Package 'DALEX'

September 4, 2020

Title moDel Agnostic Language for Exploration and eXplanation

Version 2.0

Description Unverified black box model is the path to the failure. Opaqueness leads to distrust. Distrust leads to ignoration. Ignoration leads to rejection.
DALEX package xrays any model and helps to explore and explain its behaviour.
Machine Learning (ML) models are widely used and have various applications in classification or regression. Models created with boosting, bagging, stacking or similar techniques are often used due to their high performance. But such black-box models usually lack of direct interpretability.
DALEX package contains various methods that help to understand the link between input variables and model output. Implemented methods help to explore model on the level of a single instance as well as a level of the whole dataset.
All model explainers are model agnostic and can be compared across different models.
DALEX package is the cornerstone for 'DrWhy.AI' universe of packages for visual model exploration.
Find more details in (Biecek 2018) <arXiv:1806.08915>.

License GPL

Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Depends R (>= 3.5)

Imports ggplot2, iBreakDown (>= 1.3.1), ingredients (>= 2.0)

Suggests gower, ranger, testthat, methods

URL https://ModelOriented.github.io/DALEX/, https://github.com/ModelOriented/DALEX

BugReports https://github.com/ModelOriented/DALEX/issues

NeedsCompilation no

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Repository CRAN

Date/Publication 2020-09-04 07:32:10 UTC

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apartments *Apartments Data*

Description

Datasets `apartments` and `apartments_test` are artificial, generated form 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

```
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
- n.rooms - number of rooms (correlated with surface)
- district - district in which apartment is located, factor with 10 levels
- floor - floor
- construction.date - construction year

colors_discrete_drwhy *DrWhy color palettes for ggplot objects*

Description

DrWhy color palettes for ggplot objects

Usage

```
colors_discrete_drwhy(n = 2)

colors_diverging_drwhy()

colors_breakdown_drwhy()
```

Arguments

`n`	number of colors for color palette

Value

color palette as vector of charactes

`dragons` *Dragon Data*

Description

Datasets `dragons` and `dragons_test` are artificial, generated form the same ground truth model, but with sometimes different data distridution.

Usage

```
data(dragons)
```

Format

a data frame with 2000 rows and 8 columns

Details

Values are generated in a way to: - have nonlinearity in year_of_birth and height - have concept drift in the test set

- year_of_birth - year in which the dragon was born. Negative year means year BC, eg: -1200 = 1201 BC
- year_of_discovery - year in which the dragon was found.
- height - height of the dragon in yards.
- weight - weight of the dragon in tons.
- scars - number of scars.
- colour - colour of the dragon.
- number_of_lost_teeth - number of teeth that the dragon lost.
- life_length - life length of the dragon.

`explain.default` *Create Model Explainer*

Description

Black-box models may have very different structures. This function creates a unified representation of a model, which can be further processed by functions for explanations.

Usage

```
explain.default(
  model,
  data = NULL,
  y = NULL,
  predict_function = NULL,
  residual_function = NULL,
  weights = NULL,
  ...,
  label = NULL,
  verbose = TRUE,
  precalculate = TRUE,
  colorize = TRUE,
  model_info = NULL,
  type = NULL
)

explain(
  model,
  data = NULL,
  y = NULL,
  predict_function = NULL,
  residual_function = NULL,
  weights = NULL,
  ...,
  label = NULL,
  verbose = TRUE,
  precalculate = TRUE,
  colorize = TRUE,
  model_info = NULL,
  type = NULL
)
```

Arguments

`model`	object - a model to be explained
`data`	data.frame or matrix - data which will be used to calculate the explanations. If not provided then will be extracted from the model. Data should be passed

without target column (this shall be provided as the y argument). NOTE: If target variable is present in the data, some of the functionalities my not work properly.

y numeric vector with outputs / scores. If provided then it shall have the same size as data

predict_function function that takes two arguments: model and new data and returns numeric vector with predictions. By default it is yhat.

residual_function function that takes four arguments: model, data, target vector y and predict function (optionally). It should return a numeric vector with model residuals for given data. If not provided, response residuals ($y - \hat{y}$) are calculated. By default it is residual_function_default.

weights numeric vector with sampling weights. By default it's NULL. If provided then it shall have the same length as data

... other parameters

label character - the name of the model. By default it's extracted from the 'class' attribute of the model

verbose logical. If TRUE (default) then diagnostic messages will be printed

precalculate logical. If TRUE (default) then predicted_values and residual are calculated when explainer is created. This will happen also if verbose is TRUE. Set both verbose and precalculate to FALSE to omit calculations.

colorize logical. If TRUE (default) then WARNINGS, ERRORS and NOTES are colorized. Will work only in the R console.

model_info a named list (package, version, type) containg information about model. If NULL, DALEX will seek for information on it's own.

type type of a model, either classification or regression. If not specified then type will be extracted from model_info.

Details

Please NOTE, that the model is the only required argument. But some explanations may expect that other arguments will be provided too.

Value

An object of the class explainer.

It's a list with following fields:

- model the explained model.
- data the dataset used for training.
- y response for observations from data.
- weights sample weights for data. NULL if weights are not specified.
- y_hat calculated predictions.

- `residuals` calculated residuals.
- `predict_function` function that may be used for model predictions, shall return a single numerical value for each observation.
- `residual_function` function that returns residuals, shall return a single numerical value for each observation.
- `class` class/classes of a model.
- `label` label of explainer.
- `model_info` named list contating basic information about model, like package, version of package and type.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
# simple explainer for regression problem
aps_lm_model4 <- lm(m2.price ~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v")
aps_lm_explainer4

# various parameters for the explain function
# all defaults
aps_lm <- explain(aps_lm_model4)

# silent execution
aps_lm <- explain(aps_lm_model4, verbose = FALSE)

# set target variable
aps_lm <- explain(aps_lm_model4, data = apartments, label = "model_4v", y = apartments$m2.price)
aps_lm <- explain(aps_lm_model4, data = apartments, label = "model_4v", y = apartments$m2.price,
                                    predict_function = predict)

# user provided predict_function
aps_ranger <- ranger::ranger(m2.price~., data = apartments, num.trees = 50)
custom_predict <- function(X.model, newdata) {
   predict(X.model, newdata)$predictions
}
aps_ranger_exp <- explain(aps_ranger, data = apartments, y = apartments$m2.price,
                          predict_function = custom_predict)


# user provided residual_function
aps_ranger <- ranger::ranger(m2.price~., data = apartments, num.trees = 50)
custom_residual <- function(X.model, newdata, y, predict_function) {
   abs(y - predict_function(X.model, newdata))
}
aps_ranger_exp <- explain(aps_ranger, data = apartments,
                          y = apartments$m2.price,
```

```
                          residual_function = custom_residual)

# binary classification
titanic_ranger <- ranger::ranger(as.factor(survived)~., data = titanic_imputed, num.trees = 50,
                                 probability = TRUE)
# keep in mind that for binary classification y parameter has to be numeric  with 0 and 1 values
titanic_ranger_exp <- explain(titanic_ranger, data = titanic_imputed, y = titanic_imputed$survived)

# multilabel classification
hr_ranger <- ranger::ranger(status~., data = HR, num.trees = 50, probability = TRUE)
# keep in mind that for multilabel classification y parameter has to be a factor,
# with same levels as in training data
hr_ranger_exp <- explain(hr_ranger, data = HR, y = HR$status)

# set model_info
model_info <- list(package = "stats", ver = "3.6.2", type = "regression")
aps_lm_model4 <- lm(m2.price ~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v",
                             model_info = model_info)


# set model_info
model_info <- list(package = "stats", ver = "3.6.2", type = "regression")
aps_lm_model4 <- lm(m2.price ~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v",
                             model_info = model_info)

aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v",
                             weights = as.numeric(apartments$construction.year > 2000))

# more complex model
library("ranger")
aps_ranger_model4 <- ranger(m2.price ~., data = apartments, num.trees = 50)
aps_ranger_explainer4 <- explain(aps_ranger_model4, data = apartments, label = "model_ranger")
aps_ranger_explainer4
```

