Package ‘multiview’

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multiview-package .............................................. 3
coef.cv.multiview .............................................. 3
coef.multiview .................................................. 4
coef_ordered .................................................... 5
coef_ordered.cv.multiview ..................................... 6
coef_ordered.multiview ....................................... 7
collapse_named_lists ......................................... 9
cox_obj_function .............................................. 9
cv.multiview ..................................................... 10
dev_function ..................................................... 14
eenet.fit .......................................................... 15
get_cox_lambda_max .......................................... 17
get_eta ............................................................ 18
get_start .......................................................... 19
make_row .......................................................... 20
multiview ......................................................... 20
multiview.control .............................................. 25
multiview.cox.fit ............................................. 26
multiview.cox.path ............................................ 29
multiview.fit ..................................................... 33
multiview.path .................................................. 36
obj_function ..................................................... 39
pen_function ..................................................... 40
plot.multiview ................................................... 41
predict.cv.multiview ......................................... 42
predict.multiview .............................................. 43
reshape_x_to_xlist ............................................ 45
response.coxnet ............................................... 45
select_matrix_list_columns .................................. 46
to_nvar_index ................................................... 46
to_xlist_index ................................................... 47
view.contribution .............................................. 47
weighted_mean_sd .............................................. 50

Index  51
Description

This package performs a version of early and late fusion of multiple views using penalized generalized regression.

coef.cv.multiview

Extract coefficients from a cv.multiview object

Description

Extract coefficients from a cv.multiview object

Usage

```r
## S3 method for class 'cv.multiview'
coef(object, s = c("lambda.1se", "lambda.min"), ...)
```

Arguments

- `object`: Fitted "cv.multiview" object.
- `s`: Value(s) of the penalty parameter lambda at which predictions are required. Default is the value s="lambda.1se" stored on the CV object. Alternatively s="lambda.min" can be used. If s is numeric, it is taken as the value(s) of lambda to be used. (For historical reasons we use the symbol 's' rather than 'lambda' to reference this parameter.)
- `...`: This is the mechanism for passing arguments like x= when exact=TRUE; see exact argument.

Value

the matrix of coefficients for specified lambda.

Examples

```r
set.seed(1)
x = matrix(rnorm(100*20), 100, 20)
z = matrix(rnorm(100*20), 100, 20)
U = matrix(rnorm(100*5), 100, 5)
for (m in seq(5)){
    u = rnorm(100)
x[, m] = x[, m] + u
z[, m] = z[, m] + u
```
\[ U[, m] = U[, m] + u \]
\[ x = \text{scale}(x, \text{center} = \text{TRUE}, \text{scale} = \text{FALSE}) \]
\[ z = \text{scale}(z, \text{center} = \text{TRUE}, \text{scale} = \text{FALSE}) \]
\[ \text{beta}_U = \text{c}(\text{rep}(0.1, 5)) \]
\[ y = U \times \text{beta}_U + 0.1 \times \text{rnorm}(100) \]
\[ \text{fit1} = \text{cv.multiview}(\text{list}(x=x, z=z), y, \text{rho} = 0.3) \]
\[ \text{coef(fit1, s="lambda.min")} \]

# Binomial
\[ \text{by} = 1 \times (y > \text{median}(y)) \]
\[ \text{fit2} = \text{cv.multiview}(\text{list}(x=x, z=z), \text{by}, \text{family} = \text{binomial()}, \text{rho} = 0.9) \]
\[ \text{coef(fit2, s="lambda.min")} \]

# Poisson
\[ \text{py} = \text{matrix}(\text{rpois}(100, \text{exp}(y))) \]
\[ \text{fit3} = \text{cv.multiview}(\text{list}(x=x, z=z), \text{py}, \text{family} = \text{poisson()}, \text{rho} = 0.6) \]
\[ \text{coef(fit3, s="lambda.min")} \]

