Package ‘modelStudio’

March 5, 2022

Title Interactive Studio for Explanatory Model Analysis

Version 3.1.0

Description Automate the explanatory analysis of machine learning predictive models. Generate advanced interactive model explanations in the form of a serverless HTML site with only one line of code. This tool is model-agnostic, therefore compatible with most of the black-box predictive models and frameworks. The main function computes various (instance and model-level) explanations and produces a customisable dashboard, which consists of multiple panels for plots with their short descriptions. It is possible to easily save the dashboard and share it with others. Tools for Explanatory Model Analysis unite with tools for Exploratory Data Analysis to give a broad overview of the model behavior.

Depends R (>= 3.6)

License GPL-3

Encoding UTF-8

RoxygenNote 7.1.2

Imports DALEX (>= 2.2.1), ingredients (>= 2.2.0), iBreakDown (>= 2.0.1), r2d3, jsonlite, progress, digest

Suggests parallelMap, ranger, xgboost, knitr, rmarkdown, testthat, spelling

VignetteBuilder knitr

URL https://modelstudio.drwhy.ai,
    https://github.com/ModelOriented/modelStudio

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

Language en-US

LazyData true

NeedsCompilation no

Author Hubert Baniecki [aut, cre] (https://orcid.org/0000-0001-6661-5364), Przemyslaw Biecek [aut] (https://orcid.org/0000-0001-8423-1823), Piotr Piatyszek [ctb]
Datasets `happiness_train` and `happiness_test` are real data from the World Happiness Reports. Happiness is scored according to economic production, social support, etc. `happiness_train` accumulates the data from years 2015-2018, while `happiness_test` is the data from the year 2019, which imitates the out-of-time validation.

```
data(happiness_train); data(happiness_test)
```

The following columns: GDP per Capita, Social Support, Life Expectancy, Freedom, Generosity, Corruption describe the extent to which these factors contribute in evaluating the happiness in each country. Variables:

- **score** - target variable, continuous value between 0 and 10 (regression)
- `gdp_per_capita`
- `social_support`
- `healthy_life_expectancy`
- `freedom_life_choices`
modelStudio

• generosity
• perceptions_of_corruption

modelStudio

Interactive Studio for Explanatory Model Analysis

Description

This function computes various (instance and dataset level) model explanations and produces a
customisable dashboard, which consists of multiple panels for plots with their short descriptions.
Easily save the dashboard and share it with others. Tools for Explanatory Model Analysis unite
with tools for Exploratory Data Analysis to give a broad overview of the model behavior.

The extensive documentation covers:

• Function parameters description - perks and features
• Framework and model compatibility - R & Python examples
• Theoretical introduction to the plots - Explanatory Model Analysis: Explore, Explain, and
  Examine Predictive Models

Displayed variable can be changed by clicking on the bars of plots or with the first dropdown list,
and observation can be changed with the second dropdown list. The dashboard gathers useful, but
not sensitive, information about how it is being used (e.g. computation length, package version,
dashboard dimensions). This is for the development purposes only and can be blocked by setting
telemetry to FALSE.

Usage

modelStudio(explainer, ...)

## S3 method for class 'explainer'
modelStudio(
  explainer,
  new_observation = NULL,
  new_observation_y = NULL,
  new_observation_n = 3,
  facet_dim = c(2, 2),
  time = 500,
  max_features = 10,
  max_features_fi = NULL,
  N = 300,
  N_fi = N * 10,
  N_sv = N * 3,
  B = 10,
  B_fi = B,
  eda = TRUE,
  show_info = TRUE,
modelStudio

parallel = FALSE,
options = ms_options(),
viewer = "external",
widget_id = NULL,
license = NULL,
telemetry = TRUE,
max_vars = NULL,
verbose = NULL,
...

Arguments

explainer An explainer created with DALEX::explain().

... Other parameters.

new_observation New observations with columns that correspond to variables used in the model.

new_observation_y True label for new_observation (optional).

new_observation_n Number of observations to be taken from the explainer$data if new_observation = NULL. See vignette

facet_dim Dimensions of the grid. Default is c(2,2).

time Time in ms. Set the animation length. Default is 500.

max_features Maximum number of features to be included in BD, SV, and FI plots. Default is 10.

max_features_fi Maximum number of features to be included in FI plot. Default is max_features.

N Number of observations used for the calculation of PD and AD. Default is 300. See vignette

N_fi Number of observations used for the calculation of FI. Default is 10*N.

N_sv Number of observations used for the calculation of SV. Default is 3*N.