`fifa` *FIFA 20 preprocessed data*

Description

The `fifa` dataset is a preprocessed `players_20.csv` dataset which comes as a part of "FIFA 20 complete player dataset" at Kaggle.

Usage

```
data(fifa)
```

Format

a data frame with 5000 rows, 42 columns and rownames

Details

It contains 5000 'overall' best players and 43 variables. These are:

- short_name (rownames)
- nationality of the player (not used in modeling)
- overall, potential, value_eur, wage_eur (4 potential target variables)
- age, height, weight, attacking skills, defending skills, goalkeeping skills (37 variables)

It is advised to leave only one target variable for modeling.

Source: https://www.kaggle.com/stefanoleone992/fifa-20-complete-player-dataset

All transformations:

1. take 43 columns: `[3,5,7:9,11:14,45:78]` (R indexing)
2. take rows with `value_eur > 0`
3. convert `short_name` to ASCII
4. remove rows with duplicated `short_name` (keep first)
5. sort rows on `overall` and take top `5000`
6. set `short_name` column as rownames
7. transform `nationality` to factor
8. reorder columns

Source

The `players_20.csv` dataset was downloaded from the Kaggle site and went through few transformations. The complete dataset was obtained from https://www.kaggle.com/stefanoleone992/fifa-20-complete-player-dataset#players_20.csv on January 1, 2020.

HR *Human Resources Data*

Description

Datasets `HR` and `HR_test` are artificial, generated form the same model. Structure of the dataset is based on a real data, from Human Resources department with information which employees were promoted, which were fired.

Usage

```
data(HR)
```

Format

a data frame with 10000 rows and 6 columns

Details

Values are generated in a way to: - have interaction between age and gender for the 'fired' variable - have non monotonic relation for the salary variable - have linear effects for hours and evaluation.

- gender - gender of an employee.
- age - age of an employee in the moment of evaluation.
- hours - average number of working hours per week.
- evaluation - evaluation in the scale 2 (bad) - 5 (very good).
- salary - level of salary in the scale 0 (lowest) - 5 (highest).
- status - target variable, either 'fired' or 'promoted' or 'ok'.

---

install_dependencies *Install all dependencies for the DALEX package*

Description

By default 'heavy' dependencies are not installed along DALEX. This function silently install all required packages.

Usage

```
install_dependencies(packages = c("ingredients", "iBreakDown", "ggpubr"))
```

Arguments

packages	which packages shall be installed?

---

loss_cross_entropy *Calculate Loss Functions*

Description

Calculate Loss Functions

Usage

```
loss_cross_entropy(observed, predicted, p_min = 1e-04, na.rm = TRUE)

loss_sum_of_squares(observed, predicted, na.rm = TRUE)

loss_root_mean_square(observed, predicted, na.rm = TRUE)

loss_accuracy(observed, predicted, na.rm = TRUE)

loss_one_minus_auc(observed, predicted)

loss_default(x)
```

Arguments

observed	observed scores or labels, these are supplied as explainer specific y
predicted	predicted scores, either vector of matrix, these are returned from the model specific predict_function()
p_min	for cross entropy, minimal value for probability to make sure that log will not explode
na.rm	logical, should missing values be removed?
x	either an explainer or type of the model. One of "regression", "classification", "multiclass".

Value

numeric - value of the loss function

Examples

```
library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
loss_one_minus_auc(titanic_imputed$survived, yhat(titanic_ranger_model, titanic_imputed))

HR_ranger_model_multi <- ranger(status~., data = HR, num.trees = 50, probability = TRUE)
loss_cross_entropy(as.numeric(HR$status), yhat(HR_ranger_model_multi, HR))
```

`model_diagnostics` *Dataset Level Model Diagnostics*

Description

This function performs model diagnostic of residuals. Residuals are calculated and ploted against predictions, true y values or selected variables. Find information how to use this function here: https://pbiecek.github.io/ema/residualDiagnostic.html.

Usage

```
model_diagnostics(explainer, variables = NULL, ...)
```

Arguments

`explainer`	a model to be explained, preprocessed by the `explain` function
`variables`	character - name of variables to be explained. Default `NULL` stands for all variables
`...`	other parameters

Value

An object of the class `model_diagnostics`. It's a data frame with residuals and selected variables.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
apartments_lm_model <- lm(m2.price ~ ., data = apartments)
explainer_lm <- explain(apartments_lm_model,
                        data = apartments,
                        y = apartments$m2.price)
diag_lm <- model_diagnostics(explainer_lm)
diag_lm
plot(diag_lm)

library("ranger")
apartments_ranger_model <- ranger(m2.price ~ ., data = apartments)
explainer_ranger <- explain(apartments_ranger_model,
                        data = apartments,
                        y = apartments$m2.price)
diag_ranger <- model_diagnostics(explainer_ranger)
diag_ranger
plot(diag_ranger)
plot(diag_ranger, diag_lm)
```

```
plot(diag_ranger, diag_lm, variable = "y")
plot(diag_ranger, diag_lm, variable = "construction.year")
plot(diag_ranger, variable = "y", yvariable = "y_hat")
plot(diag_ranger, variable = "y", yvariable = "abs_residuals")
plot(diag_ranger, variable = "ids")
```

`model_info` *Exract info from model*

Description

This generic function let user extract base information about model. The function returns a named list of class `model_info` that contain about package of model, version and task type. For wrappers like `mlr` or `caret` both, package and wrapper inforamtion are stored

Usage

```
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'lm'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'randomForest'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'svm'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'glm'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'lrm'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'glmnet'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'cv.glmnet'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'ranger'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'gbm'
model_info(model, is_multiclass = FALSE, ...)
```

```
## S3 method for class 'model_fit'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'train'
model_info(model, is_multiclass = FALSE, ...)