---

**coef.multiview**

*Extract coefficients from a multiview object*

**Description**

Extract coefficients from a multiview object

**Usage**

```r
## S3 method for class 'multiview'
coef(object, s = NULL, ...)```

**Arguments**

- **object**: Fitted "multiview" object.
- **s**: Value(s) of the penalty parameter lambda at which predictions are required. Default is the entire sequence used to create the model.
- **...**: This is the mechanism for passing arguments like x= when exact=TRUE; see exact argument.

**Value**

a matrix of coefficients for specified lambda.
Examples

# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 10), 100, 10)
y = rnorm(100)
fit1 = multiview(list(x=x, z=z), y, rho = 0)
coef(fit1, s=0.1)

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x, z=z), by, family = binomial(), rho=0.5)
coef(fit2, s=0.1)

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x, z=z), py, family = poisson(), rho=0.5)
coef(fit3, s=0.1)

doctors

coef_ordered

Extract an ordered list of standardized coefficients from a multiview or cv.multiview object

description

This function extracts a ranked list of coefficients after the coefficients are standardized by the standard deviation of the corresponding features. The ranking is based on the magnitude of the standardized coefficients. It also outputs the data view to which each coefficient belongs.

Usage

coef_ordered(object, ...)

Arguments

object Fitted "multiview" or "cv.multiview" object. coefficients are required.

Details

The output table shows from left to right the data view each coefficient comes from, the column index of the feature in the corresponding data view, the coefficient after being standardized by the standard deviation of the corresponding feature, and the original fitted coefficient.

Value

data frame of consisting of view name, view column, coefficient and standardized coefficient ordered by rank of standardized coefficient.
Examples

```r
# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 10), 100, 10)
y = rnorm(100)
fit1 = multiview(list(x=x, z=z), y, rho = 0)
coef_ordered(fit1, s=0.1)

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x, z=z), by, family = binomial(), rho=0.5)
coef_ordered(fit2, s=0.1)

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x, z=z), py, family = poisson(), rho=0.5)
coef_ordered(fit3, s=0.1)
```

---

c coef_ordered.cv.multiview

*Extract an ordered list of standardized coefficients from a cv.multiview object*

Description

This function extracts a ranked list of coefficients after the coefficients are standardized by the standard deviation of the corresponding features. The ranking is based on the magnitude of the standardized coefficients. It also outputs the data view to which each coefficient belongs.

Usage

```r
## S3 method for class 'cv.multiview'
coef_ordered(object, s = c("lambda.1se", "lambda.min"), ...)
```

Arguments

- **object**: Fitted "cv.multiview" object.
- **s**: Value(s) of the penalty parameter lambda at which predictions are required. Default is the value s="lambda.1se" stored on the CV object. Alternatively s="lambda.min" can be used. If s is numeric, it is taken as the value(s) of lambda to be used. (For historical reasons we use the symbol 's' rather than 'lambda' to reference this parameter.)
- **...**: This is the mechanism for passing arguments like x= when exact=TRUE; see exact argument.
The output table shows from left to right the data view each coefficient comes from, the column index of the feature in the corresponding data view, the coefficient after being standardized by the standard deviation of the corresponding feature, and the original fitted coefficient.

Value

data frame of consisting of view name, view column, coefficient and standardized coefficient ordered by rank of standardized coefficient.

Examples

code

```r
set.seed(1)
x = matrix(rnorm(100*20), 100, 20)
z = matrix(rnorm(100*20), 100, 20)
U = matrix(rnorm(100*5), 100, 5)
for (m in seq(5)){
  u = rnorm(100)
x[, m] = x[, m] + u
z[, m] = z[, m] + u
U[, m] = U[, m] + u}
x = scale(x, center = TRUE, scale = FALSE)
z = scale(z, center = TRUE, scale = FALSE)
beta_U = c(rep(0.1, 5))
y = U %*% beta_U + 0.1 * rnorm(100)
fit1 = cv.multiview(list(x=x,z=z), y, rho = 0.3)
coef_ordered(fit1, s="lambda.min")

# Binomial
by = 1 * (y > median(y))
fit2 = cv.multiview(list(x=x,z=z), by, family = binomial(), rho = 0.9)
coef_ordered(fit2, s="lambda.min")

