Package ‘rSAFE’

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## Description

Datasets `apartments` and `apartmentsTest` are artificial, generated from the same model. Structure of the dataset is copied from real dataset from PBImisc package, but they were generated in a way to mimic effect of Anscombe quartet for complex black box models.

## Usage

```r
data(apartments)
```

## Format

a data frame with 1000 rows and 6 columns

## Details

- `m2.price` - price per square meter
- `surface` - apartment area in square meters
- `no.rooms` - number of rooms (correlated with surface)
- `district` - district in which apartment is located, factor with 10 levels (Bemowo, Bielany, Mokotow, Ochota, Praga, Srodmiescie, Ursus, Ursynow, Wola, Zoliborz)
- `floor` - floor
- `construction.year` - construction year
Why are our best and most experienced employees leaving prematurely?

Description

A dataset from Kaggle competition Human Resources Analytics. https://www.kaggle.com/

Format

A data frame with 14999 rows and 10 variables

Details

- satisfaction_level Level of satisfaction (0-1)
- last_evaluation Time since last performance evaluation (in Years)
- number_project Number of projects completed while at work
- average_monthly_hours Average monthly hours at workplace
- time_spend_company Number of years spent in the company
- work_accident Whether the employee had a workplace accident
- left Whether the employee left the workplace or not (1 or 0) Factor
- promotion_last_5years Whether the employee was promoted in the last five years
- sales Department in which they work for
- salary Relative level of salary (high)

Source

Dataset HR-analytics from https://www.kaggle.com

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plot.safe_extractor Plotting Transformations of the SAFE Extractor Object

Description

Plotting Transformations of the SAFE Extractor Object

Usage

```r
## S3 method for class 'safe_extractor'
plot(x, ..., variable = NULL)
```
print.safe_extractor

Arguments

x  
safe_extractor object containing information about variables transformations created with safe_extraction() function

...  
other parameters

variable  
character, name of the variable to be plotted

Value

a plot object

Description

Printing Summary of the SAFE Extractor Object

Usage

## S3 method for class 'safe_extractor'
print(x, ..., variable = NULL)

Arguments

x  
safe_extractor object containing information about variables transformations created with safe_extraction() function

...  
other parameters

variable  
character, name of the variable to be plotted. If this argument is not specified then transformations for all variables are printed

Value

No return value, prints the structure of the object
The `safely_detect_changepoints()` function calculates the optimal positioning and number of change-points for given data and penalty. It uses a PELT algorithm with a non-parametric cost function based on the empirical distribution. The implementation is inspired by the code available on https://github.com/rkillick/changepoint.

### Usage

`safely_detect_changepoints(data, penalty = "MBIC", nquantiles = 10)`

### Arguments

- **data**: a vector within which you wish to find changepoints
- **penalty**: penalty for introducing another changepoint, one of "AIC", "BIC", "SIC", "MBIC", "Hannan-Quinn" or numeric non-negative value
- **nquantiles**: the number of quantiles used in integral approximation

### Value

A vector of optimal changepoint positions (last observations of each segment)

### See Also

`safely_transform_continuous`

### Examples

```r
library(rSAFE)

data <- rep(c(2,7), each=4)
safely_detect_changepoints(data)

set.seed(123)
data <- c(rnorm(15, 0), rnorm(20, 2), rnorm(30, 8))
safely_detect_changepoints(data)
safely_detect_changepoints(data, penalty = 25)
```
safely_detect_interactions

Detecting Interactions via Permutation Approach

Description

The safely_detect_interactions() function detects second-order interactions based on predictions made by a surrogate model. For each pair of features it performs values permutation in order to evaluate their non_additive effect.