## S3 method for class 'rpart'
model_info(model, is_multiclass = FALSE, ...)

## Default S3 method:
model_info(model, is_multiclass = FALSE, ...)
```

Arguments

`model`	- model object
`is_multiclass`	- if TRUE and task is classification, then multitask classification is set. Else is omitted. If `model_info` was executed withing `explain` function. DALEX will recognize subtype on it's own.
`...`	- another arguments Currently supported packages are: • class `cv.glmnet` and `glmnet` - models created with **glmnet** package • class `glm` - generalized linear models • class `lrm` - models created with **rms** package, • class `model_fit` - models created with **parsnip** package • class `lm` - linear models created with `stats::lm` • class `ranger` - models created with **ranger** package • class `randomForest` - random forest models created with **randomForest** package • class `svm` - support vector machines models created with the **e1071** package • class `train` - models created with **caret** package • class `gbm` - models created with **gbm** package

Value

A named list of class `model_info`

Examples

```
aps_lm_model4 <- lm(m2.price ~., data = apartments)
model_info(aps_lm_model4)

library("ranger")
model_regr_rf <- ranger::ranger(status~., data = HR, num.trees = 50, probability = TRUE)
model_info(model_regr_rf, is_multiclass = TRUE)
```

model_parts *Dataset Level Variable Importance as Change in Loss Function after Variable Permutations*

Description

From DALEX version 1.0 this function calls the feature_importance Find information how to use this function here: https://pbiecek.github.io/ema/featureImportance.html.

Usage

```
model_parts(
  explainer,
  loss_function = loss_default(explainer$model_info$type),
  ...,
  type = "variable_importance",
  N = n_sample,
  n_sample = 1000
)
```

Arguments

explainer	a model to be explained, preprocessed by the explain function
loss_function	a function that will be used to assess variable importance. By default it is 1-AUC for classification, cross entropy for multilabel classification and RMSE for regression. Custom, user-made loss function should accept two obligatory parameters (observed, predicted), where observed states for actual values of the target, while predicted for predicted values. If attribute "loss_accuracy" is associated with function object, then it will be plotted as name of the loss function.
...	other parameters
type	character, type of transformation that should be applied for dropout loss. variable_importance and raw results raw drop lossess, ratio returns drop_loss/drop_loss_full_model while difference returns drop_loss -drop_loss_full_model
N	number of observations that should be sampled for calculation of variable importance. If NULL then variable importance will be calculated on whole dataset (no sampling).
n_sample	alias for N held for backwards compatibility. number of observations that should be sampled for calculation of variable importance.

Value

An object of the class feature_importance. It's a data frame with calculated average response.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
# regression

library("ranger")
apartments_ranger_model <- ranger(m2.price~., data = apartments, num.trees = 50)
explainer_ranger  <- explain(apartments_ranger_model, data = apartments[,-1],
                             y = apartments$m2.price, label = "Ranger Apartments")
model_parts_ranger_aps <- model_parts(explainer_ranger, type = "raw")
head(model_parts_ranger_aps, 8)
plot(model_parts_ranger_aps)

# binary classification

titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm_titanic <- explain(titanic_glm_model, data = titanic_imputed[,-8],
                         y = titanic_imputed$survived)
logit <- function(x) exp(x)/(1+exp(x))
custom_loss <- function(observed, predicted){
   sum((observed - logit(predicted))^2)
}
attr(custom_loss, "loss_name") <- "Logit residuals"
model_parts_glm_titanic <- model_parts(explainer_glm_titanic, type = "raw",
                                       loss_function = custom_loss)
head(model_parts_glm_titanic, 8)
plot(model_parts_glm_titanic)

# multilabel classification

HR_ranger_model_HR <- ranger(status~., data = HR, num.trees = 50,
                             probability = TRUE)
explainer_ranger_HR  <- explain(HR_ranger_model_HR, data = HR[,-6],
                             y = HR$status, label = "Ranger HR")
model_parts_ranger_HR <- model_parts(explainer_ranger_HR, type = "raw")
head(model_parts_ranger_HR, 8)
plot(model_parts_ranger_HR)
```

`model_performance` *Dataset Level Model Performance Measures*

Description

Function `model_performance()` calculates various performance measures for classification and regression models. For classification models following measures are calculated: F1, accuracy, recall, precision and AUC. For regression models following measures are calculated: mean squared error, R squared, median absolute deviation.

Usage

```
model_performance(explainer, ..., cutoff = 0.5)
```

Arguments

`explainer`	a model to be explained, preprocessed by the `explain` function
`...`	other parameters
`cutoff`	a cutoff for classification models, needed for measures like recall, precision, ACC, F1. By default 0.5.

Value

An object of the class `model_performance`.

It's a list with following fields:

- `residuals` - data frame that contains residuals for each observation
- `measures` - list with calculated measures that are dedicated for the task, whether it is regression, binary classification or multiclass classification.
- `type` - character that specifies type of the task.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
# regression

library("ranger")
apartments_ranger_model <- ranger(m2.price~., data = apartments, num.trees = 50)
explainer_ranger_apartments  <- explain(apartments_ranger_model, data = apartments[,-1],
                            y = apartments$m2.price, label = "Ranger Apartments")
model_performance_ranger_aps <- model_performance(explainer_ranger_apartments )
model_performance_ranger_aps
plot(model_performance_ranger_aps)
plot(model_performance_ranger_aps, geom = "boxplot")
plot(model_performance_ranger_aps, geom = "histogram")

# binary classification
```

```
titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm_titanic <- explain(titanic_glm_model, data = titanic_imputed[,-8],
                         y = titanic_imputed$survived)
model_performance_glm_titanic <- model_performance(explainer_glm_titanic)
model_performance_glm_titanic
plot(model_performance_glm_titanic)
plot(model_performance_glm_titanic, geom = "boxplot")
plot(model_performance_glm_titanic, geom = "histogram")

