Package ‘ingredients’

February 18, 2020

Title  Effects and Importances of Model Ingredients

Version 1.0

Description Collection of tools for assessment of feature importance and feature effects. Key functions are:

- feature_importance() for assessment of global level feature importance,
- ceteris_paribus() for calculation of the what-if plots,
- partial_dependence() for partial dependence plots,
- conditional_dependence() for conditional dependence plots,
- accumulated_dependence() for accumulated local effects plots,
- aggregate_profiles() and cluster_profiles() for aggregation of ceteris paribus profiles,
- generic print() and plot() for better usability of selected explainers,
- generic plotD3() for interactive, D3 based explanations, and
- generic describe() for explanations in natural language.

The package 'ingredients' is a part of the 'DrWhy.AI’ universe (Biecek 2018) <arXiv:1806.08915>.

Depends R (>= 3.0)

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 7.0.2

Imports DALEX, ggplot2, scales, gridExtra

Suggests gower, randomForest, xgboost, testthat, r2d3, ggpubr, jsonlite, knitr, rmarkdown

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

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

VignetteBuilder knitr

NeedsCompilation no

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Repository CRAN
Date/Publication 2020-02-18 09:20:02 UTC

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accumulated_dependence

Accumulated Local Effects Profiles aka ALEPlots

Description

Accumulated Local Effects Profiles accumulate local changes in Ceteris Paribus Profiles. Function accumulated_dependence calls ceteris_paribus and then aggregate_profiles.

Usage

accumulated_dependence(x, ...)

## S3 method for class 'explainer'
accumulated_dependence(
  x,
  variables = NULL,
  N = 500,
  variable_splits = NULL,
  grid_points = 101,
  ..., variable_type = "numerical"
)

## Default S3 method:
accumulated_dependence(
  x,
  data,
  predict_function = predict,
  label = class(x)[1],
  variables = NULL,
  N = 500,
  variable_splits = NULL,
  grid_points = 101,
  ..., variable_type = "numerical"
)

## S3 method for class 'ceteris_paribus_explainer'
accumulated_dependence(x, ..., variables = NULL)

accumulated_dependency(x, ...)

Arguments

x an explainer created with function DALEX::explain(), an object of the class ceteris_paribus_explainer or a model to be explained.
accumulated_dependence

... other parameters
variables names of variables for which profiles shall be calculated. Will be passed to `calculate_variable_split`. If NULL then all variables from the validation data will be used.

N number of observations used for calculation of partial dependence profiles. By default, 500 observations will be chosen randomly.

variable_splits named list of splits for variables, in most cases created with `calculate_variable_split`. If NULL then it will be calculated based on validation data available in the explainer.

grid_points number of points for profile. Will be passed to `calculate_variable_split`.

variable_type a character. If "numerical" then only numerical variables will be calculated. If "categorical" then only categorical variables will be calculated.

data validation dataset Will be extracted from x if it's an explainer NOTE: It is best when target variable is not present in the data

predict_function predict function Will be extracted from x if it's an explainer

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

Details

Find more details in the Accumulated Local Dependence Chapter.

Value

an object of the class `aggregated_profiles_explainer`

References


Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
  data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
  data = titanic_imputed[,-8],
  y = titanic_imputed[,8],
  verbose = FALSE)

adp_glm <- accumulated_dependence(explain_titanic_glm,
  N = 150, variables = c("age", "fare"))

head(adp_glm)
```
aggregate_profiles

plot(adp_glm)

library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
                               data = titanic_imputed[, -8],
                               y = titanic_imputed[, 8],
                               verbose = FALSE)

adp_rf <- accumulated_dependence(explain_titanic_rf, N = 200, variable_type = "numerical")
plot(adp_rf)

adp_rf <- accumulated_dependence(explain_titanic_rf, N = 200, variable_type = "categorical")
plotD3(adp_rf, label_margin = 80, scale_plot = TRUE)

aggregate_profiles  Aggregates Ceteris Paribus Profiles

Description

The function aggregate_profiles() calculates an aggregate of ceteris paribus profiles. It can be: Partial Dependence Profile (average across Ceteris Paribus Profiles), Conditional Dependence Profile (local weighted average across Ceteris Paribus Profiles) or Accumulated Local Dependence Profile (cumulated average local changes in Ceteris Paribus Profiles).

Usage

aggregate_profiles(
  x,
  ..., 
  variable_type = "numerical",
  groups = NULL,
  type = "partial",
  variables = NULL,
  span = 0.25,
  center = FALSE
)

Arguments

x  a ceteris paribus explainer produced with function ceteris_paribus()
...
other explainers that shall be calculated together
variable_type
a character. If numerical then only numerical variables will be calculated. If
categorical then only categorical variables will be calculated.

groups
a variable name that will be used for grouping. By default NULL which means
that no groups shall be calculated.
type
either partial/conditional/accumulated for partial dependence, conditional
profiles of accumulated local effects.
variables
if not NULL then aggregate only for selected variables will be calculated.
span
smoothing coefficient, by default 0.25. It’s the sd for gaussian kernel.
center
by default accumulated profiles start at 0. If center=TRUE then they are centered
around average response.

Value
an object of the class aggregated_profiles_explainer

References

Examples
library("DALEX")
library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8])

selected_passangers <- select_sample(titanic_imputed, n = 100)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)
head(cp_rf)

# continouse variable
pdp_rf_p <- aggregate_profiles(cp_rf, variables = "age", type = "partial")
pdp_rf_p$$_label_$$ <- "RF_partial"
pdp_rf_c <- aggregate_profiles(cp_rf, variables = "age", type = "conditional")
pdp_rf_c$$_label_$$ <- "RF_conditional"
pdp_rf_a <- aggregate_profiles(cp_rf, variables = "age", type = "accumulated")
pdp_rf_a$$_label_$$ <- "RF_accumulated"

plot(pdp_rf_p, pdp_rf_c, pdp_rf_a, color = "_label_"

pdp_rf <- aggregate_profiles(cp_rf, variables = "age",
groups = "gender")

head(pdp_rf)
### bind_plots

**Bind Multiple ggplot Objects**

#### Description

This is an aesthetically efficient implementation of the `grid.arrange`.

#### Usage

```r
bind_plots(..., byrow = FALSE)
```

#### Arguments

- `...`: (`ggplot`) ggplot objects to combine.
- `byrow`: (`logical`) if FALSE (the default) the plots are bind by columns, otherwise the plots are bind by rows.
calculate_oscillations

Value

('gtable') A plottable object with plot().

Examples

```r
## Not run:
library("DALEX")
titanic_glm <- glm(survived ~ gender + age + fare,
                   data = titanic_imputed, family = "binomial")

explain_glm <- explain(titanic_glm,
                        data = titanic_imputed,
                        y = titanic_imputed$survived,
                        verbose = FALSE)
pdp_numerical <- partial_dependence(explain_glm, N = 50, variable_type = "numerical")
pdp_categorical <- partial_dependence(explain_glm, N = 50, variable_type = "categorical")

# Bind plots by rows
bind_plots(plot(pdp_numerical), plot(pdp_categorical), byrow = TRUE)

# Bind plots by columns
bind_plots(plot(pdp_numerical), plot(pdp_categorical), byrow = FALSE)
## End(Not run)
```

calculate_oscillations

*Calculate Oscillations for Ceteris Paribus Explainer*

Description

Oscillations are proxies for local feature importance at the instance level. Find more details in Ceteris Paribus Oscillations Chapter.

Usage

