

Package ‘stackgbm’

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Title Stacked Gradient Boosting Machines

Version 0.1.0

Description A minimalist implementation of model stacking by Wolpert (1992) <[doi:10.1016/S0893-6080\(05\)80023-1](https://doi.org/10.1016/S0893-6080(05)80023-1)> for boosted tree models. A classic, two-layer stacking model is implemented, where the first layer generates features using gradient boosting trees, and the second layer employs a logistic regression model that uses these features as inputs. Utilities for training the base models and parameters tuning are provided, allowing users to experiment with different ensemble configurations easily. It aims to provide a simple and efficient way to combine multiple gradient boosting models to improve predictive model performance and robustness.

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URL <https://nanx.me/stackgbm/>, <https://github.com/nanxstats/stackgbm>

BugReports <https://github.com/nanxstats/stackgbm/issues>

Encoding UTF-8

VignetteBuilder knitr

Depends R (>= 3.5.0)

Imports pROC, progress, rlang

Suggests knitr, lightgbm, msaenet, rmarkdown, xgboost

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NeedsCompilation no

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catboost_load_pool	<i>Create a dataset</i>
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Description

Create a dataset

Usage

```
catboost_load_pool(data, label = NULL, ...)
```

Arguments

data	Predictors.
label	Labels.
...	Additional parameters.

Value

A `catboost.Pool` object.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,  
  seed = 42  
)  
  
catboost_load_pool(data = sim_data$x.tr, label = sim_data$y.tr)  
catboost_load_pool(data = sim_data$x.tr, label = NULL)  
catboost_load_pool(data = sim_data$x.te, label = NULL)
```

catboost_predict	<i>Predict based on the model</i>
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Description

Predict based on the model

Usage

```
catboost_predict(model, pool, prediction_type = "Probability", ...)
```

Arguments

model	The trained model.
pool	The dataset to predict on.
prediction_type	Prediction type.
...	Additional parameters.

Value

Predicted values.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,
```

```
  seed = 42
)

x_train <- catboost_load_pool(data = sim_data$x.tr, label = sim_data$y.tr)
x_test  <- catboost_load_pool(data = sim_data$x.te, label = NULL)

fit <- catboost_train(
  x_train,
  NULL,
  params = list(
    loss_function = "Logloss",
    iterations = 100,
    depth = 3,
    logging_level = "Silent"
  )
)

catboost_predict(fit, x_test)
```

catboost_train	<i>Train the model</i>
----------------	------------------------

Description

Train the model

Usage

```
catboost_train(learn_pool, test_pool = NULL, params = list())
```

Arguments

learn_pool	Training dataset.
test_pool	Testing dataset.
params	A list of training parameters.

Value

A model object.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(
  n = 100,
  p = 10,
  rho = 0.6,
  coef = rnorm(5, mean = 0, sd = 10),
  snr = 1,
```

```
p.train = 0.8,
seed = 42
)

x_train <- catboost_load_pool(data = sim_data$x.tr, label = sim_data$y.tr)

fit <- catboost_train(
  x_train,
  NULL,
  params = list(
    loss_function = "Logloss",
    iterations = 100,
    depth = 3,
    logging_level = "Silent"
  )
)

fit
```

cv_catboost	<i>catboost - parameter tuning and model selection with k-fold cross-validation and grid search</i>
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Description

catboost - parameter tuning and model selection with k-fold cross-validation and grid search

Usage

```
cv_catboost(
  x,
  y,
  params = cv_param_grid(),
  n_folds = 5,
  n_threads = 1,
  seed = 42,
  verbose = TRUE
)
```

Arguments

x	Predictor matrix.
y	Response vector.
params	Parameter grid generated by cv_param_grid() .
n_folds	Number of folds. Default is 5.

n_threads	The number of parallel threads. For optimal speed, match this to the number of physical CPU cores, not threads. See respective model documentation for more details. Default is 1.
seed	Random seed for reproducibility.
verbose	Show progress?

Value

A data frame containing the complete tuning grid and the AUC values, with the best parameter combination and the highest AUC value.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(
  n = 100,
  p = 10,
  rho = 0.6,
  coef = rnorm(5, mean = 0, sd = 10),
  snr = 1,
  p.train = 0.8,
  seed = 42
)

params <- cv_catboost(
  sim_data$x.tr,
  sim_data$y.tr,
  params = cv_param_grid(
    n_iterations = c(100, 200),
    max_depth = c(3, 5),
    learning_rate = c(0.1, 0.5)
  ),
  n_folds = 5,
  n_threads = 1,
  seed = 42,
  verbose = FALSE
)

params$df
```

cv_lightgbm

lightgbm - parameter tuning and model selection with k-fold cross-validation and grid search

Description

lightgbm - parameter tuning and model selection with k-fold cross-validation and grid search

Usage

```
cv_lightgbm(  
  x,  
  y,  
  params = cv_param_grid(),  
  n_folds = 5,  
  n_threads = 1,  
  seed = 42,  
  verbose = TRUE  
)
```

Arguments

x	Predictor matrix.
y	Response vector.
params	Parameter grid generated by <code>cv_param_grid()</code> .
n_folds	Number of folds. Default is 5.
n_threads	The number of parallel threads. For optimal speed, match this to the number of physical CPU cores, not threads. See respective model documentation for more details. Default is 1.
seed	Random seed for reproducibility.
verbose	Show progress?