Usage

safely_detect_interactions(
  explainer,
  inter_param = 0.5,
  inter_threshold = 0.5,
  verbose = TRUE
)

Arguments

explainer DALEX explainer created with explain() function
inter_param numeric, a positive value indicating which of single observation non-additive effects are to be regarded as significant, the higher value the higher non-additive effect has to be taken into account
inter_threshold numeric, a value from \([0, 1]\) interval indicating which interactions should be returned as significant. It corresponds to the percentage of observations for which interaction measure is greater than inter_param - if this percentage is less than inter_threshold then interaction effect is ignored.
verbose logical, if progress bar is to be printed

Value
dataframe object containing interactions effects greater than or equal to the specified inter_threshold

See Also

safe_extraction

Examples

library(DALEX)
library(randomForest)
library(rSAFE)
```r
data <- apartments[1:500,]
saf.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor +
                        no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1])
safely_detect_interactions(explainer_rf, inter_param = 0.25,
                        inter_threshold = 0.2, verbose = TRUE)
```

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**safely_select_variables**  

*Performing Feature Selection on the Dataset with Transformed Variables*

**Description**

The `safely_select_variables()` function selects variables from dataset returned by `safely_transform_data()` function. For each original variable exactly one variable is chosen

- either original one or transformed one. The choice is based on the AIC value for linear model (regression) or logistic regression (classification).

**Usage**

```r
safely_select_variables(
  safe_extractor,
  data,
  y = NULL,
  which_y = NULL,
  class_pred = NULL,
  verbose = TRUE
)
```

**Arguments**

- `safe_extractor` object containing information about variables transformations created with `safe_extraction()` function
- `data` data, original dataset or the one returned by `safely_transform_data()` function. If data do not contain transformed variables then transformation is done inside this function using `safe_extractor` argument. Data may contain response variable or not - if it does then `which_y` argument must be given, otherwise `y` argument should be provided.
- `y` vector of responses, must be given if data does not contain it
- `which_y` numeric or character (optional), must be given if data contains response values
- `class_pred` numeric or character, used only in multi-classification problems. If response vector has more than two levels, then `class_pred` should indicate the class of interest which will denote failure - all other classes will stand for success.
- `verbose` logical, if progress bar is to be printed
safely_transform_categorical

Calculating a Transformation of Categorical Feature Using Hierarchical Clustering

Description

The safely_transform_categorical() function calculates a transformation function for the categorical variable using predictions obtained from black box model and hierarchical clustering. The gap statistic criterion is used to determine the optimal number of clusters.

Usage

safely_transform_categorical(
  explainer,
  variable,
  method = "complete",
  B = 500,
  collapse = "_
)

Value

vector of variables names, selected based on AIC values

See Also

safely_transform_data

Examples

library(DALEX)
library(randomForest)
library(rSAFE)

data <- apartments[1:500,]
set.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor + 
  no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1])
safe_extractor <- safe_extraction(explainer_rf, verbose = FALSE)
safely_select_variables(safe_extractor, data, which_y = "m2.price", verbose = FALSE)
Arguments

explainer          DALEX explainer created with explain() function
variable           a feature for which the transformation function is to be computed
method             the agglomeration method to be used in hierarchical clustering, one of: "ward.D", "ward.D2", "single", "complete", "average", "mcquitty", "median", "centroid"
B                  number of reference datasets used to calculate gap statistics
collapse           a character string to separate original levels while combining them to the new one

Value

list of information on the transformation of given variable

See Also

safe_extraction

Examples

library(DALEX)
library(randomForest)
library(rSAFE)

data <- apartments[1:500,]
set.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor + 
                         no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1])
safely_transform_categorical(explainer_rf, "district")
Usage

`safely_transform_continuous(
    explainer,
    variable,
    response_type = "ale",
    grid_points = 50,
    N = 200,
    penalty = "MBIC",
    nquantiles = 10,
    no_segments = 2
)
`

Arguments

- **explainer**: DALEX explainer created with `explain()` function
- **variable**: a feature for which the transformation function is to be computed
- **response_type**: character, type of response to be calculated, one of: "pdp", "ale". If features are uncorrelated, one can use "pdp" type - otherwise "ale" is strongly recommended.
- **grid_points**: number of points on x-axis used for creating the PD/ALE plot, default 50
- **N**: number of observations from the dataset used for creating the PD/ALE plot, default 200
- **penalty**: penalty for introducing another changepoint, one of "AIC", "BIC", "SIC", "MBIC", "Hannan-Quinn" or numeric non-negative value
- **nquantiles**: the number of quantiles used in integral approximation
- **no_segments**: numeric, a number of segments variable is to be divided into in case of founding no breakpoints

