Package ‘glmnetUtils’

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elasticnet regression, a method for cross-validating the alpha parameter,
and other quality-of-life tools.
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Author Microsoft [cph],
           Hong Ooi [aut, cre]
Maintainer Hong Ooi <hongooi73@gmail.com>
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cv.glmnet

Formula interface for elastic net cross-validation with cv.glmnet

Description

Formula interface for elastic net cross-validation with cv.glmnet

Usage

cv.glmnet(x, ...)  

## Default S3 method: 
cv.glmnet(x, y, ...)  

## S3 method for class 'formula'
cv.glmnet(formula, data, alpha = 1, nfolds = 10, ..., weights = NULL, offset = NULL, subset = NULL, na.action = getOption("na.action"), drop.unused.levels = FALSE, xlev = NULL, sparse = FALSE, use.model.frame = FALSE, gamma = c(0, 0.25, 0.5, 0.75, 1), relax = FALSE)

## S3 method for class 'cv.glmnet.formula'
predict(object, newdata, na.action = na.pass, ...)  

## S3 method for class 'cv.glmnet.formula'
coef(object, ...)  

## S3 method for class 'cv.glmnet.formula'
print(x, ...)  

## S3 method for class 'cv.relaxed.formula'
predict(object, newdata, na.action = na.pass, ...)  

## S3 method for class 'cv.glmnet.formula'
coef(object, ...)
Arguments

x
For the default method, a matrix of predictor variables.

... For cv.glmnet.formula and cv.glmnet.default, other arguments to be passed to glmnet::cv.glmnet; for the predict and coef methods, arguments to be passed to their counterparts in package glmnet.

y
For the default method, a response vector or matrix (for a multinomial response).

formula
A model formula; interaction terms are allowed and will be expanded per the usual rules for linear models.

data
A data frame or matrix containing the variables in the formula.

alpha
The elastic net mixing parameter. See glmnet::glmnet for more details.

nfolds
The number of crossvalidation folds to use. See glmnet::cv.glmnet for more details.

weights
An optional vector of case weights to be used in the fitting process. If missing, defaults to an unweighted fit.

offset
An optional vector of offsets, an a priori known component to be included in the linear predictor.

subset
An optional vector specifying the subset of observations to be used to fit the model.

na.action
A function which indicates what should happen when the data contains missing values. For the predict method, na.action = na.pass will predict missing values with NA; na.omit or na.exclude will drop them.

drop.unused.levels
Should factors have unused levels dropped? Defaults to FALSE.

xlev
A named list of character vectors giving the full set of levels to be assumed for each factor.

sparse
Should the model matrix be in sparse format? This can save memory when dealing with many factor variables, each with many levels.

use.model.frame
Should the base model.frame function be used when constructing the model matrix? This is the standard method that most R modelling functions use, but has some disadvantages. The default is to avoid model.frame and construct the model matrix term-by-term; see discussion.

gamma
For cv.glmnet.formula, the values of the parameter for mixing the relaxed (non-regularised) fit with the regularized fit. Not used if relax=FALSE. Requires glmnet 3.0 or later.

relax
For cv.glmnet.formula, whether to perform a relaxed fit after the regularised one. Requires glmnet 3.0 or later.

object
For the predict and coef methods, an object of class cv.glmnet.formula.

newdata
For the predict method, a data frame containing the observations for which to calculate predictions.
Details

The `cv.glmnet` function in this package is an S3 generic with a formula and a default method. The former calls the latter, and the latter is simply a direct call to the `cv.glmnet` function in package `glmnet`. All the arguments to `glmnet:::cv.glmnet` are (or should be) supported.

There are two ways in which the matrix of predictors can be generated. The default, with `use.model.frame = FALSE`, is to process the additive terms in the formula independently. With wide datasets, this is much faster and more memory-efficient than the standard R approach which uses the `model.frame` and `model.matrix` functions. However, the resulting model object is not exactly the same as if the standard approach had been used; in particular, it lacks a bona fide `terms` object. If you require interoperability with other packages that assume the standard model object structure, set `use.model.frame = TRUE`. See discussion for more information on this topic.

The predict and coef methods are wrappers for the corresponding methods in the glmnet package. The former constructs a predictor model matrix from its `newdata` argument and passes that as the `newx` argument to `glmnet:::predict.cv.glmnet`.

