Package 'triplot'

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Title Explaining Correlated Features in Machine Learning Models

Version 1.3.0

Description Tools for exploring effects of correlated features in predictive models. The predict_triplot() function delivers instance-level explanations that calculate the importance of the groups of explanatory variables. The model_triplot() function delivers data-level explanations. The generic plot function visualises in a concise way importance of hierarchical groups of predictors. All of the the tools are model agnostic, therefore works for any predictive machine learning models. Find more details in Biecek (2018) <arXiv:1806.08915>.

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Suggests testthat, knitr, randomForest, mlbench, ranger, gbm, covr

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

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R topics documented:

`aspect_importance` *Calculates importance of variable groups (called aspects) for a selected observation*

Description

Predict aspects function takes a sample from a given dataset and modifies it. Modification is made by replacing part of its aspects by values from the observation. Then function is calculating the difference between the prediction made on modified sample and the original sample. Finally, it measures the impact of aspects on the change of prediction by using the linear model or lasso.

Usage

```
aspect_importance(x, ...)

## S3 method for class 'explainer'
aspect_importance(
  x,
  new_observation,
  variable_groups,
  N = 1000,
  n_var = 0,
  sample_method = "default",
  f = 2,
  ...
)

## Default S3 method:
aspect_importance(
  x,
  data,
```

```
  predict_function = predict,
  label = class(x)[1],
  new_observation,
  variable_groups,
  N = 100,
  n_var = 0,
  sample_method = "default",
  f = 2,
  ...
)

lime(x, ...)

predict_aspects(x, ...)
```

Arguments

x	an explainer created with the DALEX::explain() function or a model to be explained.
...	other parameters
new_observation	selected observation with columns that corresponds to variables used in the model
variable_groups	list containing grouping of features into aspects
N	number of observations to be sampled (with replacement) from data NOTE: Small N may cause unstable results.
n_var	maximum number of non-zero coefficients after lasso fitting, if zero than linear regression is used
sample_method	sampling method in get_sample
f	frequency in get_sample
data	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.

Value

An object of the class aspect_importance. Contains data frame that describes aspects' importance.

Examples

```
library("DALEX")
```

```
model_titanic_glm <- glm(survived == 1 ~
                         class+gender+age+sibsp+parch+fare+embarked,
                         data = titanic_imputed,
                         family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                               data = titanic_imputed[,-8],
                               y = titanic_imputed$survived == 1,
                               verbose = FALSE)

aspects <- list(wealth = c("class", "fare"),
                family = c("sibsp", "parch"),
                personal = c("gender", "age"),
                embarked = "embarked")

predict_aspects(explain_titanic_glm,
                  new_observation = titanic_imputed[1,],
                  variable_groups = aspects)


library("randomForest")
library("DALEX")
model_titanic_rf <-
 randomForest(factor(survived) ~ class + gender + age + sibsp +
                parch + fare + embarked,
              data = titanic_imputed)

explain_titanic_rf <- explain(model_titanic_rf,
                              data = titanic_imputed[,-8],
                              y = titanic_imputed$survived == 1,
                              verbose = FALSE)

predict_aspects(explain_titanic_rf,
                  new_observation = titanic_imputed[1,],
                  variable_groups = aspects)
```

`aspect_importance_single` *Aspects importance for single aspects*

Description

Calculates aspect_importance for single aspects (every aspect contains only one feature).

Usage

```
aspect_importance_single(x, ...)
```

```
## S3 method for class 'explainer'
aspect_importance_single(
  x,
  new_observation,
  N = 1000,
  n_var = 0,
  sample_method = "default",
  f = 2,
  ...
)

## Default S3 method:
aspect_importance_single(
  x,
  data,
  predict_function = predict,
  label = class(x)[1],
  new_observation,
  N = 1000,
  n_var = 0,
  sample_method = "default",
  f = 2,
  ...
)
```

Arguments

x	an explainer created with the DALEX::explain() function or a model to be explained.
...	other parameters
new_observation	selected observation with columns that corresponds to variables used in the model, should be without target variable
N	number of observations to be sampled (with replacement) from data NOTE: Small N may cause unstable results.
n_var	how many non-zero coefficients for lasso fitting, if zero than linear regression is used
sample_method	sampling method in get_sample
f	frequency in in get_sample
data	dataset, it will be extracted from x if it's an explainer NOTE: Target variable shouldn't be 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.

Value

An object of the class 'aspect_importance'. Contains dataframe that describes aspects' importance.