# multilabel classification

HR_ranger_model <- ranger(status~., data = HR, num.trees = 50,
                              probability = TRUE)
explainer_ranger_HR  <- explain(HR_ranger_model, data = HR[,-6],
                            y = HR$status, label = "Ranger HR")
model_performance_ranger_HR <- model_performance(explainer_ranger_HR)
model_performance_ranger_HR
plot(model_performance_ranger_HR)
plot(model_performance_ranger_HR, geom = "boxplot")
plot(model_performance_ranger_HR, geom = "histogram")
```

`model_profile` *Dataset Level Variable Profile as Partial Dependence or Accumulated Local Dependence Explanations*

Description

This function calculates explanations on a dataset level set that explore model response as a function of selected variables. The explanations can be calulated as Partial Dependence Profile or Accumulated Local Dependence Profile. Find information how to use this function here: https://pbiecek.github.io/ema/partialDependenceProfiles.html. The `variable_profile` function is a copy of `model_profile`.

Usage

```
model_profile(
  explainer,
  variables = NULL,
  N = 100,
  ...,
  groups = NULL,
  k = NULL,
  center = TRUE,
  type = "partial"
)
```

```
variable_profile(
  explainer,
  variables = NULL,
  N = 100,
  ...,
  groups = NULL,
  k = NULL,
  center = TRUE,
  type = "partial"
)

single_variable(explainer, variable, type = "pdp", ...)
```

Arguments

explainer	a model to be explained, preprocessed by the explain function
variables	character - names of variables to be explained
N	number of observations used for calculation of aggregated profiles. By default 100.
...	other parameters that will be passed to ingredients::aggregate_profiles
groups	a variable name that will be used for grouping. By default NULL which means that no groups shall be calculated
k	number of clusters for the hclust function (for clustered profiles)
center	shall profiles be centered before clustering
type	the type of variable profile. Either partial, conditional or accumulated.
variable	deprecated, use variables instead

Details

Underneath this function calls the partial_dependence or accumulated_dependence functions from the ingredients package.

Value

An object of the class model_profile. It's a data frame with calculated average model responses.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm <- explain(titanic_glm_model, data = titanic_imputed)
model_profile_glm_fare <- model_profile(explainer_glm, "fare")
plot(model_profile_glm_fare)
```

```
library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed)
model_profile_ranger <- model_profile(explainer_ranger)
plot(model_profile_ranger, geom = "profiles")

model_profile_ranger_1 <- model_profile(explainer_ranger, type = "partial",
                                        variables = c("age", "fare"))
plot(model_profile_ranger_1 , variables = c("age", "fare"), geom = "points")

model_profile_ranger_2  <- model_profile(explainer_ranger, type = "partial", k = 3)
plot(model_profile_ranger_2 , geom = "profiles")

model_profile_ranger_3  <- model_profile(explainer_ranger, type = "partial", groups = "gender")
plot(model_profile_ranger_3 , geom = "profiles")

model_profile_ranger_4  <- model_profile(explainer_ranger, type = "accumulated")
plot(model_profile_ranger_4 , geom = "profiles")

# Multiple profiles
model_profile_ranger_fare <- model_profile(explainer_ranger, "fare")
plot(model_profile_ranger_fare, model_profile_glm_fare)
```

`plot.model_diagnostics` *Plot Dataset Level Model Diagnostics*

Description

Plot Dataset Level Model Diagnostics

Usage

```
## S3 method for class 'model_diagnostics'
plot(x, ..., variable = "y_hat", yvariable = "residuals", smooth = TRUE)
```

Arguments

`x`	a data.frame to be explained, preprocessed by the `model_diagnostics` function
`...`	other object to be included to the plot
`variable`	character - name of the variable on OX axis to be explained, by default `y_hat`
`yvariable`	character - name of the variable on OY axis, by default `residuals`
`smooth`	logical shall the smooth line be added

Value

an object of the class model_diagnostics_explainer.

Examples

```
apartments_lm_model <- lm(m2.price ~ ., data = apartments)
explainer_lm <- explain(apartments_lm_model,
                        data = apartments,
                        y = apartments$m2.price)
diag_lm <- model_diagnostics(explainer_lm)
diag_lm
plot(diag_lm)

library("ranger")
apartments_ranger_model <- ranger(m2.price ~ ., data = apartments)
explainer_ranger <- explain(apartments_ranger_model,
                        data = apartments,
                        y = apartments$m2.price)
diag_ranger <- model_diagnostics(explainer_ranger)
diag_ranger
plot(diag_ranger)
plot(diag_ranger, diag_lm)
plot(diag_ranger, diag_lm, variable = "y")
plot(diag_ranger, diag_lm, variable = "construction.year")
plot(diag_ranger, variable = "y", yvariable = "y_hat")
```

---

plot.model_parts *Plot Variable Importance Explanations*

Description

Plot Variable Importance Explanations

Usage

```
## S3 method for class 'model_parts'
plot(x, ...)
```

Arguments

x	an object of the class model_parts
...	other parameters described below

Value

An object of the class ggplot.

Plot options

variable_importance:

- max_varsmaximal number of features to be included in the plot. default value is `10`
- show_boxplotslogical if `TRUE` (default) boxplot will be plotted to show permutation data.
- bar_widthwidth of bars. By default `10`
- desc_sortinglogical. Should the bars be sorted descending? By default `TRUE`
- titlethe plot's title, by default `'Feature Importance'`
- subtitlea character. Plot subtitle. By default `NULL` - then subtitle is set to "created for the XXX, YYY model", where XXX, YYY are labels of given explainers.

`plot.model_performance`

Plot Dataset Level Model Performance Explanations

Description

Plot Dataset Level Model Performance Explanations

Usage

```
## S3 method for class 'model_performance'
plot(
  x,
  ...,
  geom = "ecdf",
  show_outliers = 0,
  ptlabel = "name",
  lossFunction = loss_function,
  loss_function = function(x) sqrt(mean(x^2))
)
```

Arguments

`x`	a model to be explained, preprocessed by the `explain` function
`...`	other parameters
`geom`	either `"prc"`, `"roc"`, `"ecdf"`, `"boxplot"`, `"gain"`, `"lift"` or `"histogram"` determines how residuals shall be summarized
`show_outliers`	number of largest residuals to be presented (only when geom = boxplot).
`ptlabel`	either `"name"` or `"index"` determines the naming convention of the outliers
`lossFunction`	alias for `loss_function` held for backwards compatibility.
`loss_function`	function that calculates the loss for a model based on model residuals. By default it's the root mean square. NOTE that this argument was called `lossFunction`.

Value

An object of the class `model_performance`.