```r
calculate_oscillations(x, sort = TRUE, ...)
```

Arguments

- `x` a ceteris_paribus explainer produced with the ceteris_paribus() function
- `sort` a logical value. If TRUE then rows are sorted along the oscillations
- `...` other arguments

Value

an object of the class ceteris_paribus_oscillations
References


Examples

```r
library("DALEX")
# smaller data, quicker example
titanic_small <- select_sample(titanic_imputed, n = 500, seed = 1313)

# build a model
model_titanic_glm <- glm(survived ~ gender + age + fare,
                          data = titanic_small, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_small[,-8],
                                y = titanic_small[,8])

cp_rf <- ceteris_paribus(explain_titanic_glm, titanic_small[1,])
calculate_oscillations(cp_rf)

library("randomForest")
apartments_rf_model <- randomForest(m2.price ~ construction.year + surface + floor +
                                     no.rooms + district, data = apartments)

explainer_rf <- explain(apartments_rf_model,
                         data = apartments_test[,-1],
                         y = apartments_test$m2.price)

apartment <- apartments_test[1,]

cp_rf <- ceteris_paribus(explainer_rf, apartment)
calculate_oscillations(cp_rf)
```

calculate_variable_profile

*Internal Function for Individual Variable Profiles*

Description

This function calculates individual variable profiles (ceteris paribus profiles), i.e. series of predictions from a model calculated for observations with altered single coordinate.
Usage

calculate_variable_profile(
    data,
    variable_splits,
    model,
    predict_function = predict,
    ...
)

## Default S3 method:
calculate_variable_profile(
    data,
    variable_splits,
    model,
    predict_function = predict,
    ...
)

Arguments

data set of observations. Profile will be calculated for every observation (every row)
variable_splits named list of vectors. Elements of the list are vectors with points in which
profiles should be calculated. See an example for more details.
model a model that will be passed to the predict_function
predict_function function that takes data and model and returns numeric predictions. Note that
the ... arguments will be passed to this function.
... other parameters that will be passed to the predict_function

Details

Note that calculate_variable_profile function is S3 generic. If you want to work on non
standard data sources (like H2O ddf, external databases) you should overload it.

Value

a data frame with profiles for selected variables and selected observations

References

github.io/ema
**calculate_variable_split**

*Internal Function for Split Points for Selected Variables*

**Description**

This function calculate candidate splits for each selected variable. For numerical variables splits are calculated as percentiles (in general uniform quantiles of the length grid_points). For all other variables splits are calculated as unique values.

**Usage**

```r
calculate_variable_split(data, variables = colnames(data), grid_points = 101)
```

## Default S3 method:

```r
calculate_variable_split(data, variables = colnames(data), grid_points = 101)
```

**Arguments**

- `data`: validation dataset. Is used to determine distribution of observations.
- `variables`: names of variables for which splits shall be calculated
- `grid_points`: number of points used for response path

**Details**

Note that `calculate_variable_split` function is S3 generic. If you want to work on non standard data sources (like H2O ddf, external databases) you should overload it.

**Value**

A named list with splits for selected variables

---

**ceteris_paribus**

*Ceteris Paribus Profiles aka Individual Variable Profiles*

**Description**

This explainer works for individual observations. For each observation it calculates Ceteris Paribus Profiles for selected variables. Such profiles can be used to hypothesize about model results if selected variable is changed. For this reason it is also called 'What-If Profiles'.
Usage

ceteris_paribus(x, ...)

## S3 method for class 'explainer'
ceteris_paribus(
  x,
  new_observation,
  y = NULL,
  variables = NULL,
  variable_splits = NULL,
  grid_points = 101,
  ...
)

## Default S3 method:
ceteris_paribus(
  x,
  data,
  predict_function = predict,
  new_observation,
  y = NULL,
  variables = NULL,
  variable_splits = NULL,
  grid_points = 101,
  label = class(x)[1],
  ...
)

Arguments

x an explainer created with the DALEX::explain() function, or a model to be
explained.

... other parameters

new_observation a new observation with columns that corresponds to variables used in the model

y true labels for new_observation. If specified then will be added to ceteris
paribus plots. NOTE: It is best when target variable is not present in the new_observation

variables names of variables for which profiles shall be calculated. Will be passed to
calculate_variable_split. If NULL then all variables from the validation
data will be used.

variable_splits named list of splits for variables, in most cases created with calculate_variable_split.
If NULL then it will be calculated based on validation data available in the
explainer.

grid_points maximum number of points for profile calculations. Note that the finaln number
of points may be lower than grid_points, eg. if there is not enough unique
values for a given variable. Will be passed to calculate_variable_split.
data validation dataset. It will be extracted from x if it’s an explainer NOTE: It is best when target variable is not present in the data

predict_function predict function. It will be extracted from x if it’s an explainer

label name of the model. By default it’s extracted from the class attribute of the model

Details
Find more details in Ceteris Paribus Chapter.

Value
an object of the class ceteris_paribus_explainer.

References

Examples
library("DALEX")
# smaller data, quicker example
titanic_small <- select_sample(titanic_imputed, n = 500, seed = 1313)

# build a model
model_titanic_glm <- glm(survived ~ gender + age + fare,
data = titanic_small,
family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
data = titanic_small[-8],
y = titanic_small[,8],
verbose = FALSE)

cp_rf <- ceteris_paribus(explain_titanic_glm, titanic_small[1,])
cp_rf

plot(cp_rf, variables = "age")

library("randomForest")
model_titanic_rf <- randomForest(survived ~., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[-8],
y = titanic_imputed[,8],
label = "Random Forest v7",
verbose = FALSE)
# select few passangers
selected_passangers <- select_sample(titanic_imputed, n = 20)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)
cp_rf

plot(cp_rf, variables = "age") +
  show_observations(cp_rf, variables = "age") +
  show_rugs(cp_rf, variables = "age", color = "red")

---

ceteris_paribus_2d  Ceteris Paribus 2D Plot

Description

This function calculates ceteris paribus profiles for grid of values spanned by two variables. It may be useful to identify or present interactions between two variables.

Usage

ceteris_paribus_2d(explainer, observation, grid_points = 101, variables = NULL)

Arguments

explainer    a model to be explained, preprocessed by the DALEX::explain() function
observation  a new observation for which predictions need to be explained
grid_points  number of points used for response path. Will be used for both variables
variables    if specified, then only these variables will be explained

Value

an object of the class ceteris_paribus_2d_explainer.

Examples

library("DALEX")

model_titanic_glm <- glm(survived ~ age + fare,
                          data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[, -8],
                                y = titanic_imputed[, 8])
**cluster_profiles**

```
cluster_profiles

15
```

**Cluster Ceteris Paribus Profiles**

**Description**

This function calculates aggregates of ceteris paribus profiles based on hierarchical clustering.

**Usage**