Value

list of information on the transformation of given variable

See Also

- `safe_extraction`
- `safely_detect_changepoints`

Examples

```r
library(DALEX)
library(randomForest)
library(rSAFE)

data <- apartments[1:500,]
set.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor +
                          no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1])
safely_transform_continuous(explainer_rf, "construction.year")
```
Performing Transformations on All Features in the Dataset

Description

The safely_transform_data() function creates new variables in dataset using safe_extractor object.

Usage

safely_transform_data(safe_extractor, data, verbose = TRUE)

Arguments

- safe_extractor: object containing information about variables transformations created with safe_extraction() function
- data: data for which features are to be transformed
- verbose: logical, if progress bar is to be printed

Value

- data with extra columns containing newly created variables

See Also

- safe_extraction, safely_select_variables

Examples

```r
library(DALEX)
library(randomForest)
library(rSAFE)

data <- apartments[1:500,]
set.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor + no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1])
safe_extractor <- safe_extraction(explainer_rf, verbose = FALSE)
safely_transform_data(safe_extractor, data, verbose = FALSE)
```
safe_extraction

Creating SAFE Extractor - an Object Used for Surrogate-Assisted Feature Extraction

Description

The safe_extraction() function creates a SAFE-extractor object which may be used later for surrogate feature extraction.

Usage

```r
safe_extraction(
  explainer,
  response_type = "ale",
  grid_points = 50,
  N = 200,
  penalty = "MBIC",
  nquantiles = 10,
  no_segments = 2,
  method = "complete",
  B = 500,
  collapse = "-",
  interactions = FALSE,
  inter_param = 0.25,
  inter_threshold = 0.25,
  verbose = TRUE
)
```

Arguments

- **explainer**: DALEX explainer created with explain() function
- **response_type**: character, type of response to be calculated, one of: "pdp", "ale". If features are uncorrelated, one can use "pdp" type - otherwise "ale" is strongly recommended.
- **grid_points**: number of points on x-axis used for creating the PD/ALE plot, default 50
- **N**: number of observations from the dataset used for creating the PD/ALE plot, default 200
- **penalty**: penalty for introducing another changepoint, one of "AIC", "BIC", "SIC", "MBIC", "Hannan-Quinn" or numeric non-negative value
- **nquantiles**: the number of quantiles used in integral approximation
- **no_segments**: numeric, a number of segments variable is to be divided into in case of founding no breakpoints
- **method**: the agglomeration method to be used in hierarchical clustering, one of: "ward.D", "ward.D2", "single", "complete", "average", "mcquitty", "median", "centroid"
- **B**: number of reference datasets used to calculate gap statistics
safe_extraction

collapse a character string to separate original levels while combining them to the new one
interactions logical, if interactions between variables are to be taken into account
inter_param numeric, a positive value indicating which of single observation non-additive effects are to be regarded as significant, the higher value the higher non-additive effect has to be to be taken into account
inter_threshold numeric, a value from $[0, 1]$ interval indicating which interactions should be returned as significant. It corresponds to the percentage of observations for which interaction measure is greater than inter_param - if this percentage is less than inter_threshold then interaction effect is ignored.
verbose logical, if progress bar is to be printed

Value
safe_extractor object containing information about variables transformation

See Also
safely_transform_categorical, safely_transform_continuous, safely_detect_interactions, safely_transform_data

Examples

library(DALEX)
library(randomForest)
library(rSAFE)

data <- apartments[1:500,]
set.seed(111)
model_rf <- randomForest(m2.price ~ construction.year + surface + floor + no.rooms + district, data = data)
explainer_rf <- explain(model_rf, data = data[,2:6], y = data[,1], verbose = FALSE)
safe_extractor <- safe_extraction(explainer_rf, grid_points = 30, N = 100, verbose = FALSE)
print(safe_extractor)
plot(safe_extractor, variable = "construction.year")
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