B Number of permutation rounds used for calculation of SV. Default is 10. See vignette

B_fi Number of permutation rounds used for calculation of FI. Default is B.

eda Compute EDA plots and Residuals vs Feature plot, which adds the data to the dashboard. Default is TRUE.

show_info Verbose a progress on the console. Default is TRUE.

parallel Speed up the computation using parallelMap::parallelMap(). See vignette. This might interfere with showing progress using show_info.

options Customize modelStudio. See ms_options and vignette.

viewer Default is external to display in an external RStudio window. Use browser to display in an external browser or internal to use the RStudio internal viewer pane for output.
modelStudio

- **widget_id**: Use an explicit element ID for the widget (rather than an automatically generated one). Useful e.g. when using modelStudio with Shiny. See vignette.

- **license**: Path to the file containing the license (con parameter passed to readLines()). It can be used e.g. to include the license for explainer$data as a comment in the source of .html output file.

- **telemetry**: The dashboard gathers useful, but not sensitive, information about how it is being used (e.g. computation length, package version, dashboard dimensions). This is for the development purposes only and can be blocked by setting telemetry to FALSE.

- **max_vars**: An alias for max_features. If provided, it will override the value.

- **verbose**: An alias for show_info. If provided, it will override the value.

**Value**

An object of the r2d3,htmlwidget,modelStudio class.

**References**

- The input object is implemented in DALEX
- Feature Importance, Ceteris Paribus, Partial Dependence and Accumulated Dependence explanations are implemented in ingredients
- Break Down and Shapley Values explanations are implemented in iBreakDown

**See Also**

Vignettes: modelStudio - R & Python examples and modelStudio - perks and features

**Examples**

```r
library("DALEX")
library("modelStudio")

# #: ex1 classification on 'titanic' data

# fit a model
model_titanic <- glm(survived ~ ., data = titanic_imputed, family = "binomial")

# create an explainer for the model
explainer_titanic <- explain(model_titanic,
    data = titanic_imputed, 
    y = titanic_imputed$survived, 
    label = "Titanic GLM")

# pick observations
new_observations <- titanic_imputed[1:2,]
rownames(new_observations) <- c("Lucas","James")

# make a studio for the model
modelStudio(explainer_titanic,
```
new_observations,
N = 200, B = 5) # faster example

#:# ex2 regression on 'apartments' data
if (requireNamespace("ranger", quietly=TRUE)) {
  library("ranger")
  model_apartments <- ranger(m2.price ~ ., data = apartments)
  explainer_apartments <- explain(model_apartments,
data = apartments,
y = apartments$m2.price)
  new_apartments <- apartments[1:2,]
  rownames(new_apartments) <- c("ap1", "ap2")
  # change dashboard dimensions and animation length
  modelStudio(explainer_apartments,
              new_apartments,
facet_dim = c(2, 3),
time = 800)
  # add information about true labels
  modelStudio(explainer_apartments,
              new_apartments,
              new_observation_y = new_apartments$m2.price)
  # don't compute EDA plots
  modelStudio(explainer_apartments,
              eda = FALSE)
}

#:# ex3 xgboost model on 'HR' dataset
if (requireNamespace("xgboost", quietly=TRUE)) {
  library("xgboost")
  HR_matrix <- model.matrix(status == "fired" ~ . - 1, HR)
  # fit a model
  xgb_matrix <- xgb.DMatrix(HR_matrix, label = HR$status == "fired")
  params <- list(max_depth = 3, objective = "binary:logistic", eval_metric = "auc")
  model_HR <- xgb.train(params, xgb_matrix, nrounds = 300)
  # create an explainer for the model
  explainer_HR <- explain(model_HR,
data = HR_matrix,
y = HR$status == "fired",
type = "classification",
label = "xgboost")
  # pick observations
  new_observation <- HR_matrix[1:2, , drop=FALSE]
  rownames(new_observation) <- c("id1", "id2")
## ms_merge_observations

Merge the observations of modelStudio objects

### Description

This function merges local explanations from multiple modelStudio objects into one.

### Usage

```r
ms_merge_observations(...)```

### Arguments

- `...` modelStudio objects created with `modelStudio()`.

### Value

An object of the `r2d3`, `htmlwidget`, `modelStudio` class.

### References

- The input object is implemented in **DALEX**
- Feature Importance, Ceteris Paribus, Partial Dependence and Accumulated Dependence explanations are implemented in **ingredients**
- Break Down and Shapley Values explanations are implemented in **iBreakDown**

### See Also

Vignettes: **modelStudio - R & Python examples** and **modelStudio - perks and features**

### Examples

```r
library("DALEX")
library("modelStudio")