```
cluster_profiles(  
  x,  
  ...,  
  aggregate_function = mean,  
  variable_type = "numerical",  
  center = FALSE,  
  k = 3,  
  variables = NULL  
)
```

**Arguments**

- `x`: a ceteris paribus explainer produced with function `ceteris_paribus()`
- `...`: other explainers that shall be plotted together
cluster_profiles

aggregate_function

a function for profile aggregation. By default it’s mean

variable_type

a character. If numerical then only numerical variables will be computed. If categorical then only categorical variables will be computed.

center

shall profiles be centered before clustering

k

number of clusters for the hclust function

variables

if not NULL then only variables will be presented

Details

Find more details in the Clustering Profiles Chapter.

Value

an object of the class aggregated_profiles_explainer

References


Examples

library("DALEX")

selected_passangers <- select_sample(titanic_imputed, n = 100)
model_titanic_glm <- glm(survived ~ gender + age + fare,
data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
data = titanic_imputed[,-8],
y = titanic_imputed[,8])

cp_rf <- ceteris_paribus(explain_titanic_glm, selected_passangers)
clust_rf <- cluster_profiles(cp_rf, k = 3, variables = "age")
plot(clust_rf)

library("randomForest")
model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)
model_titanic_rf

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8],
label = "Random Forest v7")

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)
cp_rf

pdp_rf <- aggregate_profiles(cp_rf, variables = "age")
conditional_dependence

*Conditional Dependence Profiles*

**Description**

Conditional Dependence Profiles (aka Local Profiles) average locally Ceteris Paribus Profiles. Function `conditional_dependence` calls `ceteris_paribus` and then `aggregate_profiles`.

**Usage**

```r
conditional_dependence(x, ...)
```

```r
## S3 method for class 'explainer'
conditional_dependence(
  x,
  variables = NULL,
  N = 500,
  variable_splits = NULL,
  grid_points = 101,
  ...,
  variable_type = "numerical"
)
```

```r
## Default S3 method:
conditional_dependence(
  x,
  data,
  predict_function = predict,
  label = class(x)[1],
  variables = NULL,
  N = 500,
  variable_splits = NULL,
  grid_points = 101,
)```

```r
head(pdp_rf)
clust_rf <- cluster_profiles(cp_rf, k = 3, variables = "age")
head(clust_rf)

plot(clust_rf, color ="_label_") +
    show_aggregated_profiles(pdp_rf, color = "black", size = 3)

plot(cp_rf, color ="grey", variables = "age") +
    show_aggregated_profiles(clust_rf, color ="_label_", size = 2)

clust_rf <- cluster_profiles(cp_rf, k = 3, center = TRUE, variables = "age")
head(clust_rf)
conditional_dependence

```r
pl, 
  variable_type = "numerical"
)
```

## S3 method for class 'ceteris_paribus_explainer'
conditional_dependence(x, ..., variables = NULL)
local_dependency(x, ...)
conditional_dependency(x, ...)

### Arguments

- **x**: an explainer created with function DALEX::explain(), an object of the class ceteris_paribus_explainer or a model to be explained.
- **...**: other parameters
- **variables**: names of variables for which profiles shall be calculated. Will be passed to calculate_variable_split. If NULL then all variables from the validation data will be used.
- **N**: number of observations used for calculation of partial dependence profiles. By default 500.
- **variable_splits**: named list of splits for variables, in most cases created with calculate_variable_split. If NULL then it will be calculated based on validation data available in the explainer.
- **grid_points**: number of points for profile. Will be passed to calculate_variable_split.
- **variable_type**: a character. If numerical then only numerical variables will be calculated. If categorical then only categorical variables will be calculated.
- **data**: validation dataset, will be extracted from x if it's an explainer NOTE: It is best when target variable is not present in the data
- **predict_function**: predict function, will be extracted from x if it's an explainer
- **label**: name of the model. By default it's extracted from the class attribute of the model

### Details

Find more details in the Accumulated Local Dependence Chapter.

### Value

an object of the class aggregated_profile_explainer

### References

Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                          data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                               data = titanic_imputed[, -8],
                               y = titanic_imputed[, 8],
                               verbose = FALSE)

cdp_glm <- conditional_dependence(explain_titanic_glm,
                                    N = 150, variables = c("age", "fare"))

head(cdp_glm)
plot(cdp_glm)

library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
                              data = titanic_imputed[, -8],
                              y = titanic_imputed[, 8],
                              verbose = FALSE)


cdp_rf <- conditional_dependence(explain_titanic_rf, N = 200, variable_type = "numerical")
plot(cdp_rf)

cdp_rf <- conditional_dependence(explain_titanic_rf, N = 200, variable_type = "categorical")
plotD3(cdp_rf, label_margin = 80, scale_plot = TRUE)
```

---

**describe.partial_dependence_explainer**

*Natural language description of feature importance explainer*

---

**Description**

Generic function `describe` generates a natural language description of `ceteris_paribus()`, `aggregated_profiles()` and `feature_importance()` explanations what enhances their interpretability.

**Usage**

```r
# S3 method for class 'partial_dependence_explainer'
describe(
  x,
  nonsignificance_threshold = 0.15,
)```
...,
display_values = FALSE,
display_numbers = FALSE,
variables = NULL,
label = "prediction"
)

describe(x, ...)

## S3 method for class 'ceteris_paribus_explainer'
describe(
  x,
nonsignificance_treshold = 0.15,
  ...,display_values = FALSE,
display_numbers = FALSE,
variables = NULL,
label = "prediction"
)

## S3 method for class 'feature_importance_explainer'
describe(x, nonsignificance_treshold = 0.15, ...)

Arguments

x a ceteris paribus explanation produced with function ceteris_paribus()
nonsignificance_treshold a parameter specifying a threshold for variable importance
... other arguments
display_values allows for displaying variable values
display_numbers allows for displaying numerical values
variables a character of a single variable name to be described
label label for model's prediction

Details

Function describe.ceteris_paribus() generates a natural language description of ceteris paribus profile. The description summarizes variable values, that would change model's prediction at most. If a ceteris paribus profile for multiple variables is passed, variables must specify a single variable to be described. Works only for a ceteris paribus profile for one observation. In current version only categorical values are described. For display_numbers = TRUE three most important variable values are displayed, while display_numbers = FALSE displays all the important variables, however without further details.

Function describe.ceteris_paribus() generates a natural language description of ceteris paribus profile. The description summarizes variable values, that would change model's prediction at most. If a ceteris paribus profile for multiple variables is passed, variables must specify a single variable...
to be described. Works only for a ceteris paribus profile for one observation. For \texttt{display_numbers = TRUE} three most important variable values are displayed, while \texttt{display_numbers = FALSE} displays all the important variables, however without further details.

Function \texttt{describe.feature.importance.explainer()} generates a natural language description of feature importance explanation. It prints the number of important variables, that have significant dropout difference from the full model, depending on \texttt{nonsignificance_threshold}. The description prints the three most important variables for the model's prediction. The current design of \textbf{DALEX} explainer does not allow for displaying variables values.

**Examples**