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = cv.multiview(list(x=x,z=z), py, family = poisson(), rho = 0.6)
coef_ordered(fit3, s="lambda.min")
```

---

title: coef_ordered.multiview

**Extract an ordered list of standardized coefficients from a multiview object**

**Description**

This function extracts a ranked list of coefficients after the coefficients are standardized by the standard deviation of the corresponding features. The ranking is based on the magnitude of the standardized coefficients. It also outputs the data view to which each coefficient belongs.
Usage

```r
## S3 method for class 'multiview'
coef_ordered(object, s = NULL, ...)
```

Arguments

- `object`: Fitted "multiview" object.
- `s`: Value(s) of the penalty parameter lambda at which coefficients are required.
- `...`: This is the mechanism for passing arguments like `x=` when `exact=TRUE`; see `exact` argument.

Details

The output table shows from left to right the data view each coefficient comes from, the column index of the feature in the corresponding data view, the coefficient after being standardized by the standard deviation of the corresponding feature, and the original fitted coefficient.

Value

data frame of consisting of view name, view column, coefficient and standardized coefficient ordered by rank of standardized coefficient.

Examples

```r
# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 10), 100, 10)
y = rnorm(100)
fit1 = multiview(list(x=x, z=z), y, rho = 0)
coef_ordered(fit1, s=0.1)

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x, z=z), by, family = binomial(), rho=0.5)
coef_ordered(fit2, s=0.1)