# fit a model
model_happiness <- glm(score ~ ., data = happiness_train)

# create an explainer for the model
explainer_happiness <- explain(model_happiness,
```
data = happiness_test,
y = happiness_test$score)

# make studios for the model
ms1 <- modelStudio(explainer_happiness,
                    N = 200, B = 5)

ms2 <- modelStudio(explainer_happiness,
                    new_observation = head(happiness_test, 3),
                    N = 200, B = 5)

# merge
ms <- ms_merge_observations(ms1, ms2)
ms

---

### ms_options

**Modify default options and pass them to modelStudio**

**Description**

This function returns default options for `modelStudio`. It is possible to modify values of this list and pass it to the `options` parameter in the main function. **WARNING: Editing default options may cause unintended behavior.**

**Usage**

```r
ms_options(...)```

**Arguments**

`...` Options to change in the form `option_name = value`.

**Value**

list of options for `modelStudio`.

**Options**

**Main options:**

- `scale_plot` TRUE Makes every plot the same height, ignores `bar_width`.
- `show_boxplot` TRUE Display boxplots in Feature Importance and Shapley Values plots.
- `show_subtitle` TRUE Should the subtitle be displayed?
- `subtitle` label parameter from `explainer`.
- `ms_title` Title of the dashboard.
- `ms_subtitle` Subtitle of the dashboard (makes space between the title and line).
- `ms_margin_` Dashboard margins. Change `margin_top` for more `ms_subtitle` space.
**ms_options**

- **margin_*** Plot margins. Change margin_left for longer/shorter axis labels.
- **w** 420 in px. Inner plot width.
- **h** 280 in px. Inner plot height.
- **bar_width** 16 in px. Default width of bars for all plots, ignored when scale_plot = TRUE.
- **line_size** 2 in px. Default width of lines for all plots.
- **point_size** 3 in px. Default point radius for all plots.
- **[bar,line,point]_color** [#46bac2,#46bac2,#371ea3]
- **positive_color** #8bdcbe for Break Down and Shapley Values bars.
- **negative_color** #f05a71 for Break Down and Shapley Values bars.
- **default_color** #371ea3 for Break Down bar and highlighted line.

**Plot-specific options:** **is a two letter code unique to each plot, might be one of [bd, sv, cp, fi, pd, ad, rv, fd, tv, at].**

- ***_title** Plot-specific title. Default varies.
- ***_subtitle** Plot-specific subtitle. Default is subtitle.
- ***_axis_title** Plot-specific axis title. Default varies.
- ***_bar_width** Plot-specific width of bars. Default is bar_width, ignored when scale_plot = TRUE.
- ***_line_size** Plot-specific width of lines. Default is line_size.
- ***_point_size** Plot-specific point radius. Default is point_size.
- ***_color** Plot-specific [bar,line,point] color. Default is [bar,line,point]_color.

**References**

- The input object is implemented in **DALEX**
- Feature Importance, Ceteris Paribus, Partial Dependence and Accumulated Dependence explanations are implemented in **ingredients**
- Break Down and Shapley Values explanations are implemented in **iBreakDown**

**See Also**

Vignettes: **modelStudio - R & Python examples** and **modelStudio - perks and features**

**Examples**

```r
library("DALEX")
library("modelStudio")

# fit a model
model_apartments <- glm(m2.price ~ ., data = apartments)

# create an explainer for the model
explainer_apartments <- explain(model_apartments,
                                data = apartments,
                                y = apartments$m2.price)

# pick observations
```


`ms_update_observations`  

Update the observations of a `modelStudio` object

Description

This function calculates local explanations on new observations and adds them to the `modelStudio` object.

Usage

```r
ms_update_observations(
  object,
  explainer,
  new_observation = NULL,
  new_observation_y = NULL,
  max_features = 10,
  B = 10,
  show_info = TRUE,
  parallel = FALSE,
  widget_id = NULL,
  overwrite = FALSE,
  ...
)
```
Arguments

object  A modelStudio created with modelStudio().
explainer  An explainer created with DALEX::explain().
new_observation  New observations with columns that correspond to variables used in the model.
new_observation_y  True label for new_observation (optional).
max_features  Maximum number of features to be included in BD and SV plots. Default is 10.
B  Number of permutation rounds used for calculation of SV and FI. Default is 10. See vignette
show_info  Verbose a progress on the console. Default is TRUE.
parallel  Speed up the computation using parallelMap::parallelMap(). See vignette. This might interfere with showing progress using show_info.
widget_id  Use an explicit element ID for the widget (rather than an automatically generated one). Useful e.g. when using modelStudio with Shiny. See vignette.
overwrite  Overwrite existing observations and their explanations. Default is FALSE which means add new observations to the existing ones.
...  Other parameters.

