Parameters

- **delta** (*float*) – stop training if diff of new score is smaller than delta
- **patience** (*int*) – patience of rounds to stop training

- **skip** (*int*) – n rounds from starting training to warm up

get_best_state ()
get best state of model

reset ()

class toad.nn.trainer.Trainer (*model*, *loader=None*, *optimizer=None*, *loss=None*,
keep_history=None, *early_stopping=None*)

Bases: toad.nn.trainer.event.Event

trainer for training models

__init__ (*model*, *loader=None*, *optimizer=None*, *loss=None*, *keep_history=None*,
early_stopping=None)
initialization

Parameters

- **model** (*nn.Module*) – model will be trained
- **loader** (*torch.DataLoader*) – training data loader
- **optimizer** (*torch.Optimier*) – the default optimizer is *Adam(lr = 1e-3)*
- **loss** (*Callable*) – could be called as ‘loss(y_hat, y)’
- **early_stopping** (*earlystopping*) – the default value is *loss_earlystopping*, you can set it to *False* to disable early stopping
- **keep_history** (*int*) – keep the last n-th epoch logs, *None* will keep all

set_model (*model*)
setup model

distributed (*address=None*, *workers=4*, *gpu=False*)
setting distribution enviroment and initial a ray cluster connection

Parameters

- **address** (*string*) – the head of ray cluster address
- **workers** (*int*) – compute task’s resource
- **gpu** (*Booleans*) – whether use GPU, “True” or “False”

train (*loader=None*, *epoch=10*, ***kwargs*)

Parameters

- **loader** (*torch.DataLoader*) – training data loader
- **epoch** (*int*) – number of epoch for training loop
- **callback** (*list[Callback]*) – callable function will be called every epoch - parameters of callback

model (*nn.Module*): the training model history (*History*): history of total log records
epoch (*int*): current epoch number trainer (*Trainer*): self trainer

- **start** (*int*) – epoch start from n round
- **backward_rounds** (*int*) – backward after every n rounds

Returns the model with best perfroments

Return type *Module*

evaluate (*loader*, *callback=None*)
evaluate model

Parameters

- **loader** (*torch.DataLoader*) – evaluation data loader
- **callback** (*callable*) – callback function

3.2.11 toad.utils module

toad.utils.func module

`toad.utils.func.to_ndarray` (*s*, *dtype=None*)

`toad.utils.func.bin_by_splits` (*feature*, *splits*)
Bin feature by split points

`toad.utils.func.feature_splits` (*feature*, *target*)
find possibility split points

`toad.utils.func.iter_df` (*dataframe*, *feature*, *target*, *splits*)
iterate dataframe by split points

Returns iterator (df, splitter)

`toad.utils.func.split_target` (*frame*, *target*)

`toad.utils.func.save_json` (*contents*, *file*, *indent=4*)
save json file

Parameters

- **contents** (*dict*) – contents to save
- **file** (*str* | *IOBase*) – file to save

`toad.utils.func.read_json` (*file*)
read json file

`toad.utils.func.clip` (*series*, *value=None*, *std=None*, *quantile=None*)
clip series

Parameters

- **series** (*array-like*) – series need to be clipped
- **value** (*number* | *tuple*) – min/max value of clipping
- **std** (*number* | *tuple*) – min/max std of clipping
- **quantile** (*number* | *tuple*) – min/max quantile of clipping

`toad.utils.func.flatten_columns` (*columns*, *sep='_'*)
flatten multiple columns to 1-dim columns joined with '_'

`toad.utils.func.bin_to_number` (*reg=None*)

Returns func(string) -> number

Return type function

`toad.utils.func.generate_target` (*size*, *rate=0.5*, *weight=None*, *reverse=False*)
generate target for reject inference

Parameters

- **size** (*int*) – size of target
- **rate** (*float*) – rate of ‘1’ in target
- **weight** (*array-like*) – weight of ‘1’ to generate target
- **reverse** (*bool*) – if need reverse weight

Returns array

```
toad.utils.func.get_dummies (dataframe, exclude=None, binary_drop=False, **kwargs)
get dummies
```

toad.utils.decorator module

```
class toad.utils.decorator.Decorator (*args, is_class=False, **kwargs)
    Bases: object
    base decorator class

    __init__ (*args, is_class=False, **kwargs)
        Initialize self. See help(type(self)) for accurate signature.

class toad.utils.decorator.frame_exclude (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    decorator for exclude columns

class toad.utils.decorator.select_dtypes (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    decorator for select frame by dtypes

class toad.utils.decorator.save_to_json (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    support save result to json file

class toad.utils.decorator.load_from_json (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    support load data from json file

class toad.utils.decorator.support_dataframe (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    decorator for supporting dataframe

class toad.utils.decorator.proxy_docstring (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator

class toad.utils.decorator.support_numpy (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    decorator for supporting numpy array to use torch function

class toad.utils.decorator.xgb_loss (*args, is_class=False, **kwargs)
    Bases: toad.utils.decorator.Decorator
    decorator for converting function to xgb supported loss function
```

Parameters

- **loss_func** (*callable*) – loss function

- ****kwargs** – other arguments for loss function except *pred* and *label*

Examples:

```
>>> @xgb_loss(**kwargs)
>>> def loss_func(pred, label, **kwargs):
>>>     ...
>>>     return loss
>>>
>>> # or use `xgb_loss` directly
>>> xgb_func = xgb_loss(**kwargs)(loss_func)
>>>
>>> # use in xgb
>>> model = xgb.XGBClassifier(objective = xgb_func)
```

toad.utils.mixin module

3.3 Module contents

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