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x, z=z), py, family = poisson(), rho=0.5)
coef_ordered(fit3, s=0.1)
```
**collapse_named_lists**  
*Collapse a list of named lists into one list with the same name*

**Description**
Collapse a list of named lists into one list with the same name.

**Usage**
```r
collapse_named_lists(in_list)
```

**Arguments**
- `in_list`: a list of named lists all with same names (not checked for efficiency)

**Value**
a single list with named components all concatenated

---

**cox_obj_function**  
*Elastic net objective function value for Cox regression model*

**Description**
Returns the elastic net objective function value for Cox regression model.

**Usage**
```r
cox_obj_function(  
y,  
pred,  
weights,  
lambda,  
alpha,  
coefficients,  
vp,  
view_components,  
rho  
)
```
Arguments

`y`  
Survival response variable, must be a `Surv` or `stratifySurv` object.

`pred`  
Model’s predictions for `y`.

`weights`  
Observation weights.

`lambda`  
A single value for the `lambda` hyperparameter.

`alpha`  
The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$.

`coefficients`  
The model’s coefficients.

`vp`  
Penalty factors for each of the coefficients.

`view_components`  
a list of lists containing indices of coefficients and associated covariate (view) pairs

`rho`  
the fusion parameter

cv.multiview  
Perform k-fold cross-validation for cooperative learning

Description

Does k-fold cross-validation (CV) for multiview and produces a CV curve.

Usage

cv.multiview(
  x_list,  
y,  
family = gaussian(),  
rho = 0,  
weights = NULL,  
offset = NULL,  
lambda = NULL,  
type.measure = c("default", "mse", "deviance", "class", "auc", "mae", "C"),  
nfolds = 10,  
foldid = NULL,  
alignment = c("lambda", "fraction"),  
grouped = TRUE,  
keep = FALSE,  
trace.it = 0,  
...  
)
Arguments

- **x_list**: a list of x matrices with same number of rows nobs
- **y**: the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
- **family**: A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. Default is `stats::gaussian`. (See `stats::family` for details on family functions.)
- **rho**: the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.
- **weights**: Observation weights; defaults to 1 per observation
- **offset**: Offset vector (matrix) as in `multiview`
- **lambda**: A user supplied lambda sequence, default NULL. Typical usage is to have the program compute its own lambda sequence. This sequence, in general, is different from that used in the `glmnet::glmnet()` call (named lambda). Note that this is done for the full model (master sequence), and separately for each fold. The fits are then aligned using the glmnet lambda sequence associated with the master sequence (see the alignment argument for additional details). Adapting lambda for each fold leads to better convergence. When lambda is supplied, the same sequence is used everywhere, but in some GLMs can lead to convergence issues.
- **type.measure**: loss to use for cross-validation. Currently five options, not all available for all models. The default is `type.measure="deviance"`, which uses squared-error for gaussian models (a.k.a `type.measure="mse"` there), deviance for logistic and poisson regression, and partial-likelihood for the Cox model. `type.measure="class"` applies to binomial and multinomial logistic regression only, and gives misclassification error. `type.measure="auc"` is for two-class logistic regression only, and gives area under the ROC curve. `type.measure="mse"` or `type.measure="mae"` (mean absolute error) can be used by all models except the "cox"; they measure the deviation from the fitted mean to the response. `type.measure="C"` is Harrel's concordance measure, only available for cox models.
- **nfolds**: number of folds - default is 10. Although nfolds can be as large as the sample size (leave-one-out CV), it is not recommended for large datasets. Smallest value allowable is nfolds=3
- **foldid**: an optional vector of values between 1 and nfolds identifying what fold each observation is in. If supplied, nfolds can be missing.
- **alignment**: This is an experimental argument, designed to fix the problems users were having with CV, with possible values "lambda" (the default) else "fraction". With "lambda" the lambda values from the master fit (on all the data) are used to line up the predictions from each of the folds. In some cases this can give strange values, since the effective lambda values in each fold could be quite different. With "fraction" we line up the predictions in each fold according to the fraction of progress along the regularization. If in the call a lambda argument is also provided, alignment="fraction" is ignored (with a warning).
grouped

This is an experimental argument, with default TRUE, and can be ignored by most users. For all models except the "cox", this refers to computing nfolds separate statistics, and then using their mean and estimated standard error to describe the CV curve. If grouped=FALSE, an error matrix is built up at the observation level from the predictions from the nfold fits, and then summarized (does not apply to type.measure="auc"). For the "cox" family, grouped=TRUE obtains the CV partial likelihood for the Kth fold by subtraction; by subtracting the log partial likelihood evaluated on the full dataset from that evaluated on the on the (K-1)/K dataset. This makes more efficient use of risk sets. With grouped=FALSE the log partial likelihood is computed only on the Kth fold.

keep

If keep=TRUE, a prevalidated array is returned containing fitted values for each observation and each value of lambda. This means these fits are computed with this observation and the rest of its fold omitted. The foldid vector is also returned. Default is keep=FALSE.

trace.it

If trace.it=1, then progress bars are displayed; useful for big models that take a long time to fit.

... Other arguments that can be passed to multiview

Details

The current code can be slow for "large" data sets, e.g. when the number of features is larger than 1000. It can be helpful to see the progress of multiview as it runs; to do this, set trace.it = 1 in the call to multiview or cv.multiview. With this, multiview prints out its progress along the way. One can also pre-filter the features to a smaller set, using the exclude option, with a filter function.

If there are missing values in the feature matrices: we recommend that you center the columns of each feature matrix, and then fill in the missing values with 0.

For example,