Value

For `cv.glmnet.formula`, an object of class either `cv.glmnet.formula` or `cv.relaxed.formula`, based on the value of the `relax` argument. This is basically the same object created by `glmnet::cv.glmnet`, but with extra components to allow formula usage.

See Also

`glmnet::cv.glmnet`, `glmnet::predict.cv.glmnet`, `glmnet::coef.cv.glmnet`, `model.frame`, `model.matrix`

Examples

```r
cv.glmnet(mpg ~ ., data=mtcars)

cv.glmnet(Species ~ ., data=iris, family="multinomial")

# Not run:
# Leukemia example dataset from Trevor Hastie's website
download.file("https://web.stanford.edu/~hastie/glmnet/glmnetData/Leukemia.RData", "Leukemia.RData")
load("Leukemia.RData")
leuk <- do.call(data.frame, Leukemia)

## End(Not run)
```

cva.glmnet

Do elastic net cross-validation for alpha and lambda simultaneously

Description

Do elastic net cross-validation for alpha and lambda simultaneously
cva.glmnet

Usage

cva.glmnet(x, ...)

## Default S3 method:
cva.glmnet(
  x,
  y,
  alpha = seq(0, 1, len = 11)^3,
  nfolds = 10,
  foldid = sample(rep(seq_len(nfolds), length = nrow(x))),
  ...
  outerParallel = NULL,
  checkInnerParallel = TRUE
)

## S3 method for class 'formula'
cva.glmnet(
  formula,
  data,
  ...
  weights = NULL,
  offset = NULL,
  subset = NULL,
  na.action = getOption("na.action"),
  drop.unused.levels = FALSE,
  xlev = NULL,
  sparse = FALSE,
  use.model.frame = FALSE
)

## S3 method for class 'cva.glmnet'
predict(
  object,
  newx,
  alpha,
  which = match(TRUE, abs(object$alpha - alpha) < 1e-08),
  ...
)

## S3 method for class 'cva.glmnet.formula'
predict(
  object,
  newdata,
  alpha,
  which = match(TRUE, abs(object$alpha - alpha) < 1e-08),
  na.action = na.pass,
  ...
)
## S3 method for class 'cva.glmnet'
coef(
  object,
  alpha,
  which = match(TRUE, abs(object$alpha - alpha) < 1e-08),
  ...
)

## S3 method for class 'cva.glmnet.formula'
print(x, ...)

## S3 method for class 'cva.glmnet'
plot(x, ..., legend.x = xlim[1], legend.y = xlim[2], log.x = TRUE)
minlossplot(x, ...)

## S3 method for class 'cva.glmnet'
minlossplot(x, ..., cv.type = c("1se", "min"))

### Arguments

- **x**: A matrix of predictor variables; or for the plotting methods, an object returned by cva.glmnet.
- **...**: Further arguments to be passed to lower-level functions. In the case of cva.glmnet, these arguments are passed to cv.glmnet; for predict and coef, they are passed to predict.cv.glmnet; and for plot and minlossplot, to plot.
- **y**: A response vector or matrix (for a multinomial response).
- **alpha**: A vector of alpha values for which to do cross-validation. The default is a sequence of 11 values more closely spaced around alpha = 0. For the predict and coef methods, the specific value of alpha for which to return predictions/regression coefficients.
- **nfolds**: The number of cross-validation folds to use. Defaults to 10.
- **foldid**: Vector of fold IDs for cross-validation. See glmnet::cv.glmnet.
- **outerParallel**: Method of parallelising the outer loop over alpha. See 'Details' below. If NULL, the loop is run sequentially.
- **checkInnerParallel**: If the outer loop is run in parallel, check that the inner loop over lambda will not be in contention for cores.
- **formula**: A model formula; interaction terms are allowed and will be expanded per the usual rules for linear models.
- **data**: A data frame or matrix containing the variables in the formula.
- **weights**: An optional vector of case weights to be used in the fitting process. If missing, defaults to an unweighted fit.
- **offset**: An optional vector of offsets, an *a priori* known component to be included in the linear predictor.
subset  
An optional vector specifying the subset of observations to be used to fit the model.

na.action  
A function which indicates what should happen when the data contains missing values. For the predict method, na.action = na.pass will predict missing values with NA; na.omit or na.exclude will drop them.

drop.unused.levels  
Should factors have unused levels dropped? Defaults to FALSE.

xlev  
A named list of character vectors giving the full set of levels to be assumed for each factor.