```r
library("DALEX")
library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
   data = titanic_imputed[,-8],
   y = titanic_imputed[,8],
   label = "rf")

selected_passangers <- select_sample(titanic_imputed, n = 10)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)
pdp <- aggregate_profiles(cp_rf, type = "partial", variable_type = "categorical")
describe(pdp, variables = "gender")

library("DALEX")
library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
   data = titanic_imputed[,-8],
   y = titanic_imputed[,8],
   label = "rf")

selected_passanger <- select_sample(titanic_imputed, n = 1, seed = 123)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passanger)

plot(cp_rf, variable_type = "categorical")
describe(cp_rf, variables = "class", label = "the predicted probability")

library("DALEX")

lm_model <- lm(m2.price~., data = apartments)
explainer_lm <- explain(lm_model, data = apartments[,-1], y = apartments[,1])

fi_lm <- feature_importance(explainer_lm, loss_function = loss_root_mean_square)
```
plot(fi_lm)
describe(fi_lm)

---

feature_importance  Feature Importance

Description

This function calculates permutation based feature importance. For this reason it is also called the
Variable Dropout Plot.

Usage

feature_importance(x, ...)

## S3 method for class 'explainer'
feature_importance(
    x,
    loss_function = loss_root_mean_square,
    ...,
    type = c("raw", "ratio", "difference"),
    n_sample = NULL,
    B = 10,
    variables = NULL,
    variable_groups = NULL,
    label = NULL
)

## Default S3 method:
feature_importance(
    x,
    data,
    y,
    predict_function = predict,
    loss_function = loss_root_mean_square,
    ...,
    label = class(x)[1],
    type = c("raw", "ratio", "difference"),
    n_sample = NULL,
    B = 10,
    variables = NULL,
    variable_groups = NULL
)
Arguments

- **x**: an explainer created with function `DALEX::explain()`, or a model to be explained.
- ... other parameters
- **loss_function**: a function that will be used to assess variable importance
- **type**: character, type of transformation that should be applied for dropout loss. "raw" results raw drop lossess, "ratio" returns `drop_loss/drop_loss_full_model` while "difference" returns `drop_loss - drop_loss_full_model`
- **n_sample**: 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).
- **B**: integer, number of permutation rounds to perform on each variable. By default it's 10.
- **variables**: vector of variables. If `NULL` then variable importance will be tested for each variable from the data separately. By default `NULL`
- **variable_groups**: list of variables names vectors. This is for testing joint variable importance. If `NULL` then variable importance will be tested separately for variables. By default `NULL`. If specified then it will override variables
- **label**: name of the model. By default it's extracted from the class attribute of the model
- **data**: validation dataset, will be extracted from `x` if it's an explainer NOTE: It is best when target variable is not present in the data
- **y**: true labels for data, will be extracted from `x` if it's an explainer
- **predict_function**: predict function, will be extracted from `x` if it's an explainer

Details

Find more details in the Feature Importance Chapter.

Value

an object of the class `feature_importance`

References


Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                        data = titanic_imputed, family = "binomial")
```
```r
explain_titanic_glm <- explain(model_titanic_glm,
data = titanic_imputed[,-8],
y = titanic_imputed[,8])

fi_glm <- feature_importance(explain_titanic_glm)
plot(fi_glm)

fi_glm_joint1 <- feature_importance(explain_titanic_glm,
variable_groups = list("demographics" = c("gender", "age"),
"ticket_type" = c("fare"),
label = "lm 2 groups")
plot(fi_glm_joint1)

fi_glm_joint2 <- feature_importance(explain_titanic_glm,
variable_groups = list("demographics" = c("gender", "age"),
"wealth" = c("fare", "class"),
"family" = c("sibsp", "parch"),
"embarked" = "embarked"),
label = "lm 5 groups")
plot(fi_glm_joint2, fi_glm_joint1)

explain_titanic_glm

library("randomForest")

model_titanic_rf <- randomForest(survived ~., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8])

fi_rf <- feature_importance(explain_titanic_rf)
plot(fi_rf)

fi_rf <- feature_importance(explain_titanic_rf, B = 5) # 5 replications
plot(fi_rf)

fi_rf_group <- feature_importance(explain_titanic_rf,
variable_groups = list("demographics" = c("gender", "age"),
"wealth" = c("fare", "class"),
"family" = c("sibsp", "parch"),
"embarked" = "embarked"),
label = "rf 4 groups")
plot(fi_rf_group, fi_rf)

HR_rf_model <- randomForest(status ~., data = HR, ntree = 100)

explainer_rf <- explain(HR_rf_model, data = HR, y = HR$status,
```
Partial Dependence Profiles

Description

Partial Dependence Profiles are averages from Ceteris Paribus Profiles. Function `partial_dependency` calls `ceteris_paribus` and then `aggregate_profiles`.

Usage

```r
partial_dependency(x, ...)
```

## S3 method for class 'explainer'

default(x, 
    variables = NULL, 
    N = 500, 
    variable_splits = NULL, 
    grid_points = 101, 
    ...,

```
variable_type = "numerical"
)

## Default S3 method:
partial_dependence(  
  x,  
  data,  
  predict_function = predict,  
  label = class(x)[1],  
  variables = NULL,  
  grid_points = 101,  
  variable_splits = NULL,  
  N = 500,  
  ...,  
  variable_type = "numerical"
)

## S3 method for class 'ceteris_paribus_explainer'
partial_dependence(x, ..., variables = NULL)

partial_dependency(x, ...)

Arguments

x an explainer created with function DALEX::explain(), an object of the class ceteris_paribus_explainer or a model to be explained.
...
other parameters
variables names of variables for which profiles shall be calculated. Will be passed to calculate_variable_split. If NULL then all variables from the validation data will be used.
N number of observations used for calculation of partial dependence profiles. By default 500.
variable_splits named list of splits for variables, in most cases created with calculate_variable_split. If NULL then it will be calculated based on validation data available in the explainer.
grid_points number of points for profile. Will be passed to calculate_variable_split.
variable_type a character. If numerical then only numerical variables will be calculated. If categorical then only categorical variables will be calculated.
data validation dataset, will be extracted from x if it’s an explainer NOTE: It is best when target variable is not present in the data
predict_function predict function, will be extracted from x if it’s an explainer
label name of the model. By default it’s extracted from the class attribute of the model

Details

Find more details in the Partial Dependence Profiles Chapter.
Value

an object of the class `aggregated_profiles_explainer`

References


Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                         data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[,-8],
                                y = titanic_imputed[,8],
                                verbose = FALSE)

pdp_glm <- partial_dependence(explain_titanic_glm,
                               N = 50, variables = c("age", "fare"))
head(pdp_glm)
plot(pdp_glm)

library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
                               data = titanic_imputed[,-8],
                               y = titanic_imputed[,8],
                               verbose = FALSE)

pdp_rf <- partial_dependence(explain_titanic_rf, variable_type = "numerical")
plot(pdp_rf)

pdp_rf <- partial_dependence(explain_titanic_rf, variable_type = "categorical")
plotD3(pdp_rf, label_margin = 80, scale_plot = TRUE)
```
plot.aggregated_profiles_explainer

Description
Function plot.aggregated_profiles_explainer plots partial dependence plot or accumulated effect plot. It works in a similar way to plot.ceteris_paribus, but instead of individual profiles show average profiles for each variable listed in the variables vector.