Examples

```
library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed[,-8],
                             y = titanic_imputed$survived)
mp_ranger <- model_performance(explainer_ranger)
plot(mp_ranger)
plot(mp_ranger, geom = "boxplot", show_outliers = 1)

titanic_ranger_model2 <- ranger(survived~gender + fare, data = titanic_imputed,
                                num.trees = 50, probability = TRUE)
explainer_ranger2  <- explain(titanic_ranger_model2, data = titanic_imputed[,-8],
                              y = titanic_imputed$survived,
                              label = "ranger2")
mp_ranger2 <- model_performance(explainer_ranger2)
plot(mp_ranger, mp_ranger2, geom = "prc")
plot(mp_ranger, mp_ranger2, geom = "roc")
plot(mp_ranger, mp_ranger2, geom = "lift")
plot(mp_ranger, mp_ranger2, geom = "gain")
plot(mp_ranger, mp_ranger2, geom = "boxplot")
plot(mp_ranger, mp_ranger2, geom = "histogram")
plot(mp_ranger, mp_ranger2, geom = "ecdf")

titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm <- explain(titanic_glm_model, data = titanic_imputed[,-8],
                         y = titanic_imputed$survived, label = "glm",
                      predict_function = function(m,x) predict.glm(m,x,type = "response"))
mp_glm <- model_performance(explainer_glm)
plot(mp_glm)

titanic_lm_model <- lm(survived~., data = titanic_imputed)
explainer_lm <- explain(titanic_lm_model, data = titanic_imputed[,-8],
                        y = titanic_imputed$survived, label = "lm")
mp_lm <- model_performance(explainer_lm)
plot(mp_lm)

plot(mp_ranger, mp_glm, mp_lm)
plot(mp_ranger, mp_glm, mp_lm, geom = "boxplot")
plot(mp_ranger, mp_glm, mp_lm, geom = "boxplot", show_outliers = 1)
```

`plot.model_profile` *Plot Dataset Level Model Profile Explanations*

Description

Plot Dataset Level Model Profile Explanations

Usage

```
## S3 method for class 'model_profile'
plot(x, ..., geom = "aggregates")
```

Arguments

x	a variable profile explanation, created with the model_profile function
...	other parameters
geom	either "aggregates", "profiles", "points" determines which will be plotted

Value

An object of the class ggplot.

aggregates:

- colora character. Either name of a color, or hex code for a color, or _label_ if models shall be colored, or _ids_ if instances shall be colored
- sizea numeric. Size of lines to be plotted
- alphaa numeric between 0 and 1. Opacity of lines
- facet_ncolnumber of columns for the facet_wrap
- variablesif not NULL then only variables will be presented
- titlea character. Partial and accumulated dependence explainers have deafult value.
- subtitlea character. If NULL value will be dependent on model usage.

Examples

```
titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm <- explain(titanic_glm_model, data = titanic_imputed)
expl_glm <- model_profile(explainer_glm, "fare")
plot(expl_glm)


library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed)
expl_ranger <- model_profile(explainer_ranger)
plot(expl_ranger)
plot(expl_ranger, geom = "aggregates")

vp_ra <- model_profile(explainer_ranger, type = "partial", variables = c("age", "fare"))
plot(vp_ra, variables = c("age", "fare"), geom = "points")

vp_ra <- model_profile(explainer_ranger, type = "partial", k = 3)
plot(vp_ra)
```

```
plot(vp_ra, geom = "profiles")
plot(vp_ra, geom = "points")

vp_ra <- model_profile(explainer_ranger, type = "partial", groups = "gender")
plot(vp_ra)
plot(vp_ra, geom = "profiles")
plot(vp_ra, geom = "points")

vp_ra <- model_profile(explainer_ranger, type = "accumulated")
plot(vp_ra)
plot(vp_ra, geom = "profiles")
plot(vp_ra, geom = "points")
```

`plot.predict_diagnostics` *Plot Instance Level Residual Diagnostics*

Description

Plot Instance Level Residual Diagnostics

Usage

```
## S3 method for class 'predict_diagnostics'
plot(x, ...)
```

Arguments

`x`	an object with instance level residual diagnostics created with `predict_diagnostics` function
`...`	other parameters that will be passed to `plot.ceteris_paribus_explaine`.

Value

an `ggplot2` object of the class `gg`.

Examples

```
library("ranger")
titanic_glm_model <- ranger(survived ~ gender + age + class + fare + sibsp + parch,
                      data = titanic_imputed)
explainer_glm <- explain(titanic_glm_model,
                         data = titanic_imputed,
                         y = titanic_imputed$survived)
johny_d <- titanic_imputed[24, c("gender", "age", "class", "fare", "sibsp", "parch")]
```

```
pl <- predict_diagnostics(explainer_glm, johny_d, variables = NULL)
plot(pl)

pl <- predict_diagnostics(explainer_glm, johny_d,
                      neighbors = 10,
                      variables = c("age", "fare"))
plot(pl)

pl <- predict_diagnostics(explainer_glm,
                      johny_d,
                      neighbors = 10,
                      variables = c("class", "gender"))
plot(pl)
```

`plot.predict_parts` *Plot Variable Attribution Explanations*

Description

Plot Variable Attribution Explanations

Usage

```
## S3 method for class 'predict_parts'
plot(x, ...)
```

Arguments

`x`	an object of the class `predict_parts`
`...`	other parameters described below

Value

An object of the class `ggplot`.

Plot options

break_down:

- max_featuresmaximal number of features to be included in the plot. default value is `10`
- min_maxa range of OX axis. By default `NA`, therefore it will be extracted from the contributions of `x`. But it can be set to some constants, useful if these plots are to be used for comparisons.
- add_contributionsif `TRUE`, variable contributions will be added to the plot.
- shift_contributionsnumber describing how much labels should be shifted to the right, as a fraction of range. By default equal to `0.05`.

- vcolorsIf NA (default), DrWhy colors are used.
- vnamesa character vector, if specified then will be used as labels on OY axis. By default NULL.
- digitsnumber of decimal places (round) or significant digits (signif) to be used.
- rounding_functiona function to be used for rounding numbers.
- plot_distributionsif TRUE then distributions of conditional propotions will be plotted. This requires keep_distributions=TRUE in the break_down, local_attributions, or local_interactions.
- baselineif numeric then veritical line starts in baseline.
- titlea character. Plot title. By default "Break Down profile".
- subtitlea character. Plot subtitle. By default NULL - then subtitle is set to "created for the XXX, YYY model", where XXX, YYY are labels of given explainers.
- max_varsalias for the max_features parameter.

shap:

- show_boxplotslogical if TRUE (default) boxplot will be plotted to show uncertainty of attributions.
- vcolorsIf NA (default), DrWhy colors are used.
- max_featuresmaximal number of features to be included in the plot. default value is 10
- max_varsalias for the max_features parameter.

oscillations:

- bar_widthwidth of bars. By default 10

---

plot.predict_profile *Plot Variable Profile Explanations*

Description

Plot Variable Profile Explanations

Usage

```
## S3 method for class 'predict_profile'
plot(x, ...)
```

Arguments

x	an object of the class predict_profile
...	other parameters

Value

An object of the class ggplot.