```r
x <- scale(x,TRUE,FALSE)
x[is.na(x)] <- 0
z <- scale(z,TRUE,FALSE)
z[is.na(z)] <- 0
```

Then run multiview in the usual way. It will exploit the assumed shared latent factors to make efficient use of the available data.

The function runs multiview nfolds+1 times; the first to get the lambda sequence, and then the remainder to compute the fit with each of the folds omitted. The error is accumulated, and the average error and standard deviation over the folds is computed. Note that cv.multiview does NOT search for values for rho. A specific value should be supplied, else rho=0 is assumed by default. If users would like to cross-validate rho as well, they should call cv.multiview with a pre-computed vector foldid, and then use this same fold vector in separate calls to cv.multiview with different values of rho.

Value

an object of class "cv.multiview" is returned, which is a list with the ingredients of the cross-validation fit.
lambda

the values of lambda used in the fits.

cvm

The mean cross-validated error - a vector of length length(lambda).

cvsd

estimate of standard error of cvm.

cvup

upper curve = cvm+cvsd.

cvlo

lower curve = cvm-cvsd.
nzero

number of non-zero coefficients at each lambda.

name

a text string indicating type of measure (for plotting purposes).

multiview.fit

a fitted multiview object for the full data.

lambda.min

value of lambda that gives minimum cvm.

lambda.1se

largest value of lambda such that error is within 1 standard error of the minimum.

fit.preval

if keep=TRUE, this is the array of prevalidated fits. Some entries can be NA, if that and subsequent values of lambda are not reached for that fold.

cvship

if keep=TRUE, the fold assignments used.

index

a one column matrix with the indices of lambda.min and lambda.1se in the sequence of coefficients, fits etc.

Examples

# Gaussian
# Generate data based on a factor model
set.seed(1)
x = matrix(rnorm(100*20), 100, 20)
z = matrix(rnorm(100*20), 100, 20)
U = matrix(rnorm(100*5), 100, 5)
for (m in seq(5)){
  u = rnorm(100)
x[, m] = x[, m] + u
z[, m] = z[, m] + u
U[, m] = U[, m] + u}
x = scale(x, center = TRUE, scale = FALSE)
z = scale(z, center = TRUE, scale = FALSE)
beta_U = c(rep(0.1, 5))
y = U %*% beta_U + 0.1 * rnorm(100)
fit1 = cv.multiview(list(x=x,z=z), y, rho = 0.3)

# plot the cross-validation curve
plot(fit1)

# extract coefficients
coef(fit1, s="lambda.min")

# extract ordered coefficients
coef_ordered(fit1, s="lambda.min")

# make predictions
predict(fit1, newx = list(x[1:5,],z[1:5,]), s="lambda.min")
# Binomial

by = 1 * (y > median(y))
fit2 = cv.multiview(list(x=x, z=z), by, family = binomial(), rho = 0.9)
predict(fit2, newx = list(x[1:5,], z[1:5,]), s = "lambda.min", type = "response")
plot(fit2)
coef(fit2, s="lambda.min")
coef_ordered(fit2, s="lambda.min")

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = cv.multiview(list(x=x, z=z), py, family = poisson(), rho = 0.6)
predict(fit3, newx = list(x[1:5,], z[1:5,]), s = "lambda.min", type = "response")
plot(fit3)
coef(fit3, s="lambda.min")
coef_ordered(fit3, s="lambda.min")

---

dev_function  

Elastic net deviance value

Description

Returns the elastic net deviance value.

Usage

dev_function(y, mu, weights, family)

Arguments

y  
Quantitative response variable.

mu  
Model’s predictions for y.

weights  
Observation weights.

family  
A description of the error distribution and link function to be used in the model. This is the result of a call to a family function.
elnet.fit

Solve weighted least squares (WLS) problem for a single lambda value

Description
Solves the weighted least squares (WLS) problem for a single lambda value. Internal function that users should not call directly.

Usage