Usage
```r
## S3 method for class 'aggregated_profiles_explainer'
plot(
  x, 
  ..., 
  size = 1, 
  alpha = 1, 
  color = "_label_", 
  facet_ncol = NULL, 
  variables = NULL
)
```

Arguments
- `x` a ceteris paribus explainer produced with function aggregate_profiles()
- `...` other explainers that shall be plotted together
- `size` a numeric. Size of lines to be plotted
- `alpha` a numeric between 0 and 1. Opacity of lines
- `color` a character. Either name of a color or name of a variable that should be used for coloring
- `facet_ncol` number of columns for the facet_wrap
- `variables` if not NULL then only variables will be presented

Value
a ggplot2 object

References

Examples
```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                          data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[,-8],
                                y = titanic_imputed[,8],
                                
```
library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf, 
  data = titanic_imputed[, -8],
  y = titanic_imputed[, 8],
  label = "Random Forest v7",
  verbose = FALSE)

selected_passangers <- select_sample(titanic_imputed, n = 100)

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

pdp_rf_p <- aggregate_profiles(cp_rf, variables = "age", type = "partial")
head(pdp_rf_p)
plot(pdp_rf_p)

pdp_rf_c <- aggregate_profiles(cp_rf, variables = "age", type = "conditional")
head(pdp_rf_c)
plot(pdp_rf_c)

pdp_rf_a <- aggregate_profiles(cp_rf, variables = "age", type = "accumulated")
head(pdp_rf_a)
plot(pdp_rf_a)

plot(cp_rf, variables = "age") + show_observations(cp_rf, variables = "age") + show_rugs(cp_rf, variables = "age", color = "red") + show_aggregated_profiles(pdp_rf_p, size = 2)
Description

This function plots What-If Plots for a single prediction / observation.

Usage

```r
## S3 method for class 'ceteris_paribus_2d_explainer'
plot(
  x,
  ...,  # currently will be ignored
  facet_ncol = NULL,
  add_raster = TRUE,
  add_contour = TRUE,
  bins = 3,
  add_observation = TRUE,
  pch = "+",
  size = 6
)
```

Arguments

- `x` a ceteris paribus explainer produced with the `ceteris_paribus_2d()` function
- `...` currently will be ignored
- `facet_ncol` number of columns for the `facet_wrap`
- `add_raster` if TRUE then `geom_raster` will be added to present levels with diverging colors
- `add_contour` if TRUE then `geom_contour` will be added to present contours
- `bins` number of contours to be added
- `add_observation` if TRUE then `geom_point` will be added to present observation that is explained
- `pch` character, symbol used to plot observations
- `size` numeric, size of individual datapoints

Value

a ggplot2 object

References


Examples

```r
library("DALEX")
library("randomForest")

apartments_rf_model <- randomForest(m2.price ~., data = apartments)
```
plot.ceteris_paribus_explainer

Plots Ceteris Paribus Profiles

Description

Function plot.ceteris_paribus_explainer plots Individual Variable Profiles for selected observations. Various parameters help to decide what should be plotted, profiles, aggregated profiles, points or rugs.

Find more details in Ceteris Paribus Chapter.
## Usage

```r
## S3 method for class 'ceteris_paribus_explainer'
plot(
  x,
  ...,
  size = 1,
  alpha = 1,
  color = "#46bac2",
  variable_type = "numerical",
  facet_ncol = NULL,
  variables = NULL
)
```

### Arguments

- **x**: a ceteris paribus explainer produced with function `ceteris_paribus()`
- **...**: other explainers that shall be plotted together
- **size**: a numeric. Size of lines to be plotted
- **alpha**: a numeric between 0 and 1. Opacity of lines
- **color**: a character. Either name of a color or name of a variable that should be used for coloring
- **variable_type**: a character. If `numerical` then only numerical variables will be plotted. If `categorical` then only categorical variables will be plotted.
- **facet_ncol**: number of columns for the `facet_wrap`
- **variables**: if not `NULL` then only variables will be presented

### Value

A `ggplot2` object

### References


### Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                          data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[, -8],
                                y = titanic_imputed[, 8],
                                verbose = FALSE)

cp_rf <- ceteris_paribus(explain_titanic_glm, titanic_imputed[1,])
```
cp_rf

plot(cp_rf, variables = "age")

library("randomForest")
model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8],
label = "Random Forest v7",
verbose = FALSE)

selected_passangers <- select_sample(titanic_imputed, n = 100)

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

plot(cp_rf, variables = "age") +
  show_observations(cp_rf, variables = "age") +
  show_rugs(cp_rf, variables = "age", color = "red")

selected_passangers <- select_sample(titanic_imputed, n = 1)
selected_passangers

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

plot(cp_rf) +
  show_observations(cp_rf)

plot(cp_rf, variables = "age") +
  show_observations(cp_rf, variables = "age")

plot(cp_rf, variables = "class")
plot(cp_rf, variables = c("class", "embarked"), facet_ncol = 1)
plotD3(cp_rf, variables = c("class", "embarked", "gender"),
  variable_type = "categorical", scale_plot = TRUE,
  label_margin = 70)

plot.ceteris_paribus_oscillations

_plot Ceteris Paribus Oscillations_

Description

This function plots local variable importance plots calculated as oscillations in the Ceteris Paribus Profiles.
Usage

```r
## S3 method for class 'ceteris_paribus_oscillations'
plot(x, ..., bar_width = 10)
```

Arguments

- `x`: a ceteris paribus oscillation explainer produced with function `calculate_oscillations()`
- `...`: other explainers that shall be plotted together
- `bar_width`: width of bars. By default 10

Value

- a `ggplot2` object

References


Examples

```r
library("DALEX")
library("randomForest")
apartments_rf_model <- randomForest(m2.price ~ ., data = apartments)
explainer_rf <- explain(apartments_rf_model,
  data = apartments_test[,-1],
  y = apartments_test[,1])
apartment <- apartments_test[1:2,]

apartment

vips <- calculate_oscillations(cp_rf)
vips
plot(vips)
```
### Description

This function plots variable importance calculated as changes in the loss function after variable drops. It uses output from `feature_importance` function that corresponds to permutation based measure of variable importance. Variables are sorted in the same order in all panels. The order depends on the average drop out loss. In different panels variable contributions may not look like sorted if variable importance is different in different models.

### Usage

```r
## S3 method for class 'feature_importance_explainer'
plot(
x, ...
max_vars = NULL,
show_boxplots = TRUE,
bar_width = 10,
desc_sorting = TRUE
)
```

### Arguments

- `x`: a feature importance explainer produced with the `feature_importance()` function
- `...`: other explainers that shall be plotted together
- `max_vars`: maximum number of variables that shall be presented for each model. By default NULL what means all variables
- `show_boxplots`: logical if TRUE (default) boxplot will be plotted to show permutation data.
- `bar_width`: width of bars. By default 10
- `desc_sorting`: logical. Should the bars be sorted descending? By default TRUE

### Details

Find more details in the Feature Importance Chapter.

### Value

a `ggplot2` object

### References

Examples

```r
library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
                         data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[, -8],
                                y = titanic_imputed[, 8])

fi_rf <- feature_importance(explain_titanic_glm)
plot(fi_rf)

library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
                               data = titanic_imputed[, -8],
                               y = titanic_imputed[, 8])

fi_rf <- feature_importance(explain_titanic_rf)
plot(fi_rf)

HR_rf_model <- randomForest(status ~ ., data = HR, ntree = 100)

explainer_rf <- explain(HR_rf_model, data = HR, y = HR$status,
                         verbose = FALSE, precalculate = FALSE)

fi_rf <- feature_importance(explainer_rf, type = "raw",
                            loss_function = loss_cross_entropy)
head(fi_rf)
plot(fi_rf)