sparse  
Should the model matrix be in sparse format? This can save memory when dealing with many factor variables, each with many levels.

use.model.frame  
Should the base model.frame function be used when constructing the model matrix? This is the standard method that most R modelling functions use, but has some disadvantages. The default is to avoid model.frame and construct the model matrix term-by-term; see discussion.

object  
For the predict and coef methods, an object returned by cva.glmnet.

newx  
For the predict method, a matrix of predictor variables.

which  
An alternative way of specifying alpha; the index number of the desired value within the alpha vector. If both which and alpha are supplied, the former takes precedence.

newdata  
For the predict and coef methods, a data frame containing the observations for which to calculate predictions.

legend.x, legend.y  
Location for the legend. Defaults to the top-left corner of the plot. Set either of these to NULL to omit the legend.

log.x  
Whether to plot the X-axis (lambda) on the log scale. Defaults to TRUE, which for most lambda sequences produces a more reasonable looking plot. If your lambda sequence includes zero, set this to FALSE.

cv.type  
For minlossplot, which cross-validated loss value to plot for each value of alpha. This can be either "min" which is the minimum loss, or "1se" which is the highest loss within 1 standard error of the minimum. The default is "1se".

Details

The cva.glmnet function does simultaneous cross-validation for both the alpha and lambda parameters in an elastic net model. The procedure is as outlined in the documentation for glmnet::cv.glmnet: it creates a vector foldid allocating the observations into folds, and then calls cv.glmnet in a loop over different values of alpha, but the same values of foldid each time.

Optionally this loop over alpha can be parallelised; currently, cva.glmnet knows about two methods of doing so:

- Via parLapply in the parallel package. To use this, set outerParallel to a valid cluster object created by makeCluster.
cva.glmnet

- Via rxExec as supplied by Microsoft R Server’s RevoScaleR package. To use this, set outerParallel to a valid compute context created by RxComputeContext, or a character string specifying such a context.

If the outer loop is run in parallel, cva.glmnet can check if the inner loop (over lambda) is also set to run in parallel, and disable this if it would lead to contention for cores. This is done if it is likely that the parallelisation is local on a multicore machine, ie if outerParallel is a SOCKcluster object running on "localhost", or if the RevoScaleR compute context is local parallel.

There are two ways in which the matrix of predictors can be generated. The default, with use.model.frame = FALSE, is to process the additive terms in the formula independently. With wide datasets, this is much faster and more memory-efficient than the standard R approach which uses the model.frame and model.matrix functions. However, the resulting model object is not exactly the same as if the standard approach had been used; in particular, it lacks a bona fide terms object. If you require interoperability with other packages that assume the standard model object structure, set use.model.frame = TRUE. See discussion for more information on this topic.

The predict method computes predictions for a specific alpha value given a cva.glmnet object. It looks up the supplied alpha (possibly supplied indirectly via the which argument) in the object’s stored alpha vector, and calls glmnet:::predict.cv.glmnet on the corresponding cv.glmnet fit. All the arguments to that function are (or should be) supported.

The coef method is similar, returning the coefficients for the selected alpha value via glmnet:::coef.cv.glmnet.

The plot method for cva.glmnet objects plots the average cross-validated loss by lambda, for each value of alpha. Each line represents one cv.glmnet fit, corresponding to one value of alpha. Note that the specific lambda values can vary substantially by alpha.

The minlossplot function gives the best (lowest) cross-validated loss for each value of alpha.

Value

For cva.glmnet.default, an object of class cva.glmnet. This is a list containing the following:

- alpha The vector of alpha values
- nfolds The number of folds
- modlist A list of cv.glmnet objects, containing the cross-validation results for each value of alpha

The function cva.glmnet.formula adds a few more components to the above, to facilitate working with formulas.

For the predict method, a vector or matrix of predicted values.

For the coef method, a vector of regularised regression coefficients.