Examples

```
library("DALEX")
model_titanic_glm <- glm(survived == 1 ~ class + gender + age +
                         sibsp + parch + fare + embarked,
                         data = titanic_imputed,
                         family = "binomial")

explainer_titanic <- explain(model_titanic_glm,
                             data = titanic_imputed[,-8],
                             verbose = FALSE)
aspect_importance_single(explainer_titanic,
                         new_observation = titanic_imputed[1,-8])
```

---

calculate_triplot *Calculate triplot that sums up automatic aspect/feature importance grouping*

Description

This function shows:

- plot for the importance of single variables,
- tree that shows importance for every newly expanded group of variables,
- clustering tree.

Usage

```
calculate_triplot(x, ...)

## S3 method for class 'explainer'
calculate_triplot(
  x,
  type = c("predict", "model"),
  new_observation = NULL,
  N = 1000,
  loss_function = DALEX::loss_root_mean_square,
  B = 10,
  fi_type = c("raw", "ratio", "difference"),
  clust_method = "complete",
  cor_method = "spearman",
  ...
)
```

```
## Default S3 method:
calculate_triplot(
  x,
  data,
  y = NULL,
  predict_function = predict,
  label = class(x)[1],
  type = c("predict", "model"),
  new_observation = NULL,
  N = 1000,
  loss_function = DALEX::loss_root_mean_square,
  B = 10,
  fi_type = c("raw", "ratio", "difference"),
  clust_method = "complete",
  cor_method = "spearman",
  ...
)

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

model_triplot(x, ...)

predict_triplot(x, ...)
```

Arguments

x	an explainer created with the DALEX::explain() function or a model to be explained.
...	other parameters
type	if predict then aspect_importance is used, if model than feature_importance is calculated
new_observation	selected observation with columns that corresponds to variables used in the model, should be without target variable
N	number of rows to be sampled from data NOTE: Small N may cause unstable results.
loss_function	a function that will be used to assess variable importance, if type = model
B	integer, number of permutation rounds to perform on each variable in feature importance calculation, if type = model
fi_type	character, type of transformation that should be applied for dropout loss, if type = model. "raw" results raw drop losses, "ratio" returns drop_loss/drop_loss_full_model.
clust_method	the agglomeration method to be used, see hclust methods
cor_method	the correlation method to be used see cor methods
data	dataset, it will be extracted from x if it's an explainer NOTE: Target variable shouldn't be present in the data

y	true labels for data, will be extracted from x if it's an explainer
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.

Value

triplot object

Examples

```
library(DALEX)
set.seed(123)
apartments_num <- apartments[,unlist(lapply(apartments, is.numeric))]
apartments_num_lm_model <- lm(m2.price ~ ., data = apartments_num)
apartments_num_new_observation <- apartments_num[30, ]
explainer_apartments <- explain(model = apartments_num_lm_model,
                                data = apartments_num[,-1],
                                y = apartments_num[, 1],
                                verbose = FALSE)
apartments_tri <- calculate_triplot(x = explainer_apartments,
                                    new_observation =
                                      apartments_num_new_observation[-1])
apartments_tri
```

---

cluster_variables *Creates a cluster tree from numeric features*

Description

Creates a cluster tree from numeric features and their correlations.

Usage

```
cluster_variables(x, ...)

## Default S3 method:
cluster_variables(x, clust_method = "complete", cor_method = "spearman", ...)
```

Arguments

x	dataframe with only numeric columns
...	other parameters
clust_method	the agglomeration method to be used see hclust methods
cor_method	the correlation method to be used see cor methods

Value

an hclust object

Examples

```
library("DALEX")
dragons_data <- dragons[,c(2,3,4,7,8)]
cluster_variables(dragons_data, clust_method = "complete")
```

`get_sample` *Function for getting binary matrix*

Description

Function creates binary matrix, to be used in aspect_importance method. It starts with a zero matrix. Then it replaces some zeros with ones. If `sample_method = "default"` it randomly replaces one or two zeros per row. If `sample_method = "binom"` it replaces random number of zeros per row - average number of replaced zeros can be controlled by parameter `sample_method = "f"`. Function doesn't allow the returned matrix to have rows with only zeros.