HR_glm_model <- glm(status == "fired" ~ ., data = HR, family = "binomial")

explainer_glm <- explain(HR_glm_model, data = HR, y = HR$status == "fired")

fi_glm <- feature_importance(explainer_glm, type = "raw",
                            loss_function = loss_root_mean_square)
head(fi_glm)
plot(fi_glm)

library("xgboost")

model_matrix_train <- model.matrix(status == "fired" ~ . - 1, HR)
data_train <- xgb.DMatrix(model_matrix_train, label = HR$status == "fired")

param <- list(max_depth = 2, eta = 1, silent = 1, nthread = 2,
              objective = "binary:logistic", eval_metric = "auc")

HR_xgb_model <- xgb.train(param, data_train, nrounds = 50)
```
explainer_xgb <- explain(HR_xgb_model, data = model_matrix_train,
                        y = HR$status == "fired", label = "xgboost")

fi_xgb <- feature_importance(explainer_xgb, type = "raw")

head(fi_xgb)
plot(fi_glm, fi_xgb, bar_width = 5)

---

**plotD3**  
*Plots Ceteris Paribus Profiles in D3 with r2d3 Package.*

**Description**

Function `plotD3.ceteris_paribus_explainer` plots Individual Variable Profiles for selected observations. It uses output from `ceteris_paribus` function. Various parameters help to decide what should be plotted, profiles, aggregated profiles, points or rugs.

Find more details in Ceteris Paribus Chapter.

**Usage**

```r
plotD3(x, ...)
```

```
## S3 method for class 'ceteris_paribus_explainer'
plotD3(
  x,
  ...,  
size = 2,
  alpha = 1,
  color = "#46bac2",
  variable_type = "numerical",
  facet_ncol = 2,
  scale_plot = FALSE,
  variables = NULL,
  chart_title = "Ceteris Paribus Profiles",
  label_margin = 60,
  show_observations = TRUE,
  show_rugs = TRUE
)
```

**Arguments**

- `x` a ceteris paribus explainer produced with function `ceteris_paribus()`
- `...` other explainers that shall be plotted together
- `size` a numeric. Set width of lines
alpha a numeric between 0 and 1. Opacity of lines

color a character. Set line color

variable_type a character. If "numerical" then only numerical variables will be plotted. If "categorical" then only categorical variables will be plotted.

facet_ncol number of columns for the facet_wrap

scale_plot a logical. If TRUE, the height of plot scales with window size. By default it’s FALSE

variables if not NULL then only variables will be presented

chart_title a character. Set custom title

label_margin a numeric. Set width of label margins in categorical type

show_observations a logical. Adds observations layer to a plot. By default it’s TRUE

show_rugs a logical. Adds rugs layer to a plot. By default it’s TRUE

Value

a r2d3 object.

Examples

library("DALEX")
library("randomForest")

model_titanic_rf <- randomForest(survived ~., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8],
label = "rf")

selected_passangers <- select_sample(titanic_imputed, n = 10)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

plotD3(cp_rf, variables = c("age","parch","fare","sibsp"),
facet_ncol = 2, scale_plot = TRUE)

selected_passanger <- select_sample(titanic_imputed, n = 1)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passanger)

plotD3(cp_rf, variables = c("class", "embarked", "gender", "sibsp"),
facet_ncol = 2, variable_type = "categorical", label_margin = 100, scale_plot = TRUE)
plotD3.aggregated_profiles_explainer

Plots Aggregated Ceteris Paribus Profiles in D3 with r2d3 Package.

Description

Function plotD3.aggregated_profiles_explainer plots an aggregate of ceteris paribus profiles. It works in a similar way to plotD3.ceteris_paribus_explainer but, instead of individual profiles, show average profiles for each variable listed in the variables vector.

Find more details in Ceteris Paribus Chapter.

Usage

```r
## S3 method for class 'aggregated_profiles_explainer'
plotD3(
  x,
  ..., 
  size = 2,
  alpha = 1,
  color = "#46bac2",
  facet_ncol = 2,
  scale_plot = FALSE,
  variables = NULL,
  chart_title = "Aggregated Profiles",
  label_margin = 60
)
```

Arguments

- `x`: a aggregated profiles explainer produced with function aggregate_profiles()
- `...`: other explainers that shall be plotted together
- `size`: a numeric. Set width of lines
- `alpha`: a numeric between 0 and 1. Opacity of lines
- `color`: a character. Set line/bar color
- `facet_ncol`: number of columns for the `facet_wrap`
- `scale_plot`: a logical. If TRUE, the height of plot scales with window size. By default it's FALSE
- `variables`: if not NULL then only variables will be presented
- `chart_title`: a character. Set custom title
- `label_margin`: a numeric. Set width of label margins in categorical type

Value

A r2d3 object.
plotD3.feature_importance_explainer

References

Examples

```r
library("DALEX")
library("randomForest")

# smaller data, quicker example
titanic_small <- select_sample(titanic_imputed, n = 500, seed = 1313)

# build a model
model_titanic_rf <- randomForest(survived ~ ., data = titanic_small)

explain_titanic_rf <- explain(model_titanic_rf, data = titanic_small[,-8], y = titanic_small[,8], label = "Random Forest v7")

selected_passangers <- select_sample(titanic_small, n = 100)
cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

pdp_rf_p <- aggregate_profiles(cp_rf, type = "partial", variable_type = "numerical")
pdp_rf_p$\"label\" <- "RF_partial"
pdp_rf_c <- aggregate_profiles(cp_rf, type = "conditional", variable_type = "numerical")
pdp_rf_c$\"label\" <- "RF_conditional"
pdp_rf_a <- aggregate_profiles(cp_rf, type = "accumulated", variable_type = "numerical")
pdp_rf_a$\"label\" <- "RF_accumulated"

plotD3(pdp_rf_p, pdp_rf_c, pdp_rf_a, scale_plot = TRUE)

pdp <- aggregate_profiles(cp_rf, type = "partial", variable_type = "categorical")
pdp$\"label\" <- "RF_partial"

plotD3(pdp, variables = c("gender","class"), label_margin = 70)
```

---

plotD3.feature_importance_explainer

Plot Feature Importance Objects in D3 with r2d3 Package.

Description
Function `plotD3.feature_importance_explainer` plots dropouts for variables used in the model. It uses output from `feature_importance` function that corresponds to permutation based measure of feature importance. Variables are sorted in the same order in all panels. The order depends on the average drop out loss. In different panels variable contributions may not look like sorted if variable importance is different in different models.
Usage

```r
## S3 method for class 'feature_importance_explainer'
plotD3(
  x,
  ..., 
  max_vars = NULL,
  show_boxplots = TRUE,
  bar_width = 12,
  split = "model",
  scale_height = FALSE,
  margin = 0.15,
  chart_title = "Feature importance"
)
```

Arguments

- **x**: a feature importance explainer produced with the `feature_importance()` function
- **...**: other explainers that shall be plotted together
- **max_vars**: maximum number of variables that shall be presented for each model. By default `NULL` which means all variables
- **show_boxplots**: logical if `TRUE` (default) boxplot will be plotted to show permutation data.
- **bar_width**: width of bars in px. By default 12px
- **split**: either "model" or "feature" determines the plot layout
- **scale_height**: a logical. If `TRUE`, the height of plot scales with window size. By default it's `FALSE`
- **margin**: extend x axis domain range to adjust the plot. Usually value between 0.1 and 0.3, by default it's 0.15
- **chart_title**: a character. Set custom title

Value

A `r2d3` object.

Examples