See Also

glmnet::cv.glmnet
glmnet:::predict.cv.glmnet, glmnet:::coef.cv.glmnet
cva.glmnet, glmnet::cv.glmnet, plot
Examples

cva <- cva.glmnet(mpg ~ ., data=mtcars)
predict(cva, mtcars, alpha=1)

## Not run:

# Leukemia example dataset from Trevor Hastie's website
download.file("https://web.stanford.edu/~hastie/glmnet/glmnetData/Leukemia.RData",
 "Leukemia.RData")
load("Leukemia.RData")
leuk <- do.call(data.frame, Leukemia)
leuk.cva <- cva.glmnet(y ~ ., leuk, family="binomial")
leuk.pred <- predict(leuk.cva, leuk, which=6)

## End(Not run)

---

**glmnet**  
*Formula interface for elastic net modelling with glmnet*

**Description**

Formula interface for elastic net modelling with glmnet

**Usage**

```r
glmnet(x, ...)
```

## Default S3 method:

```r
glmnet(x, y, ...)
```

## S3 method for class 'formula'

```r
glmnet(
  formula,
  data,
  family = c("gaussian", "binomial", "poisson", "multinomial", "cox", "mgaussian"),
  alpha = 1,
  ...,
  weights = NULL,
  offset = NULL,
  subset = NULL,
  na.action =getOption("na.action"),
  drop.unused.levels = FALSE,
  xlev = NULL,
  sparse = FALSE,
  use.model.frame = FALSE,
  relax = FALSE
)
```
Arguments

- **x**: For the default method, a matrix of predictor variables.
- **...**: For glmnet.formula and glmnet.default, other arguments to be passed to glmnet::glmnet; for the predict and coef methods, arguments to be passed to their counterparts in package glmnet.
- **y**: For the default method, a response vector or matrix (for a multinomial response).
- **formula**: A model formula; interaction terms are allowed and will be expanded per the usual rules for linear models.
- **data**: A data frame or matrix containing the variables in the formula.
- **family**: The model family. See glmnet::glmnet for how to specify this argument.
- **alpha**: The elastic net mixing parameter. See glmnet::glmnet for more details.
- **weights**: An optional vector of case weights to be used in the fitting process. If missing, defaults to an unweighted fit.
- **offset**: An optional vector of offsets, an a priori known component to be included in the linear predictor.
- **subset**: An optional vector specifying the subset of observations to be used to fit the model.
**na.action**  
A function which indicates what should happen when the data contains missing values. For the predict method, na.action = na.pass will predict missing values with NA; na.omit or na.exclude will drop them.

**drop.unused.levels**  
Should factors have unused levels dropped? Defaults to FALSE.

**xlev**  
A named list of character vectors giving the full set of levels to be assumed for each factor.

**sparse**  
Should the model matrix be in sparse format? This can save memory when dealing with many factor variables, each with many levels.

**use.model.frame**  
Should the base model.frame function be used when constructing the model matrix? This is the standard method that most R modelling functions use, but has some disadvantages. The default is to avoid model.frame and construct the model matrix term-by-term; see discussion.

**relax**  
For glmnet.formula, whether to perform a relaxed (non-regularised) fit after the regularised one. Requires glmnet 3.0 or later.

**object**  
For the predict and coef methods, an object of class glmnet.formula.

**newdata**  
For the predict method, a data frame containing the observations for which to calculate predictions.

**digits**  
Significant digits in printed output.

**print.deviance.ratios**  
Whether to print the table of deviance ratios, as per glmnet::print.glmnet.

---

**Details**

The glmnet function in this package is an S3 generic with a formula and a default method. The former calls the latter, and the latter is simply a direct call to the glmnet function in package glmnet. All the arguments to glmnet::glmnet are (or should be) supported.

There are two ways in which the matrix of predictors can be generated. The default, with use.model.frame = FALSE, is to process the additive terms in the formula independently. With wide datasets, this is much faster and more memory-efficient than the standard R approach which uses the model.frame and model.matrix functions. However, the resulting model object is not exactly the same as if the standard approach had been used; in particular, it lacks a bona fide terms object. If you require interoperability with other packages that assume the standard model object structure, set use.model.frame = TRUE. See discussion for more information on this topic.

The predict and coef methods are wrappers for the corresponding methods in the glmnet package. The former constructs a predictor model matrix from its newdata argument and passes that as the newx argument to glmnet:::predict.glmnet.