Usage

```
get_sample(n, p, sample_method = c("default", "binom"), f = 2)
```

Arguments

`n`	number of rows
`p`	number of columns
`sample_method`	sampling method
`f`	frequency for binomial sampling

Value

a binary matrix

Examples

```
get_sample(100,6,"binom",3)
```

group_variables *Helper function that combines clustering variables and creating aspect list*

Description

Divides correlated features into groups, called aspects. Division is based on correlation cutoff level.

Usage

```
group_variables(x, h, clust_method = "complete", cor_method = "spearman")
```

Arguments

x	hclust object
h	correlation value for tree cutting
clust_method	the agglomeration method to be used see hclust methods
cor_method	the correlation method to be used see cor methods

Value

list with aspect

Examples

```
library("DALEX")
dragons_data <- dragons[,c(2,3,4,7,8)]
group_variables(dragons_data, h = 0.5, clust_method = "complete")
```

hierarchical_importance *Calculates importance of hierarchically grouped aspects*

Description

This function creates a tree that shows order of feature grouping and calculates importance of every newly created aspect.

Usage

```
hierarchical_importance(
  x,
  data,
  y = NULL,
  predict_function = predict,
  type = "predict",
  new_observation = NULL,
  N = 1000,
  loss_function = DALEX::loss_root_mean_square,
  B = 10,
  fi_type = c("raw", "ratio", "difference"),
  clust_method = "complete",
  cor_method = "spearman",
  ...
)

## S3 method for class 'hierarchical_importance'
plot(
  x,
  absolute_value = FALSE,
  show_labels = TRUE,
  add_last_group = TRUE,
  axis_lab_size = 10,
  text_size = 3,
  ...
)
```

Arguments

x	a model to be explained.
data	dataset NOTE: Target variable shouldn't be present in the data
y	true labels for data
predict_function	predict function
type	if predict then aspect_importance is used, if model than feature_importance is calculated
new_observation	selected observation with columns that corresponds to variables used in the model, should be without target variable
N	number of rows to be sampled from data NOTE: Small N may cause unstable results.
loss_function	a function that will be used to assess variable importance, if type = model
B	integer, number of permutation rounds to perform on each variable in feature importance calculation, if type = model

fi_type	character, type of transformation that should be applied for dropout loss, if type = model. "raw" results raw drop losses, "ratio" returns drop_loss/drop_loss_full_model.
clust_method	the agglomeration method to be used, see hclust methods
cor_method	the correlation method to be used see cor methods
...	other parameters
absolute_value	if TRUE, aspects importance values will be drawn as absolute values
show_labels	if TRUE, plot will have annotated axis Y
add_last_group	if TRUE, plot will draw connecting line between last two groups
axis_lab_size	size of labels on axis Y, if applicable
text_size	size of labels annotating values of aspects importance

Value

ggplot

Examples

```
library(DALEX)
apartments_num <- apartments[,unlist(lapply(apartments, is.numeric))]
apartments_num_lm_model <- lm(m2.price ~ ., data = apartments_num)
hi <- hierarchical_importance(x = apartments_num_lm_model,
 data = apartments_num[,-1],
 y = apartments_num[,1],
 type = "model")
plot(hi, add_last_group = TRUE, absolute_value = TRUE)
```

---

list_variables *Cuts tree at custom height and returns a list*

Description

This function creates aspect list after cutting a cluster tree of features at a given height.

Usage

```
list_variables(x, h)
```

Arguments

x	hclust object
h	correlation value for tree cutting

Value

list of aspects

Examples

```
library("DALEX")
dragons_data <- dragons[,c(2,3,4,7,8)]
cv <- cluster_variables(dragons_data, clust_method = "complete")
list_variables(cv, h = 0.5)
```

`plot.aspect_importance` *Function for plotting aspect_importance results*

Description

This function plots the results of aspect_importance.

Usage

```
## S3 method for class 'aspect_importance'
plot(
  x,
  ...,
  bar_width = 10,
  show_features = aspects_on_axis,
  aspects_on_axis = TRUE,
  add_importance = FALSE,
  digits_to_round = 2,
  text_size = 3
)
```

Arguments

`x`	object of aspect_importance class
`...`	other parameters
`bar_width`	bar width
`show_features`	if TRUE, labels on axis Y show aspect names, otherwise they show features names
`aspects_on_axis`	alias for `show_features` held for backwards compatibility
`add_importance`	if TRUE, plot is annotated with values of aspects importance
`digits_to_round`	integer indicating the number of decimal places used for rounding values of aspects importance shown on the plot
`text_size`	size of labels annotating values of aspects importance, if applicable