Value

An object of the r2d3,htmlwidget,modelStudio class.

References

• The input object is implemented in DALEX
• Feature Importance, Ceteris Paribus, Partial Dependence and Accumulated Dependence explanations are implemented in ingredients
• Break Down and Shapley Values explanations are implemented in iBreakDown

See Also

Vignettes: modelStudio - R & Python examples and modelStudio - perks and features

Examples

library("DALEX")
library("modelStudio")

# fit a model
model_titanic <- glm(survived ~ ., data = titanic_imputed, family = "binomial")

# create an explainer for the model
explainer_titanic <- explain(model_titanic, 
    data = titanic_imputed, 
    y = titanic_imputed$survived)
# make a studio for the model
ms <- modelStudio(explainer_titanic,
  N = 200, B = 5) # faster example

# add new observations
ms <- ms_update_observations(ms,
  explainer_titanic,
  new_observation = titanic_imputed[100:101,],
  new_observation_y = titanic_imputed$survived[100:101])
ms

# overwrite the observations with new ones
ms <- ms_update_observations(ms,
  explainer_titanic,
  new_observation = titanic_imputed[100:101,],
  overwrite = TRUE)
ms

---

**ms_update_options**  
*Update the options of a modelStudio object*

**Description**

This function updates the options of a `modelStudio` object. **WARNING: Editing default options may cause unintended behavior.**

**Usage**

```
ms_update_options(object, ...)
```

**Arguments**

- **object**  
  A `modelStudio` created with `modelStudio()`.

- **...**  
  Options to change in the form `option_name = value`, e.g. `time = 0, facet_dim = c(1,2)`.

**Value**

An object of the `r2d3,htmlwidget,modelStudio` class.
ms_update_options

Options

Main options::

scale_plot  TRUE  Makes every plot the same height, ignores bar_width.
show_boxplot  TRUE  Display boxplots in Feature Importance and Shapley Values plots.
show_subtitle  TRUE  Should the subtitle be displayed?
subtitle  label parameter from explainer.
ms_title  Title of the dashboard.
ms_subtitle  Subtitle of the dashboard (makes space between the title and line).
ms_margin_*  Dashboard margins. Change margin_top for more ms_subtitle space.
margin_*  Plot margins. Change margin_left for longer/shorter axis labels.
w  420 in px. Inner plot width.
h  280 in px. Inner plot height.
bar_width  16 in px. Default width of bars for all plots, ignored when scale_plot = TRUE.
line_size  2 in px. Default width of lines for all plots.
point_size  3 in px. Default point radius for all plots.
[bar,line,point _color]  [#46bac2,#46bac2,#371ea3]
positive_color  #8bdcbe for Break Down and Shapley Values bars.
negative_color  #f05a71 for Break Down and Shapley Values bars.
default_color  #371ea3 for Break Down bar and highlighted line.

Plot-specific options::  ** is a two letter code unique to each plot, might be one of [bd, sv, cp, fi, pd, ad, rv, fd, tv, at].

**_title  Plot-specific title. Default varies.
**_subtitle  Plot-specific subtitle. Default is subtitle.
**_axis_title  Plot-specific axis title. Default varies.
**_bar_width  Plot-specific width of bars. Default is bar_width, ignored when scale_plot = TRUE.
**_line_size  Plot-specific width of lines. Default is line_size.
**_point_size  Plot-specific point radius. Default is point_size.
**_*_color  Plot-specific [bar,line,point]color. Default is [bar,line,point]_color.

References

• The input object is implemented in DALEX
• Feature Importance, Ceteris Paribus, Partial Dependence and Accumulated Dependence ex-
planations are implemented in ingredients
• Break Down and Shapley Values explanations are implemented in iBreakDown

See Also

Vignettes: modelStudio - R & Python examples and modelStudio - perks and features
Examples

```r
library("DALEX")
library("modelStudio")

# fit a model
model_titanic <- glm(survived ~ ., data = titanic_imputed, family = "binomial")

# create an explainer for the model
explainer_titanic <- explain(model_titanic,
data = titanic_imputed,
y = titanic_imputed$survived)

# make a studio for the model
ms <- modelStudio(explainer_titanic,
                   N = 200, B = 5) # faster example

# update the options
new_ms <- ms_update_options(ms,
                             time = 0,
                             facet_dim = c(1,2),
                             margin_left = 150)

new_ms
```
Index

happiness_test (happiness_train), 2
happiness_train, 2

modelStudio, 3, 8, 12
ms_merge_observations, 7
ms_options, 4, 8
ms_update_observations, 10
ms_update_options, 12