```r
elnet.fit(
  x,
  y,
  weights,
  lambda,
  alpha = 1,
  intercept = TRUE,
  thresh = 1e-07,
  maxit = 1e+05,
  penalty.factor = rep(1, nvars),
  exclude = c(),
  lower.limits = -Inf,
  upper.limits = Inf,
  warm = NULL,
  from.glmnet.fit = FALSE,
  save.fit = FALSE
)
```

Arguments

- **x**: Input matrix, of dimension nobs x nvars; each row is an observation vector. If it is a sparse matrix, it is assumed to be unstandardized. It should have attributes `xm` and `xs`, where `xm(j)` and `xs(j)` are the centering and scaling factors for variable j respectively. If it is not a sparse matrix, it is assumed that any standardization needed has already been done.

- **y**: Quantitative response variable.

- **weights**: Observation weights. `elnet.fit` does NOT standardize these weights.

- **lambda**: A single value for the lambda hyperparameter.

- **alpha**: The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$. The penalty is defined as

$$
(1 - \alpha)/2||\beta||^2_2 + \alpha||\beta||_1.
$$

`alpha=1` is the lasso penalty, and `alpha=0` the ridge penalty.

- **intercept**: Should intercept be fitted (default=TRUE) or set to zero (FALSE)?
thresh  Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null deviance. Default value is $1e^{-7}$.

maxit  Maximum number of passes over the data; default is $10^5$. (If a warm start object is provided, the number of passes the warm start object performed is included.)

penalty.factor  Separate penalty factors can be applied to each coefficient. This is a number that multiplies lambda to allow differential shrinkage. Can be 0 for some variables, which implies no shrinkage, and that variable is always included in the model. Default is 1 for all variables (and implicitly infinity for variables listed in exclude). Note: the penalty factors are internally rescaled to sum to nvars.

exclude  Indices of variables to be excluded from the model. Default is none. Equivalent to an infinite penalty factor.

lower.limits  Vector of lower limits for each coefficient; default -Inf. Each of these must be non-positive. Can be presented as a single value (which will then be replicated), else a vector of length nvars.

upper.limits  Vector of upper limits for each coefficient; default Inf. See lower.limits.

warm  Either a glmnetfit object or a list (with names beta and a0 containing coefficients and intercept respectively) which can be used as a warm start. Default is NULL, indicating no warm start. For internal use only.

from.glmnet.fit  Was elnet.fit() called from glmnet.fit()? Default is FALSE. This has implications for computation of the penalty factors.

save.fit  Return the warm start object? Default is FALSE.

Details

WARNING: Users should not call elnet.fit directly. Higher-level functions in this package call elnet.fit as a subroutine. If a warm start object is provided, some of the other arguments in the function may be overridden.

elnet.fit is essentially a wrapper around a C++ subroutine which minimizes

$$\frac{1}{2} \sum w_i (y_i - X_i^T \beta)^2 + \sum \lambda \gamma_j [(1 - \alpha)/2 \beta^2 + \alpha |\beta|],$$

over $\beta$, where $\gamma_j$ is the relative penalty factor on the jth variable. If intercept = TRUE, then the term in the first sum is $w_i (y_i - \beta_0 - X_i^T \beta)^2$, and we are minimizing over both $\beta_0$ and $\beta$.

None of the inputs are standardized except for penalty.factor, which is standardized so that they sum up to nvars.

Value

An object with class "glmnetfit" and "glmnet". The list returned has the same keys as that of a glmnet object, except that it might have an additional warm_fit key.

a0  Intercept value.

beta  A nvars x 1 matrix of coefficients, stored in sparse matrix format.
get_cox_lambda_max

df
The number of nonzero coefficients.
dim
Dimension of coefficient matrix.
lambda
Lambda value used.
dev.ratio
The fraction of (null) deviance explained. The deviance calculations incorporate
weights if present in the model. The deviance is defined to be 2*(loglike_sat -
loglike), where loglike_sat is the log-likelihood for the saturated model (a model
with a free parameter per observation). Hence dev.ratio=1-dev/nulldev.
nulldev
Null deviance (per observation). This is defined to be 2*(loglike_sat -loglike(Null)).
The null model refers to the intercept model.
npasses
Total passes over the data.
jerr