Value

A data frame containing the complete tuning grid and the AUC values, with the best parameter combination and the highest AUC value.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,  
  seed = 42  
)
```

```
params <- suppressWarnings(  
  cv_lightgbm(  
    sim_data$x.tr,  
    sim_data$y.tr,  
    params = cv_param_grid(  
      n_iterations = c(100, 200),  
      max_depth = c(3, 5),  
      learning_rate = c(0.1, 0.5)
```

```

    ),
    n_folds = 5,
    n_threads = 1,
    seed = 42,
    verbose = FALSE
  )
)

params$df

```

 cv_param_grid

Generate a parameter grid for cross-validation

Description

This function generates a parameter grid to be used in the cross-validation of gradient boosting decision tree (GBDT) models.

Usage

```

cv_param_grid(
  n_iterations = c(100, 200, 500, 1000),
  max_depth = c(3, 5, 7, 9),
  learning_rate = c(0.01, 0.05, 0.1, 0.2)
)

```

Arguments

n_iterations	A numeric vector of the number of iterations (trees) for the GBDT model. This is equivalent to nrounds in XGBoost, num_iterations in LightGBM, and iterations in CatBoost.
max_depth	A numeric vector of the maximum tree depths. This parameter is equivalent to max_depth in XGBoost and LightGBM, and depth in CatBoost.
learning_rate	A numeric vector of learning rates for the GBDT model. This parameter is equivalent to eta in XGBoost, learning_rate in LightGBM, and ignored in CatBoost.

Value

A list where the names are the parameter names and the values are vectors of possible values for those parameters.

Examples

```
params <- cv_param_grid(  
  n_iterations = c(10, 100),  
  max_depth = c(3, 5),  
  learning_rate = c(0.01, 0.1)  
)
```

cv_xgboost	<i>xgboost - parameter tuning and model selection with k-fold cross-validation and grid search</i>
------------	--

Description

xgboost - parameter tuning and model selection with k-fold cross-validation and grid search

Usage

```
cv_xgboost(  
  x,  
  y,  
  params = cv_param_grid(),  
  n_folds = 5,  
  n_threads = 1,  
  seed = 42,  
  verbose = TRUE  
)
```

Arguments

x	Predictor matrix.
y	Response vector.
params	Parameter grid generated by cv_param_grid() .
n_folds	Number of folds. Default is 5.
n_threads	The number of parallel threads. For optimal speed, match this to the number of physical CPU cores, not threads. See respective model documentation for more details. Default is 1.
seed	Random seed for reproducibility.
verbose	Show progress?

Value

A data frame containing the complete tuning grid and the AUC values, with the best parameter combination and the highest AUC value.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,  
  seed = 42  
)  
  
params <- cv_xgboost(  
  sim_data$x.tr,  
  sim_data$y.tr,  
  params = cv_param_grid(  
    n_iterations = c(100, 200),  
    max_depth = c(3, 5),  
    learning_rate = c(0.1, 0.5)  
  ),  
  n_folds = 5,  
  n_threads = 1,  
  seed = 42,  
  verbose = FALSE  
)  
  
params$df
```

is_installed_catboost *Is catboost installed?*

Description

Is catboost installed?

Usage

```
is_installed_catboost()
```

Value

TRUE if installed, FALSE if not.

Examples

```
is_installed_catboost()
```

`is_installed_lightgbm` *Is lightgbm installed?*

Description

Is lightgbm installed?

Usage

`is_installed_lightgbm()`

Value

TRUE if installed, FALSE if not.

Examples

`is_installed_lightgbm()`

`is_installed_xgboost` *Is xgboost installed?*

Description

Is xgboost installed?

Usage

`is_installed_xgboost()`

Value

TRUE if installed, FALSE if not.

Examples

`is_installed_xgboost()`

lightgbm_train	<i>Train lightgbm model</i>
----------------	-----------------------------

Description

Train lightgbm model

Usage

```
lightgbm_train(data, label, params, ...)
```

Arguments

data	Training data.
label	Labels.
params	A list of parameters.
...	Additional parameters.