Plot options

ceteris_paribus:

- colora character. Either name of a color or name of a variable that should be used for coloring
- sizea numeric. Size of lines to be plotted
- alphaa numeric between `0` and `1`. Opacity of lines
- facet_ncolnumber of columns for the `facet_wrap`
- variablesif not `NULL` then only `variables` will be presented
- variable_typea character. If `numerical` then only numerical variables will be plotted. If `categorical` then only categorical variables will be plotted.
- titlea character. Plot title. By default `"Ceteris Paribus profile"`.
- subtitlea character. Plot subtitle. By default `NULL` - then subtitle is set to "created for the XXX, YYY model", where XXX, YYY are labels of given explainers.
- categorical_typea character. How categorical variables shall be plotted? Either `"lines"` (default) or `"bars"`.

`predict.explainer` *Predictions for the Explainer*

Description

This is a generic `predict()` function works for `explainer` objects.

Usage

```
## S3 method for class 'explainer'
predict(object, newdata, ...)

model_prediction(explainer, new_data, ...)
```

Arguments

`object`	a model to be explained, object of the class `explainer`
`newdata`	data.frame or matrix - observations for prediction
`...`	other parameters that will be passed to the predict function
`explainer`	a model to be explained, object of the class `explainer`
`new_data`	data.frame or matrix - observations for prediction

Value

An numeric matrix of predictions

Examples

```
HR_glm_model <- glm(status == "fired"~., data = HR, family = "binomial")
explainer_glm <- explain(HR_glm_model, data = HR)
predict(explainer_glm, HR[1:3,])


library("ranger")
HR_ranger_model <- ranger(status~., data = HR, num.trees = 50, probability = TRUE)
explainer_ranger  <- explain(HR_ranger_model, data = HR)
predict(explainer_ranger, HR[1:3,])

model_prediction(explainer_ranger, HR[1:3,])
```

---

predict_diagnostics *Instance Level Residual Diagnostics*

Description

This function performs local diagnostic of residuals. For a single instance its neighbors are identified in the validation data. Residuals are calculated for neighbors and plotted against residuals for all data. Find information how to use this function here: https://pbiecek.github.io/ema/localDiagnostics.html.

Usage

```
predict_diagnostics(
  explainer,
  new_observation,
  variables = NULL,
  ...,
  nbins = 20,
  neighbors = 50,
  distance = gower::gower_dist
)

individual_diagnostics(
  explainer,
  new_observation,
  variables = NULL,
  ...,
  nbins = 20,
  neighbors = 50,
  distance = gower::gower_dist
)
```

Arguments

explainer	a model to be explained, preprocessed by the 'explain' function
new_observation	a new observation for which predictions need to be explained
variables	character - name of variables to be explained
...	other parameters
nbins	number of bins for the histogram. By default 20
neighbors	number of neighbors for histogram. By default 50.
distance	the distance function, by default the gower_dist() function.

Value

An object of the class 'predict_diagnostics'. It's a data frame with calculated distribution of residuals.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
library("ranger")
titanic_glm_model <- ranger(survived ~ gender + age + class + fare + sibsp + parch,
                     data = titanic_imputed)
explainer_glm <- explain(titanic_glm_model,
                         data = titanic_imputed,
                         y = titanic_imputed$survived)
johny_d <- titanic_imputed[24, c("gender", "age", "class", "fare", "sibsp", "parch")]


id_johny <- predict_diagnostics(explainer_glm, johny_d, variables = NULL)
id_johny
plot(id_johny)

id_johny <- predict_diagnostics(explainer_glm, johny_d,
                        neighbors = 10,
                        variables = c("age", "fare"))
id_johny
plot(id_johny)

id_johny <- predict_diagnostics(explainer_glm,
                        johny_d,
                        neighbors = 10,
                        variables = c("class", "gender"))
id_johny
plot(id_johny)
```

predict_parts *Instance Level Parts of the Model Predictions*

Description

Instance Level Variable Attributions as Break Down, SHAP or Oscillations explanations. Model prediction is decomposed into parts that are attributed for particular variables. From DALEX version 1.0 this function calls the break_down or shap functions from the iBreakDown package or ceteris_paribus from the ingredients package. Find information how to use the break_down method here: https://pbiecek.github.io/ema/breakDown.html. Find information how to use the shap method here: https://pbiecek.github.io/ema/shapley.html. Find information how to use the oscillations method here: https://pbiecek.github.io/ema/ceterisParibusOscillations.html.

Usage

```
predict_parts(explainer, new_observation, ..., type = "break_down")

predict_parts_oscillations(explainer, new_observation, ...)

predict_parts_oscillations_uni(
  explainer,
  new_observation,
  variable_splits_type = "uniform",
  ...
)

predict_parts_oscillations_emp(
  explainer,
  new_observation,
  variable_splits = NULL,
  variables = colnames(explainer$data),
  N = 500,
  ...
)

predict_parts_break_down(explainer, new_observation, ...)

predict_parts_break_down_interactions(explainer, new_observation, ...)

predict_parts_shap(explainer, new_observation, ...)

variable_attribution(explainer, new_observation, ..., type = "break_down")
```

Arguments

explainer	a model to be explained, preprocessed by the explain function

new_observation
: a new observation for which predictions need to be explained

... : other parameters that will be passed to iBreakDown::break_down

type : the type of variable attributions. Either shap, oscillations, oscillations_uni, oscillations_emp, break_down or break_down_interactions.

variable_splits_type
: how variable grids shall be calculated? Will be passed to ceteris_paribus.

variable_splits
: named list of splits for variables. It is used by oscillations based measures. Will be passed to ceteris_paribus.

variables : names of variables for which splits shall be calculated. Will be passed to ceteris_paribus.

N : number of observations used for calculation of oscillations. By default 500.

Value

Depending on the type there are different classes of the resulting object. It's a data frame with calculated average response.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
library(DALEX)

new_dragon <- data.frame(
    year_of_birth = 200,
    height = 80,
    weight = 12.5,
    scars = 0,
    number_of_lost_teeth  = 5
)

model_lm <- lm(life_length ~ year_of_birth + height +
               weight + scars + number_of_lost_teeth,
               data = dragons)

explainer_lm <- explain(model_lm,
                        data = dragons,
                        y = dragons$year_of_birth,
                        label = "model_lm")

bd_lm <- predict_parts_break_down(explainer_lm, new_observation = new_dragon)
head(bd_lm)
plot(bd_lm)


library("ranger")
```

```
model_ranger <- ranger(life_length ~ year_of_birth + height +
                       weight + scars + number_of_lost_teeth,
                       data = dragons, num.trees = 50)

explainer_ranger <- explain(model_ranger,
                            data = dragons,
                            y = dragons$year_of_birth,
                            label = "model_ranger")

bd_ranger <- predict_parts_break_down(explainer_ranger, new_observation = new_dragon)
head(bd_ranger)
plot(bd_ranger)
```

`predict_profile` *Instance Level Profile as Ceteris Paribus*

Description

This function calculated individual profiles aka Ceteris Paribus Profiles. From DALEX version 1.0 this function calls the `ceteris_paribus` from the `ingredients` package. Find information how to use this function here: https://pbiecek.github.io/ema/ceterisParibus.html.