```r
library("DALEX")

lm_model <- lm(m2.price ~ ., data = apartments)
explainer_lm <- explain(lm_model,
  data = apartments[, -1],
  y = apartments[, 1],
  verbose = FALSE)

fi_lm <- feature_importance(explainer_lm, loss_function = loss_root_mean_square)
head(fi_lm)
```
### S3 method for class 'aggregated_profiles_explainer'

```r
print(x, ...)  
```

#### Arguments

- `x`  
  - An individual variable profile explainer produced with the `aggregate_profiles()` function
- `...`  
  - Other arguments that will be passed to `head()`
Examples

library("DALEX")

model_titanic_glm <- glm(survived ~ gender + age + fare,
  data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
  data = titanic_imputed[,-8],
  y = titanic_imputed[,8])

selected_passangers <- select_sample(titanic_imputed, n = 100)
cp_rf <- ceteris_paribus(explain_titanic_glm, selected_passangers)

head(cp_rf)

pdp_rf <- aggregate_profiles(cp_rf, variables = "age")
head(pdp_rf)

library("randomForest")

model_titanic_rf <- randomForest(survived ~ ., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
  data = titanic_imputed[,-8],
  y = titanic_imputed[,8],
  verbose = FALSE, precalculate = FALSE)

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

head(cp_rf)

pdp_rf <- aggregate_profiles(cp_rf, variables = "age")
head(pdp_rf)

print.ceteris_paribus_explainer

Prints Individual Variable Explainer Summary

Description

Prints Individual Variable Explainer Summary

Usage

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

print.ceteris_paribus_explainer

Prints Individual Variable Explainer Summary

Usage

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

print.feature_importance_explainer

Arguments

x an individual variable profile explainer produced with the ceteris_paribus() function

... other arguments that will be passed to head()

Examples

library("DALEX")
library("randomForest")

apartments_rf_model <- randomForest(m2.price ~ ., data = apartments)

explainer_rf <- explain(apartments_rf_model,
data = apartments_test[-1],
y = apartments_test[,1])

apartments_small <- select_sample(apartments_test, 10)

cp_rf <- ceteris_paribus(explainer_rf, apartments_small)

cp_rf

print.feature_importance_explainer

Print Generic for Feature Importance Object

Description

Print Generic for Feature Importance Object

Usage

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

Arguments

x an explanation created with feature_importance

... other parameters.

Value

a data frame.

References

select_neighbours

Examples

```r
library("DALEX")
library(ingredients)

model_titanic_glm <- glm(survived ~ gender + age + fare,
                           data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[,-8],
                                y = titanic_imputed[,8])

fi_glm <- feature_importance(explain_titanic_glm)
fi_glm
```

select_neighbours

Select Subset of Rows Closest to a Specified Observation

Description

Function `select_neighbours` selects subset of rows from data set. This is useful if data is large and we need just a sample to calculate profiles.

Usage

```r
select_neighbours(
  observation,
  data,
  variables = NULL,
  distance = gower::gower_dist,
  n = 20,
  frac = NULL
)
```

Arguments

- `observation`: single observation
- `data`: set of observations
- `variables`: names of variables that shall be used for calculation of distance. By default these are all variables present in data and observation
- `distance`: the distance function, by default the `gower::gower_dist()` function.
- `n`: number of neighbours to select
- `frac`: if `n` is not specified (NULL), then will be calculated as `frac * number of rows in data`. Either `n` or `frac` need to be specified.
select_sample

Details

Note that `select_neighbours()` function is S3 generic. If you want to work on non standard data sources (like H2O ddf, external databases) you should overload it.

Value

a data frame with selected rows

Examples

```r
library("DALEX")

new_apartment <- apartments[1,]
small_apartments <- select_neighbours(new_apartment, apartments_test, n = 10)

new_apartment
small_apartments
```

select_sample Select Subset of Rows

Description

Function `select_sample` selects subset of rows from data set. This is useful if data is large and we need just a sample to calculate profiles.

Usage

`select_sample(data, n = 100, seed = 1313)`

Arguments

- `data` set of observations. Profile will be calculated for every observation (every row)
- `n` number of observations to select.
- `seed` seed for random number generator.

Details

Note that `select_subsample()` function is S3 generic. If you want to work on non standard data sources (like H2O ddf, external databases) you should overload it.

Value

a data frame with selected rows
show_aggregated_profiles

Examples

library("DALEX")
	small_apartments <- select_sample(apartments_test)
thead(small_apartments)

show_aggregated_profiles

Adds a Layer with Aggregated Profiles

Description

Function show_aggregated_profiles adds a layer to a plot created with plot.ceteris_paribus_explainer.

Usage

show_aggregated_profiles(
  x,
  ..., 
  size = 0.5,
  alpha = 1,
  color = "#371ea3",
  variables = NULL
)

Arguments

x a ceteris paribus explainer produced with function ceteris_paribus()
...
other explainers that shall be plotted together
size a numeric. Size of lines to be plotted
alpha a numeric between 0 and 1. Opacity of lines
color a character. Either name of a color or name of a variable that should be used for coloring
variables if not NULL then only variables will be presented

Value

a ggplot2 layer
show_observations

Examples

library("DALEX")

selected_passangers <- select_sample(titanic_imputed, n = 100)

model_titanic_glm <- glm(survived ~ gender + age + fare, 
  data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm, 
  data = titanic_imputed[,-8], 
  y = titanic_imputed[,8])

cp_rf <- ceteris_paribus(explain_titanic_glm, selected_passangers)

pdp_rf <- aggregate_profiles(cp_rf, type = "partial", variables = "age")

plot(cp_rf, variables = "age") +
  show_observations(cp_rf, variables = "age") +
  show_aggregated_profiles(pdp_rf, size = 3)

library("randomForest")

model_titanic_rf <- randomForest(survived ~., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf, 
  data = titanic_imputed[,-8], 
  y = titanic_imputed[,8], 
  verbose = FALSE, precalculate = FALSE)

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)

cp_rf

pdp_rf <- aggregate_profiles(cp_rf, type = "partial", variables = "age")

head(pdp_rf)

plot(cp_rf, variables = "age") +
  show_observations(cp_rf, variables = "age") +
  show_rugs(cp_rf, variables = "age", color = "red") +
  show_aggregated_profiles(pdp_rf, size = 3)

show_observations

 Adds a Layer with Observations to a Profile Plot

Description

Function show_observations adds a layer to a plot created with plot.ceteris_paribus_explainer for selected observations. Various parameters help to decide what should be plotted, profiles, aggregated profiles, points or rugs.
Usage