---

**Value**

For glmnet.formula, an object of class either glmnet.formula or relaxed.formula, based on the value of the relax argument. This is basically the same object created by glmnet::glmnet, but with extra components to allow formula usage.
glmnet.model.matrix

See Also

glmnet::glmnet, glmnet::predict.glmnet, glmnet::coef.glmnet, model.frame, model.matrix

Examples

glmnet(mpg ~ ., data=mtcars)

glmnet(Species ~ ., data=iris, family="multinomial")

## Not run:

# Leukemia example dataset from Trevor Hastie's website
download.file("https://web.stanford.edu/~hastie/glmnet/glmnetData/Leukemia.RData", "Leukemia.RData")
load("Leukemia.Rdata")
leuk <- do.call(data.frame, Leukemia)
glmnet(y ~ ., leuk, family="binomial")

## End(Not run)

glmnet.model.matrix

Model matrix options for glmnet

Description

This page describes the options available for generating the model matrix.

Details

There are two ways in which glmnetUtils can generate a model matrix out of a formula and data frame. The first is to use the standard R machinery comprising model.frame and model.matrix; and the second is to build the matrix one variable at a time. These options are discussed and contrasted below.

Using model.frame

This is the simpler option, and the one that is most compatible with other R modelling functions. The model.frame function takes a formula and data frame and returns a model frame: a data frame with special information attached that lets R make sense of the terms in the formula. For example, if a formula includes an interaction term, the model frame will specify which columns in the data relate to the interaction, and how they should be treated. Similarly, if the formula includes expressions like $\exp(x)$ or $I(x^2)$ on the RHS, model.frame will evaluate these expressions and include them in the output.

The major disadvantage of using model.frame is that it generates a terms object, which encodes how variables and interactions are organised. One of the attributes of this object is a matrix with one row per variable, and one column per main effect and interaction. At minimum, this is (approximately) a $p \times p$ square matrix where $p$ is the number of main effects in the model. For wide datasets with $p > 10000$, this matrix can approach or exceed a gigabyte in size. Even if there is...
enough memory to store such an object, generating the model matrix can take a significant amount of time.

Another issue with the standard R approach is the treatment of factors. Normally, \texttt{model.matrix} will turn an \( N \)-level factor into an indicator matrix with \( N - 1 \) columns, with one column being dropped. This is necessary for unregularised models as fit with \texttt{lm} and \texttt{glm}, since the full set of \( N \) columns is linearly dependent. With the usual treatment contrasts, the interpretation is that the dropped column represents a baseline level, while the coefficients for the other columns represent the difference in the response relative to the baseline.

This may not be appropriate for a regularised model as fit with glmnet. The regularisation procedure shrinks the coefficients towards zero, which forces the estimated differences from the baseline to be smaller. But this only makes sense if the baseline level was chosen beforehand, or is otherwise meaningful as a default; otherwise it is effectively making the levels more similar to an arbitrarily chosen level.

Manually building the model matrix

To deal with the problems above, glmnetUtils by default will avoid using \texttt{model.frame}, instead building up the model matrix term-by-term. This avoids the memory cost of creating a \texttt{terms} object, and can be noticeably faster than the standard approach. It will also include one column in the model matrix for all levels in a factor; that is, no baseline level is assumed. In this situation, the coefficients represent differences from the overall mean response, and shrinking them to zero is meaningful (usually).

This works in an additive fashion, ie the formula \(~ a + b : c + d \times e\) is treated as consisting of three terms, \( a, b : c \) and \( d \times e \) each of which is processed independently of the others. A dot in the formula includes all main effect terms, ie \(~ . + a : b + f(x)\) expands to \(~ a + b + x + a : b + f(x)\) (assuming \( a, b \) and \( x \) are the only columns in the data). Note that a formula like \(~ (a + b) + (c + d)\) will be treated as two terms, \( a + b \) and \( c + d \).

The code can handle fairly complex formulas, but it is not as sophisticated as base \texttt{model.frame} and \texttt{model.matrix}. In particular, terms that are to be omitted from the model must be at the end of the formula: \(~ . - c\) works, but not \(~ - c + .\).

**Description**

Some quality-of-life functions to streamline the process of fitting elastic net models with the \texttt{glmnet} package, specifically:

- \texttt{glmnet.formula} provides a formula/data frame interface to \texttt{glmnet}.
- \texttt{cv.glmnet.formula} does a similar thing for \texttt{cv.glmnet}.
- Methods for \texttt{predict} and \texttt{coef} for both the above.
- A function \texttt{cva.glmnet} to choose both the alpha and lambda parameters via cross-validation, following the approach described in the help page for \texttt{cv.glmnet}. Optionally does the cross-validation in parallel.
- Methods for \texttt{plot}, \texttt{predict} and \texttt{coef} for the above.
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