Usage

```
predict_profile(
  explainer,
  new_observation,
  variables = NULL,
  ...,
  type = "ceteris_paribus",
  variable_splits_type = "uniform"
)

individual_profile(
  explainer,
  new_observation,
  variables = NULL,
  ...,
  type = "ceteris_paribus",
  variable_splits_type = "uniform"
)
```

Arguments

`explainer`	a model to be explained, preprocessed by the `explain` function

new_observation
: a new observation for which predictions need to be explained

variables
: character - names of variables to be explained

...
: other parameters

type
: character, currently only the ceteris_paribus is implemented

variable_splits_type
: how variable grids shall be calculated? Use "quantiles" (default) for percentiles or "uniform" to get uniform grid of points. Will be passed to 'ingredients'.

Value

An object of the class ceteris_paribus_explainer. It's a data frame with calculated average response.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
new_dragon <- data.frame(year_of_birth = 200,
     height = 80,
     weight = 12.5,
     scars = 0,
     number_of_lost_teeth  = 5)

dragon_lm_model4 <- lm(life_length ~ year_of_birth + height +
                                     weight + scars + number_of_lost_teeth,
                       data = dragons)
dragon_lm_explainer4 <- explain(dragon_lm_model4, data = dragons, y = dragons$year_of_birth,
                                label = "model_4v")
dragon_lm_predict4 <- predict_profile(dragon_lm_explainer4,
                new_observation = new_dragon,
                variables = c("year_of_birth", "height", "scars"))
head(dragon_lm_predict4)
plot(dragon_lm_predict4,
    variables = c("year_of_birth", "height", "scars"))


library("ranger")
dragon_ranger_model4 <- ranger(life_length ~ year_of_birth + height +
                                           weight + scars + number_of_lost_teeth,
                                data = dragons, num.trees = 50)
dragon_ranger_explainer4 <- explain(dragon_ranger_model4, data = dragons, y = dragons$year_of_birth,
                                label = "model_ranger")
dragon_ranger_predict4 <- predict_profile(dragon_ranger_explainer4,
                                          new_observation = new_dragon,
                                       variables = c("year_of_birth", "height", "scars"))
head(dragon_ranger_predict4)
plot(dragon_ranger_predict4,
```

```
variables = c("year_of_birth", "height", "scars"))
```

`print.description` *Print Natural Language Descriptions*

Description

Generic function

Usage

```
## S3 method for class 'description'
print(x, ...)
```

Arguments

`x`	an individual explainer produced with the ‘describe()‘ function
`...`	other arguments

`print.explainer` *Print Explainer Summary*

Description

Print Explainer Summary

Usage

```
## S3 method for class 'explainer'
print(x, ...)
```

Arguments

`x`	a model explainer created with the ‘explain‘ function
`...`	other parameters

Examples

```
aps_lm_model4 <- lm(m2.price~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, y = apartments$m2.price,
                             label = "model_4v")
aps_lm_explainer4


library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed[,-8],
                             y = titanic_imputed$survived,
                             label = "model_ranger")
explainer_ranger
```

---

print.model_diagnostics *Print Dataset Level Model Diagnostics*

Description

Generic function

Usage

```
## S3 method for class 'model_diagnostics'
print(x, ...)
```

Arguments

x	an object with dataset level residual diagnostics created with model_diagnostics function
...	other parameters

---

print.model_info *Print model_info*

Description

Function prints object of class model_info created with model_info

Usage

```
## S3 method for class 'model_info'
print(x, ...)
```

Arguments

x	- an object of class model_info
...	- other parameters

---

print.model_performance *Print Dataset Level Model Performance Summary*

Description

Print Dataset Level Model Performance Summary

Usage

```
## S3 method for class 'model_performance'
print(x, ...)
```

Arguments

x	a model to be explained, object of the class 'model_performance_explainer'
...	other parameters

Examples

```
library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 100,
                               probability = TRUE)
# It's a good practice to pass data without target variable
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed[,-8],
                             y = titanic_imputed$survived)
# resulting dataframe has predicted values and residuals
mp_ex_rn <- model_performance(explainer_ranger)
mp_ex_rn
plot(mp_ex_rn)
```

print.model_profile *Print Dataset Level Model Profile*

Description

Generic function

Usage

```
## S3 method for class 'model_profile'
print(x, ...)
```

Arguments

x	an object with dataset level profile created with model_profile function
...	other parameters

print.predict_diagnostics *Print Instance Level Residual Diagnostics*

Description

Generic function

Usage

```
## S3 method for class 'predict_diagnostics'
print(x, ...)
```

Arguments

x	an object with instance level residual diagnostics created with predict_diagnostics function
...	other parameters

theme_drwhy *DrWhy Theme for ggplot objects*

Description

DrWhy Theme for ggplot objects

Usage

```
theme_drwhy()

theme_ema()

theme_drwhy_vertical()

theme_ema_vertical()
```

Value

theme for ggplot2 objects

titanic *Passengers and Crew on the RMS Titanic Data*

Description

The titanic data is a complete list of passengers and crew members on the RMS Titanic. It includes a variable indicating whether a person did survive the sinking of the RMS Titanic on April 15, 1912.

Usage