```r
show_observations(
  x,
  ..., 
  size = 2,  
  alpha = 1, 
  color = "#371ea3", 
  variable_type = "numerical", 
  variables = NULL
)
```

Arguments

- **x**: a ceteris paribus explainer produced with function `ceteris_paribus()`
- ... other explainers that shall be plotted together
- **size**: a numeric. Size of lines to be plotted
- **alpha**: a numeric between 0 and 1. Opacity of lines
- **color**: a character. Either name of a color or name of a variable that should be used for coloring
- **variable_type**: a character. If `numerical` then only numerical variables will be plotted. If `categorical` then only categorical variables will be plotted.
- **variables**: if not `NULL` then only variables will be presented

Value

a `ggplot2` layer

Examples

```r
library("DALEX")
library("randomForest")

rf_model <- randomForest(survived ~.,
  data = titanic_imputed)

explainer_rf <- explain(rf_model,
  data = titanic_imputed[,-8],
  y = titanic_imputed[,8],
  label = "RF", verbose = FALSE)

selected_passangers <- select_sample(titanic_imputed, n = 100)
cp_rf <- ceteris_paribus(explainer_rf, selected_passangers)
cp_rf

plot(cp_rf, variables = "age", color = "grey") +
show_observations(cp_rf, variables = "age", color = "black") +
show_rugs(cp_rf, variables = "age", color = "red")
```
show_profiles  

Adds a Layer with Profiles

Description

Function `show_profiles` adds a layer to a plot created with `plot.ceteris_paribus_explainer`.

Usage

```r
show_profiles(
  x,
  ..., 
  size = 0.5,
  alpha = 1,
  color = "#371ea3",
  variables = NULL
)
```

Arguments

- `x`  
a ceteris paribus explainer produced with function `ceteris_paribus()`
- `...`  
other explainers that shall be plotted together
- `size`  
a numeric. Size of lines to be plotted
- `alpha`  
a numeric between 0 and 1. Opacity of lines
- `color`  
a character. Either name of a color or name of a variable that should be used for coloring
- `variables`  
if not NULL then only variables will be presented

Value

a `ggplot2` layer

Examples

```r
library("DALEX")

selected_passangers <- select_sample(titanic_imputed, n = 100)
selected_john <- titanic_imputed[1,]

model_titanic_glm <- glm(survived ~ gender + age + fare,
                         data = titanic_imputed, family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                                data = titanic_imputed[,-8],
                                y = titanic_imputed[,8],
                                label = "cool_model", verbose = FALSE)
```
library("randomForest")

model_titanic_rf <- randomForest(survived ~., data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
   data = titanic_imputed[,-8],
   y = titanic_imputed[,8],
   verbose = FALSE, precalculate = FALSE)

cp_rf <- ceteris_paribus(explain_titanic_rf, selected_passangers)
cp_rf_john <- ceteris_paribus(explain_titanic_rf, selected_john)

plot(cp_rf, variables = "age") +
   show_profiles(cp_rf_john, variables = "age", size = 2)

pdp_rf <- aggregate_profiles(cp_rf, variables = "age")
head(pdp_rf)

plot(cp_rf, variables = "age") +
   show_observations(cp_rf, variables = "age") +
   show_rugs(cp_rf, variables = "age", color = "red") +
   show_profiles(cp_rf_john, variables = "age", color = "red", size = 2)

---

**show_residuals**

*Adds a Layer with Residuals to a Profile Plot*

**Description**

Function `show_residuals` adds a layer to a plot created with `plot.ceteris_paribus_explainer` for selected observations. Note that the `y` argument has to be specified in the `ceteris_paribus` function.

**Usage**

```r
show_residuals(
  x,
  ..., size = 0.75,
  alpha = 1,
  color = c('TRUE' = "#8bdcbc", 'FALSE' = "#f05a71"),
  variables = NULL
)
```
show_residuals

Arguments

x a ceteris paribus explainer produced with function ceteris_paribus(). Note that y parameter shall be supplied in this function.

... other explainers that shall be plotted together

size a numeric. Size of lines to be plotted

alpha a numeric between 0 and 1. Opacity of lines

color a character. Either name of a color or name of a variable that should be used for coloring

variables if not NULL then only variables will be presented

Value

a ggplot2 layer

Examples

library("DALEX")
library("randomForest")

johny_d <- data.frame(
class = factor("1st", levels = c("1st", "2nd", "3rd", "deck crew", "engineering crew",
                           "restaurant staff", "victualling crew")),
gender = factor("male", levels = c("female", "male")),
age = 8,
sibsp = 0,
parch = 0,
fare = 72,
embarked = factor("Southampton", levels = c("Belfast", "Cherbourg", "Queenstown", "Southampton"))
)

model_titanic_rf <- randomForest(survived ~., data = titanic_imputed, ntree = 500)

explain_titanic_rf <- explain(model_titanic_rf,
data = titanic_imputed[,-8],
y = titanic_imputed[,8],
label = "Random Forest v7")

johny_neighbours <- select_neighbours(data = titanic_imputed,
observation = johny_d,
variables = c("age", "gender", "class",
               "fare", "sibsp", "parch"),
n = 10)

cp_neighbours <- ceteris_paribus(explain_titanic_rf,
johny_neighbours,
y = johny_neighbours$Survived == "yes",
variable_splits = list(age = seq(0,70, length.out = 100)))

plot(cp_neighbours, variables = "age") +
show_rugs

show_observations(cp_neighbours, variables = "age")

cp_johny <- ceteris_paribus(explain_titanic_rf, johny_d,
variable_splits = list(age = seq(0,70, length.out = 100)))

plot(cp_johny, variables = "age", size = 1.5, color = "#8bdcbe") +
show_profiles(cp_neighbours, variables = "age", color = "#ceced9") +
show_observations(cp_johny, variables = "age", size = 5, color = "#371ea3") +
show_residuals(cp_neighbours, variables = "age")

show_rugs

Description

Function `show_rugs` adds a layer to a plot created with `plot.ceteris_paribus_explainer` for selected observations. Various parameters help to decide what should be plotted, profiles, aggregated profiles, points or rugs.

Usage

```r
show_rugs(
x, ...
size = 0.5,
alpha = 1,
color = "#371ea3",
variable_type = "numerical",
sides = "b",
variables = NULL
)
```

Arguments

- `x` a ceteris paribus explainer produced with function `ceteris_paribus()`
- `...` other explainers that shall be plotted together
- `size` a numeric. Size of lines to be plotted
- `alpha` a numeric between 0 and 1. Opacity of lines
- `color` a character. Either name of a color or name of a variable that should be used for coloring
- `variable_type` a character. If `numerical` then only numerical variables will be plotted. If `categorical` then only categorical variables will be plotted.
- `sides` a string containing any of "trbl", for top, right, bottom, and left. Passed to geom rug.
- `variables` if not NULL then only variables will be presented
Value

a ggplot2 layer

Examples

```r
library("DALEX")
library("randomForest")

rf_model <- randomForest(survived ~ ., data = titanic_imputed)

explainer_rf <- explain(rf_model, data = titanic_imputed[,-8],
                        y = titanic_imputed[,8],
                        label = "RF", verbose = FALSE)

selected_passangers <- select_sample(titanic_imputed, n = 100)
cp_rf <- ceteris_paribus(explainer_rf, selected_passangers)
cp_rf

plot(cp_rf, variables = "age", color = "grey") +
show_observations(cp_rf, variables = "age", color = "black") +
show_rugs(cp_rf, variables = "age", color = "red")
```
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