Value

a ggplot2 object

Examples

```
library("DALEX")

model_titanic_glm <- glm(survived == 1 ~
                         class+gender+age+sibsp+parch+fare+embarked,
                         data = titanic_imputed,
                         family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                               data = titanic_imputed[,-8],
                               y = titanic_imputed$survived == 1,
                               verbose = FALSE)

aspects <- list(wealth = c("class", "fare"),
                family = c("sibsp", "parch"),
                personal = c("gender", "age"),
                embarked = "embarked")

titanic_ai <- predict_aspects(explain_titanic_glm,
                  new_observation = titanic_imputed[1,],
                  variable_groups = aspects)
plot(titanic_ai)
```

---

plot.cluster_variables

Plots tree with correlation values

Description

Plots tree that illustrates the results of cluster_variables function.

Usage

```
## S3 method for class 'cluster_variables'
plot(x, p = NULL, show_labels = TRUE, axis_lab_size = 10, text_size = 3, ...)
```

Arguments

x	`cluster_variables` or `hclust` object
p	correlation value for cutoff level, if not NULL, cutoff line will be drawn
show_labels	if TRUE, plot will have annotated axis Y
axis_lab_size	size of labels on axis Y, if applicable
text_size	size of labels annotating values of correlations
...	other parameters

Value

plot

Examples

```
library("DALEX")
dragons_data <- dragons[,c(2,3,4,7,8)]
cv <- cluster_variables(dragons_data, clust_method = "complete")
plot(cv, p = 0.7)
```

`plot.triplot` *Plots triplot*

Description

Plots triplot that sum up automatic aspect/feature importance grouping

Usage

```
## S3 method for class 'triplot'
plot(
  x,
  absolute_value = FALSE,
  add_importance_labels = FALSE,
  show_model_label = FALSE,
  abbrev_labels = 0,
  add_last_group = TRUE,
  axis_lab_size = 10,
  text_size = 3,
  bar_width = 5,
  margin_mid = 0.3,
  ...
)
```

Arguments

`x`	triplot object
`absolute_value`	if TRUE, aspect importance values will be drawn as absolute values
`add_importance_labels`	if TRUE, first plot is annotated with values of aspects importance on the bars
`show_model_label`	if TRUE, adds subtitle with model label
`abbrev_labels`	if greater than 0, labels for axis Y in single aspect importance plot will be abbreviated according to this parameter

add_last_group	if TRUE and type = predict, plot will draw connecting line between last two groups at the level of 105 biggest importance value, for model this line is always drawn at the baseline value
axis_lab_size	size of labels on axis
text_size	size of labels annotating values of aspects importance and correlations
bar_width	bar width in the first plot
margin_mid	size of a right margin of a middle plot
...	other parameters

Value

plot

Examples

```
library(DALEX)
set.seed(123)
apartments_num <- apartments[,unlist(lapply(apartments, is.numeric))]
apartments_num_lm_model <- lm(m2.price ~ ., data = apartments_num)
apartments_num_new_observation <- apartments_num[30, ]
explainer_apartments <- explain(model = apartments_num_lm_model,
                                data = apartments_num[,-1],
                                y = apartments_num[, 1],
                                verbose = FALSE)
apartments_tri <- calculate_triplot(x = explainer_apartments,
 new_observation = apartments_num_new_observation[-1])
plot(apartments_tri)
```

---

print.aspect_importance

Function for printing aspect_importance results

Description

This function prints the results of aspect_importance.

Usage

```
## S3 method for class 'aspect_importance'
print(x, show_features = FALSE, show_corr = FALSE, ...)
```

Arguments

x	object of aspect_importance class
show_features	show list of features for every aspect
show_corr	show if all features in aspect are pairwise positively correlated (for numeric features only)
...	other parameters

Examples

```
library("DALEX")

model_titanic_glm <- glm(survived == 1 ~
                         class+gender+age+sibsp+parch+fare+embarked,
                         data = titanic_imputed,
                         family = "binomial")

explain_titanic_glm <- explain(model_titanic_glm,
                               data = titanic_imputed[,-8],
                               y = titanic_imputed$survived == 1,
                               verbose = FALSE)

aspects <- list(wealth = c("class", "fare"),
                family = c("sibsp", "parch"),
                personal = c("gender", "age"),
                embarked = "embarked")

titanic_ai <- predict_aspects(explain_titanic_glm,
                  new_observation = titanic_imputed[1,],
                  variable_groups = aspects)
print(titanic_ai)
```

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