```
data(titanic)
data(titanic_imputed)
```

Format

a data frame with 2207 rows and 9 columns

Details

This dataset was copied from the stablelearner package and went through few variable transformations. Levels in embarked was replaced with full names, sibsp, parch and fare were converted to numerical variables and values for crew were replaced with 0. If you use this dataset please cite the original package.

From stablelearner: The website https://www.encyclopedia-titanica.org offers detailed information about passengers and crew members on the RMS Titanic. According to the website 1317 passengers and 890 crew member were abord. 8 musicians and 9 employees of the shipyard company are listed as passengers, but travelled with a free ticket, which is why they have NA values in fare. In addition to that, fare is truely missing for a few regular passengers.

- gender a factor with levels male and female.
- age a numeric value with the persons age on the day of the sinking.
- class a factor specifying the class for passengers or the type of service aboard for crew members.
- embarked a factor with the persons place of of embarkment (Belfast/Cherbourg/Queenstown/Southampton).
- country a factor with the persons home country.
- fare a numeric value with the ticket price (0 for crew members, musicians and employees of the shipyard company).
- sibsp an ordered factor specifying the number if siblings/spouses aboard; adopted from Vanderbild data set (see below).
- parch an ordered factor specifying the number of parents/children aboard; adopted from Vanderbild data set (see below).
- survived a factor with two levels (no and yes) specifying whether the person has survived the sinking.

NOTE: The titanic_imputed dataset use following imputation rules.

- Missing ‘age‘ is replaced with the mean of the observed ones, i.e., 30.
- For sibsp and parch, missing values are replaced by the most frequently observed value, i.e., 0.
- For fare, mean fare for a given class is used, i.e., 0 pounds for crew, 89 pounds for the 1st, 22 pounds for the 2nd, and 13 pounds for the 3rd class.

Source

This dataset was copied from the stablelearner package and went through few variable transformations. The complete list of persons on the RMS titanic was downloaded from https://www.encyclopedia-titanica.org on April 5, 2016. The information given in sibsp and parch was adopoted from a data set obtained from http://biostat.mc.vanderbilt.edu/DataSets.

References

https://www.encyclopedia-titanica.org, http://biostat.mc.vanderbilt.edu/DataSets and https://CRAN.R-project.org/package=stablelearner

update_data *Update data of an explainer object*

Description

Function allows users to update data an y of any explainer in a unified way. It doesn't require knowledge about structre of an explainer.

Usage

```
update_data(explainer, data, y = NULL, verbose = TRUE)
```

Arguments

explainer	- explainer object that is supposed to be updated.
data	- new data, is going to be passed to an explainer
y	- new y, is going to be passed to an explainer
verbose	- logical, indicates if information about update should be printed

Value

updated explainer object

Examples

```
aps_lm_model4 <- lm(m2.price ~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v")
explainer <- update_data(aps_lm_explainer4, data = apartmentsTest, y = apartmentsTest$m2.price)
```

update_label *Update label of explainer object*

Description

Function allows users to update label of any explainer in a unified way. It doesn't require knowledge about structre of an explainer.

Usage

```
update_label(explainer, label, verbose = TRUE)
```

Arguments

explainer	- explainer object that is supposed to be updated.
label	- new label, is going to be passed to an explainer
verbose	- logical, indicates if information about update should be printed

Value

updated explainer object

Examples

```
aps_lm_model4 <- lm(m2.price ~., data = apartments)
aps_lm_explainer4 <- explain(aps_lm_model4, data = apartments, label = "model_4v")
explainer <- update_label(aps_lm_explainer4, label = "lm")
```

---

variable_effect *Dataset Level Variable Effect as Partial Dependency Profile or Accumulated Local Effects*

Description

From DALEX version 1.0 this function calls the accumulated_dependence or partial_dependence from the ingredients package. Find information how to use this function here: https://pbiecek.github.io/ema/partialDependenceProfiles.html.

Usage

```
variable_effect(explainer, variables, ..., type = "partial_dependency")

variable_effect_partial_dependency(explainer, variables, ...)

variable_effect_accumulated_dependency(explainer, variables, ...)
```

Arguments

explainer	a model to be explained, preprocessed by the 'explain' function
variables	character - names of variables to be explained
...	other parameters
type	character - type of the response to be calculated. Currently following options are implemented: 'partial_dependency' for Partial Dependency and 'accumulated_dependency' for Accumulated Local Effects

Value

An object of the class 'aggregated_profiles_explainer'. It's a data frame with calculated average response.

References

Explanatory Model Analysis. Explore, Explain and Examine Predictive Models. https://pbiecek.github.io/ema/

Examples

```
titanic_glm_model <- glm(survived~., data = titanic_imputed, family = "binomial")
explainer_glm <- explain(titanic_glm_model, data = titanic_imputed)
expl_glm <- variable_effect(explainer_glm, "fare", "partial_dependency")
plot(expl_glm)


library("ranger")
titanic_ranger_model <- ranger(survived~., data = titanic_imputed, num.trees = 50,
                               probability = TRUE)
explainer_ranger  <- explain(titanic_ranger_model, data = titanic_imputed)
expl_ranger  <- variable_effect(explainer_ranger, variables = "fare",
                            type = "partial_dependency")
plot(expl_ranger)
plot(expl_ranger, expl_glm)

# Example for factor variable (with factorMerger)
expl_ranger_factor  <- variable_effect(explainer_ranger, variables =  "class")
plot(expl_ranger_factor)
```

---

yhat *Wrap Various Predict Functions*

Description

This function is a wrapper over various predict functions for different models and differnt model structures. The wrapper returns a single numeric score for each new observation. To do this it uses different extraction techniques for models from different classes, like for classification random forest is forces the output to be probabilities not classes itself.

Usage

```
yhat(X.model, newdata, ...)

## S3 method for class 'lm'
yhat(X.model, newdata, ...)

## S3 method for class 'randomForest'
yhat(X.model, newdata, ...)

## S3 method for class 'svm'
```

```
yhat(X.model, newdata, ...)

## S3 method for class 'gbm'
yhat(X.model, newdata, ...)

## S3 method for class 'glm'
yhat(X.model, newdata, ...)

## S3 method for class 'cv.glmnet'
yhat(X.model, newdata, ...)

## S3 method for class 'glmnet'
yhat(X.model, newdata, ...)

## S3 method for class 'ranger'
yhat(X.model, newdata, ...)

## S3 method for class 'model_fit'
yhat(X.model, newdata, ...)

## S3 method for class 'train'
yhat(X.model, newdata, ...)

## S3 method for class 'lrm'
yhat(X.model, newdata, ...)

## S3 method for class 'rpart'
yhat(X.model, newdata, ...)

## Default S3 method:
yhat(X.model, newdata, ...)
```

Arguments

`X.model`	object - a model to be explained
`newdata`	data.frame or matrix - observations for prediction
`...`	other parameters that will be passed to the predict function

Details

Currently supported packages are:

- class `cv.glmnet` and `glmnet` - models created with **glmnet** package,
- class `glm` - generalized linear models created with glm,
- class `model_fit` - models created with **parsnip** package,
- class `lm` - linear models created with lm,
- class `ranger` - models created with **ranger** package,

- class `randomForest` - random forest models created with **randomForest** package,
- class `svm` - support vector machines models created with the **e1071** package,
- class `train` - models created with **caret** package,
- class `gbm` - models created with **gbm** package,
- class `lrm` - models created with **rms** package,
- class `rpart` - models created with **rpart** package.

Value

An numeric matrix of predictions

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