h2oml rfmulticlass — Random forest multiclass classification[+]

[+]This command includes features that are part of StataNow.

Description

`h2oml rfmulticlass` implements random forest multiclass classification for categorical responses. You can validate your model by using validation data or cross-validation, and you can tune hyperparameters and stop early to improve model performance on new data. This command provides only measures of performance. See [H2OML] **h2oml postestimation** for commands to compute and explain predictions, examine variable importance, and perform other postestimation analyses.

For an introduction to decision trees and the random forest method, see [H2OML] **Intro**.

Quick start

Before running the `h2oml rfmulticlass` command, an H2O cluster must be initialized and data must be imported to an H2O frame; see [H2OML] **H2O setup** and *Prepare your data for H2O machine learning in Stata* in [H2OML] **h2oml**.

Perform random forest multiclass classification of categorical response `y1` on predictors `x1` through `x100`

```
h2oml rfmulticlass y1 x1-x100
```

As above, but also report measures of fit for the validation frame named `valid`, and set an H2O random-number seed for reproducibility

```
h2oml rfmulticlass y1 x1-x100, validframe(valid) h2orseed(123)
```

As above, but instead of a validation frame, use 3-fold cross-validation to report measures of fit

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123)
```

As above, but set the number of trees to 30, the maximum tree depth to 10, and the number of predictors to sample to 15

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123) ntrees(30)     ///
    maxdepth(10) predsampvalue(15)
```

As above, but use the default exhaustive grid search to select the optimal number of trees and the maximum tree depth that minimize the log-loss metric

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123) predsampvalue(15) ///
    ntrees(10(5)100) maxdepth(3(1)10)                ///
    tune(metric(logloss))
```

As above, but use a random grid search, set an H2O random-number seed, and limit the maximum search time to 200 seconds

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123) predsampvalue(15) ///
    ntrees(10(5)100) maxdepth(3(1)10)                ///
    tune(metric(logloss) grid(random, h2orseed(456)) maxtime(200))
```

As above, but use early stopping with the default stopping log-loss metric and 5 iterations of tuning

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123) predsampvalue(15) ///
    ntrees(10(5)100) maxdepth(3(1)10)                ///
    tune(metric(logloss) grid(random, h2orseed(456)) maxtime(200)  ///
    stop(5))
```

As above, but tune the number of bins for the categorical and continuous predictors