Value

A model object.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,  
  seed = 42  
)  
  
fit <- suppressWarnings(  
  lightgbm_train(  
    data = sim_data$x.tr,  
    label = sim_data$y.tr,  
    params = list(  
      objective = "binary",  
      learning_rate = 0.1,  
      num_iterations = 100,  
      max_depth = 3,  
      num_leaves = 2^3 - 1,  
      num_threads = 1  
    ),  
    verbose = -1  
  )  
)
```

```
)
fit
```

```
predict.stackgbm      Make predictions from a stackgbm model object
```

Description

Make predictions from a stackgbm model object

Usage

```
## S3 method for class 'stackgbm'
predict(object, newx, threshold = 0.5, classes = c(1L, 0L), ...)
```

Arguments

object	A stackgbm model object.
newx	New predictor matrix.
threshold	Decision threshold. Default is 0.5.
classes	The class encoding vector of the predicted outcome. The naming and order will be respected.
...	Unused.

Value

A list of two vectors presenting the predicted classification probabilities and predicted response.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(
  n = 1000,
  p = 50,
  rho = 0.6,
  coef = rnorm(25, mean = 0, sd = 10),
  snr = 1,
  p.train = 0.8,
  seed = 42
)

params_xgboost <- structure(
  list("nrounds" = 200, "eta" = 0.05, "max_depth" = 3),
  class = c("cv_params", "cv_xgboost")
)

params_lightgbm <- structure(
  list("num_iterations" = 200, "max_depth" = 3, "learning_rate" = 0.05),
```

```

    class = c("cv_params", "cv_lightgbm")
  )
  params_catboost <- structure(
    list("iterations" = 100, "depth" = 3),
    class = c("cv_params", "cv_catboost")
  )

  fit <- stackgbm(
    sim_data$x.tr,
    sim_data$y.tr,
    params = list(
      params_xgboost,
      params_lightgbm,
      params_catboost
    )
  )

  predict(fit, newx = sim_data$x.te)

```

stackgbm

Model stacking for boosted trees

Description

Model stacking with a two-layer architecture: first layer being boosted tree models fitted by xgboost, lightgbm, and catboost; second layer being a logistic regression model.

Usage

```
stackgbm(x, y, params, n_folds = 5L, seed = 42, verbose = TRUE)
```

Arguments

x	Predictor matrix.
y	Response vector.
params	A list of optimal parameter objects for boosted tree models derived from cv_xgboost() , cv_lightgbm() , and cv_catboost() . The order does not matter.
n_folds	Number of folds. Default is 5.
seed	Random seed for reproducibility.
verbose	Show progress?

Value

Fitted boosted tree models and stacked tree model.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(
  n = 1000,
  p = 50,
  rho = 0.6,
  coef = rnorm(25, mean = 0, sd = 10),
  snr = 1,
  p.train = 0.8,
  seed = 42
)

params_xgboost <- structure(
  list("nrounds" = 200, "eta" = 0.05, "max_depth" = 3),
  class = c("cv_params", "cv_xgboost")
)

params_lightgbm <- structure(
  list("num_iterations" = 200, "max_depth" = 3, "learning_rate" = 0.05),
  class = c("cv_params", "cv_lightgbm")
)

params_catboost <- structure(
  list("iterations" = 100, "depth" = 3),
  class = c("cv_params", "cv_catboost")
)

fit <- stackgbm(
  sim_data$x.tr,
  sim_data$y.tr,
  params = list(
    params_xgboost,
    params_lightgbm,
    params_catboost
  )
)

predict(fit, newx = sim_data$x.te)
```

`xgboost_dmatrix`*Create xgb.DMatrix object*

Description

Create xgb.DMatrix object

Usage`xgboost_dmatrix(data, label = NULL, ...)`

Arguments

data	Matrix or file.
label	Labels (optional).
...	Additional parameters.

Value

An xgb.DMatrix object.

Examples

```

sim_data <- msaenet::msaenet.sim.binomial(
  n = 100,
  p = 10,
  rho = 0.6,
  coef = rnorm(5, mean = 0, sd = 10),
  snr = 1,
  p.train = 0.8,
  seed = 42
)

xgboost_dmatrix(sim_data$x.tr, label = sim_data$y.tr)
xgboost_dmatrix(sim_data$x.te)

```

xgboost_train	<i>Train xgboost model</i>
---------------	----------------------------

Description

Train xgboost model

Usage

```
xgboost_train(params, data, nrounds, ...)
```

Arguments

params	A list of parameters.
data	Training data.
nrounds	The Maximum number of boosting iterations.
...	Additional parameters.

Value

A model object.

Examples

```
sim_data <- msaenet::msaenet.sim.binomial(  
  n = 100,  
  p = 10,  
  rho = 0.6,  
  coef = rnorm(5, mean = 0, sd = 10),  
  snr = 1,  
  p.train = 0.8,  
  seed = 42  
)  
  
x_train <- xgboost_dmatrix(sim_data$x.tr, label = sim_data$y.tr)  
  
fit <- xgboost_train(  
  params = list(  
    objective = "binary:logistic",  
    eval_metric = "auc",  
    max_depth = 3,  
    eta = 0.1  
  ),  
  data = x_train,  
  nrounds = 100,  
  nthread = 1  
)  
  
fit
```

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