Error flag, for warnings and errors (largely for internal debugging).
offset
Always FALSE, since offsets do not appear in the WLS problem. Included for
compatibility with glmnet output.
call
The call that produced this object.
nobs
Number of observations.
warm_fit
If save.fit=TRUE, output of C++ routine, used for warm starts. For internal use
only.

get_cox_lambda_max

Description

Return the lambda max value for Cox regression model, used for computing initial lambda values.
For internal use only.

Usage

get_cox_lambda_max(
  x,
  y,
  alpha,
  weights = rep(1, nrow(x)),
  offset = rep(0, nrow(x)),
  exclude = c(),
  vp = rep(1, ncol(x))
)

Arguments

x
Input matrix, of dimension nobs x nvars; each row is an observation vector. If it
is a sparse matrix, it is assumed to be unstandardized. It should have attributes xm
and xs, where xm(j) and xs(j) are the centering and scaling factors for variable
j respectively. If it is not a sparse matrix, it is assumed to be standardized.
get_eta

y Survival response variable, must be a Surv or stratifySurv object.
alpha The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$.
weights Observation weights.
offset Offset for the model. Default is a zero vector of length nrow(y).
exclude Indices of variables to be excluded from the model.
vp Separate penalty factors can be applied to each coefficient.

Details
This function is called by cox.path for the value of lambda max.
When x is not sparse, it is expected to already by centered and scaled. When x is sparse, the function will get its attributes xm and xs for its centering and scaling factors. The value of lambda_max changes depending on whether x is centered and scaled or not, so we need xm and xs to get the correct value.

get_eta  

Helper function to get etas (linear predictions)

Description
Given x, coefficients and intercept, return linear predictions. Wrapper that works with both regular and sparse x. Only works for single set of coefficients and intercept.

Usage
get_eta(x, beta, a0)

Arguments
x Input matrix, of dimension nobs x nvars; each row is an observation vector. If it is a sparse matrix, it is assumed to be unstandardized. It should have attributes xm and xs, where xm(j) and xs(j) are the centering and scaling factors for variable j respectively. If it is not a sparse matrix, it is assumed to be standardized.
beta Feature coefficients.
a0 Intercept.
Description

Return the null deviance, starting mu and lambda max values for initialization. For internal use only.

Usage

get_start(x, y, weights, family, intercept, is.offset, offset, exclude, vp, alpha)

Arguments

- **x**: Input matrix, of dimension nobs \times nvars; each row is an observation vector. If it is a sparse matrix, it is assumed to be unstandardized. It should have attributes \(xm\) and \(xs\), where \(xm(j)\) and \(xs(j)\) are the centering and scaling factors for variable \(j\) respectively. If it is not a sparse matrix, it is assumed to be standardized.
- **y**: Quantitative response variable.
- **weights**: Observation weights.
- **family**: A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. (See `family` for details on family functions.)
- **intercept**: Does the model we are fitting have an intercept term or not?
- **is.offset**: Is the model being fit with an offset or not?
- **offset**: Offset for the model. If is.offset=FALSE, this should be a zero vector of the same length as \(y\).
- **exclude**: Indices of variables to be excluded from the model.
- **vp**: Separate penalty factors can be applied to each coefficient.
- **alpha**: The elasticnet mixing parameter, with \(0 \leq \alpha \leq 1\).
Details

This function is called by glmnet.path for null deviance, starting mu and lambda max values. It is also called by glmnet.fit when used without warmstart, but they only use the null deviance and starting mu values.

When \( x \) is not sparse, it is expected to already be centered and scaled. When \( x \) is sparse, the function will get its attributes \( x_m \) and \( x_s \) for its centering and scaling factors.

Note that whether \( x \) is centered & scaled or not, the values of \( mu \) and nulldev don’t change. However, the value of lambda_max does change, and we need \( x_m \) and \( x_s \) to get the correct value.

---

**make_row**

*Build a block row matrix for multiview*

**Description**

Build a block row matrix for multiview

**Usage**