```
h2oml rfmulticlass y1 x1-x100, cv(3) h2orseed(123) predsampvalue(15) ///
    ntrees(10(5)100) maxdepth(3(1)10) binscont(15(5)50)       ///
    binscat(500(50)1100) tune(metric(logloss)            ///
    grid(random, h2orseed(456)) maxtime(200) stop(5))
```

Menu

Statistics > H2O machine learning

Syntax

`h2oml rfmulticlass` *response_mult predictors* [, *options*]

response_mult and *predictors* correspond to column names of the current H2O frame.

options	Description
Model	
`validframe(`*framename*`)`	specify the name of the H2O frame containing the validation dataset that will be used to evaluate the performance of the model
`cv[ (# [ , `*cvmethod*` ]) ]`	specify the number of folds and method for cross-validation
`cv(`*colname*`)`	specify the name of the variable (H2O column) for cross-validation that identifies the fold to which each observation is assigned
`balanceclasses`	balance the distribution of classes (categories of the response variable) by oversampling minority classes
`h2orseed(#)`	set H2O random-number seed for random forest
`encode(`*encode_type*`)`	specify H2O encoding type for categorical predictors; default is `encode(enum)`
`auc`	enable potentially time-consuming calculation of the area under the curve and area under the precision–recall curve metrics
`stop[ (# [ , `*stop_opts*` ]) ]`	specify the number of training iterations and other criteria for stopping random forest training if the stopping metric does not improve
`maxtime(#)`	specify the maximum run time in seconds for random forest; by default, no time restriction is imposed
`scoreevery(#)`	specify that metrics be scored after every # trees during training
Hyperparameter	
`ntrees(# | `*numlist*`)`	specify the number of trees to build the random forest model; default is `ntrees(50)`
`maxdepth(# | `*numlist*`)`	specify the maximum depth of each tree; default is `maxdepth(20)`
`minobsleaf(# | `*numlist*`)`	specify the minimum number of observations per child for splitting a leaf node; default is `minobsleaf(1)`
`predsampvalue(# | `*numlist*`)`	specify rules for how to sample predictors; default is `predsampvalue(-1)`
`samprate(# | `*numlist*`)`	specify the sampling rate for randomly selecting a fraction of observations to build a tree; default is `samprate(0.632)`
`minsplitthreshold(# | `*numlist*`)`	specify the threshold for the minimum relative improvement needed for a node split; default is `minsplitthreshold(1e-05)`
`binscat(# | `*numlist*`)`	specify the number of bins to build the histogram for node splits for categorical predictors (`enum` columns in H2O); default is `binscat(1024)`
`binsroot(# | `*numlist*`)`	specify the number of bins to build the histogram for root node splits for continuous predictors (`real` and `int` columns in H2O); default is `binsroot(1024)`
`binscont(# | `*numlist*`)`	specify the number of bins to build the histogram for node splits for continuous predictors (`real` and `int` columns in H2O); default is `binscont(20)`
Tuning	
`tune(`*tune_opts*`)`	specify hyperparameter tuning options for selecting the best-performing model

Only one of `validframe()` or `cv[()]` is allowed.

If neither `validframe()` nor `cv[()]` is specified, the evaluation metrics are reported for the training dataset.

When *numlist* is specified in one or more hyperparameter options, tuning is performed for those hyperparameters.

`collect` is allowed; see **[U] 11.1.10 Prefix commands**.

See **[U] 20 Estimation and postestimation commands** for more capabilities of estimation commands.

cvmethod	Description
`random`	randomly split the training dataset into folds; the default
`modulo`	evenly split the training dataset into folds using the modulo operation
`stratify`	evenly distribute observations from the different classes of the response to all folds

stop_opts	Description
`metric(`*metric_option*`)`	specify the stopping metric for training or grid search
`tolerance(`#`)`	specify the tolerance value by which a model must improve before the training or grid search stops; default is `tolerance(1e-3)`

tune_opts	Description
`metric(`*metric_option*`)`	specify the metric for selecting the best-performing model
`grid(`*gridspec*`)`	specify whether to perform an exhaustive or random search for all hyperparameter combinations
`maxmodels(`#`)`	specify the maximum number of models considered in the grid search; default is all configurations
`maxtime(`#`)`	specify the maximum run time for the grid search in seconds; default is no time limit
`stop[(`#`[,` *stop_opts* `])]`	specify the number of iterations and other criteria for stopping random forest training if the stopping metric does not improve in the grid search
`parallel(`#`)`	specify the number of models to build in parallel during the grid search; default is `parallel(1)`, sequential model building
`nooutput`	suppress the table summarizing hyperparameter tuning

If any of `maxmodels()`, `maxtime()`, or `stop[()]` is specified, then `grid(random)` is implied.

Options

Model

`validframe()`, `cv[()]`, `balanceclasses`, `h2orseed()`, `encode()`, `auc`, `stop[()]`, `maxtime()`, and `scoreevery()`; see [H2OML] ***h2oml rf***.

Hyperparameter

`ntrees()`, `maxdepth()`, `minobsleaf()`, `predsampvalue()`, `samprate()`, `minsplitthreshold()`, `binscat()`, `binsroot()`, and `binscont()`; see [H2OML] ***h2oml rf***.

Tuning

`tune()`; see [H2OML] ***h2oml rf***.

stata.com

Remarks and examples

For examples, see *Remarks and examples* in [H2OML] ***h2oml rf***.

Stored results

`h2oml rfmulticlass` stores the following in `e()`:

Scalars

`e(N_train)`	number of observations in the training frame
`e(N_valid)`	number of observations in the validation frame (with option `validframe()`)
`e(N_cv)`	number of observations in the cross-validation (with option `cv()`)
`e(n_cvfolds)`	number of cross-validation folds (with option `cv()`)
`e(k_predictors)`	number of predictors
`e(n_class)`	number of classes
`e(n_trees)`	number of trees
`e(n_trees_a)`	actual number of trees used in random forest
`e(maxdepth)`	maximum specified tree depth
`e(depth_min_a)`	achieved minimum tree depth
`e(depth_avg_a)`	achieved average depth among trees
`e(depth_max_a)`	achieved maximum tree depth
`e(minobsleaf)`	minimum specified number of observations for a child leaf
`e(samprate)`	observation sampling rate
`e(predsampvalue)`	predictor sampling value
`e(minsplitthr)`	minimum split improvement threshold
`e(binscat)`	number of bins for categorical predictors
`e(binsroot)`	number of bins for root node
`e(binscont)`	number of bins for continuous predictors
`e(h2orseed)`	H2O random-number seed
`e(maxtime)`	maximum run time
`e(balanceclass)`	`1` if classes are balanced; `0` otherwise
`e(stop_iter)`	maximum iterations before stopping training without metric improvement
`e(stop_tol)`	tolerance for metric improvement before training stops
`e(scoreevery)`	number of trees before scoring metrics during training
`e(tune_h2orseed)`	random-number seed for tuning (with option `tune()`)
`e(tune_stop_iter)`	maximum iterations before stopping tuning without metric improvement (with option `tune()`)
`e(tune_stop_tol)`	tolerance for metric improvement before tuning stops (with option `tune()`)
`e(tune_maxtime)`	maximum run time for tuning grid search (with option `tune()`)
`e(tune_maxmodels)`	maximum number of models considered in tuning grid search (with option `tune()`)

Macros

`e(cmd)`	`h2oml rfmulticlass`
`e(cmdline)`	command as typed
`e(subcmd)`	`rfmulticlass`
`e(method)`	`randomforest`
`e(method_type)`	`classification`
`e(class_type)`	`multiclass`
`e(method_full_name)`	`Random forest multiclass classification`
`e(response)`	name of response
`e(predictors)`	names of predictors
`e(title)`	title in estimation output

e(train_frame)	name of the training frame
e(valid_frame)	name of the validation frame (with option validframe())
e(cv_method)	fold assignment method (with option cv())
e(cv_varname)	name of variable identifying cross-validation folds (with option cv())
e(encode_type)	encoding type for categorical predictors
e(stop_metric)	stopping metric for training
e(tune_grid)	grid search method used for tuning (with option tune())
e(tune_metric)	name of the tuning metric (with option tune())
e(tune_stop_metric)	stopping metric for tuning (with option tune())
e(properties)	nob noV
e(estat_cmd)	program used to implement h2omlestat
e(predict)	program used to implement h2omlpredict
e(marginsnotok)	predictions disallowed by margins
Matrices	
e(metrics)	training, validation, and cross-validation metrics
e(hyperparam_table)	minimum, maximum, and selected hyperparameter values

Also see

[H2OML] **h2oml postestimation** — Postestimation tools for h2oml gbm and h2oml rf+

[H2OML] **h2oml** — Introduction to commands for Stata integration with H2O machine learning+

[H2OML] ***h2oml rf*** — Random forest for regression and classification+

[H2OML] **h2oml rfbinclass** — Random forest binary classification+

[H2OML] **h2oml rfregress** — Random forest regression+

[H2OML] **h2oml gbmulticlass** — Gradient boosting multiclass classification+

[U] **20 Estimation and postestimation commands**