```r
make_row(x_list, p_x, pair, rho)
```

**Arguments**

- `x_list`: list of x matrices
- `p_x`: a list of ncol of elements in x_list
- `pair`: an integer vector of two indices
- `rho`: the rho value

**Value**

A block row of matrix for multiview

---

**multiview**

*Perform cooperative learning using the direct algorithm for two or more views.*

**Description**

multiview uses glmnet::glmnet() to do most of its work and therefore takes many of the same parameters, but an intercept is always included and several other parameters do not apply. Such inapplicable arguments are overridden and warnings issued.
multiview

Usage

multiview(x_list, y, rho = 0, family = gaussian(), weights = NULL, offset = NULL, alpha = 1, nlambda = 100, lambda.min.ratio = ifelse(nobs < nvars, 0.01, 1e-04), lambda = NULL, standardize = TRUE, intercept = TRUE, thresh = 1e-07, maxit = 1e+05, penalty.factor = rep(1, nvars), exclude = list(), lower.limits = -Inf, upper.limits = Inf, trace.it = 0)

Arguments

x_list a list of x matrices with same number of rows nobs

y the quantitative response with length equal to nobs, the (same) number of rows in each x matrix

rho the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.

family A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. Default is stats::gaussian. (See stats::family for details on family functions.)

weights observation weights. Can be total counts if responses are proportion matrices. Default is 1 for each observation

offset A vector of length nobs that is included in the linear predictor (a nobs x nc matrix for the "multinomial" family). Useful for the "poisson" family (e.g. log of exposure time), or for refining a model by starting at a current fit. Default is NULL. If supplied, then values must also be supplied to the predict function.

alpha The elasticnet mixing parameter, with 0 ≤ α ≤ 1. The penalty is defined as

(1 - α)/2||β||_2^2 + α||β||_1.

alpha=1 is the lasso penalty, and alpha=0 the ridge penalty.

nlambda The number of lambda values - default is 100.
lambda.min.ratio
Smallest value for lambda, as a fraction of lambda.max, the (data derived) entry value (i.e. the smallest value for which all coefficients are zero). The default depends on the sample size nobs relative to the number of variables nvars. If nobs > nvars, the default is 0.0001, close to zero. If nobs < nvars, the default is 0.01. A very small value of lambda.min.ratio will lead to a saturated fit in the nobs < nvars case. This is undefined for "binomial" and "multinomial" models, and glmnet will exit gracefully when the percentage deviance explained is almost 1.

lambda
A user supplied lambda sequence, default NULL. Typical usage is to have the program compute its own lambda sequence. This sequence, in general, is different from that used in the glmnet::glmnet() call (named lambda) Supplying a value of lambda overrides this. WARNING: use with care. Avoid supplying a single value for lambda (for predictions after CV use stats::predict() instead. Supply instead a decreasing sequence of lambda values as multiview relies on its warms starts for speed, and its often faster to fit a whole path than compute a single fit.

standardize
Logical flag for x variable standardization, prior to fitting the model sequence. The coefficients are always returned on the original scale. Default is standardize=TRUE. If variables are in the same units already, you might not wish to standardize. See details below for y standardization with family="gaussian".

intercept
Should intercept(s) be fitted (default TRUE)

thresh
Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null deviance. Defaults value is 1E-7.

maxit
Maximum number of passes over the data for all lambda values; default is 10^5.

penalty.factor
Separate penalty factors can be applied to each coefficient. This is a number that multiplies lambda to allow differential shrinkage. Can be 0 for some variables, which implies no shrinkage, and that variable is always included in the model. Default is 1 for all variables (and implicitly infinity for variables listed in exclude). Note: the penalty factors are internally rescaled to sum to nvars, and the lambda sequence will reflect this change.

exclude
Indices of variables to be excluded from the model. Default is none. Equivalent to an infinite penalty factor for the variables excluded (next item). Users can supply instead an exclude function that generates the list of indices. This function is most generally defined as function(x_list, y, ...), and is called inside multiview to generate the indices for excluded variables. The ... argument is required, the others are optional. This is useful for filtering wide data, and works correctly with cv.multiview. See the vignette 'Introduction' for examples.

lower.limits
Vector of lower limits for each coefficient; default -Inf. Each of these must be non-positive. Can be presented as a single value (which will then be replicated), else a vector of length nvars

upper.limits
Vector of upper limits for each coefficient; default Inf. See lower.limits

trace.it
If trace.it=1, then a progress bar is displayed; useful for big models that take a long time to fit.
Details
The current code can be slow for "large" data sets, e.g. when the number of features is larger than 1000. It can be helpful to see the progress of multiview as it runs; to do this, set trace.it = 1 in the call to multiview or cv.multiview. With this, multiview prints out its progress along the way. One can also pre-filter the features to a smaller set, using the exclude option, with a filter function.

If there are missing values in the feature matrices: we recommend that you center the columns of each feature matrix, and then fill in the missing values with 0.

For example,

```r
x <- scale(x,TRUE,FALSE)
x[is.na(x)] <- 0
z <- scale(z,TRUE,FALSE)
z[is.na(z)] <- 0
```

Then run multiview in the usual way. It will exploit the assumed shared latent factors to make efficient use of the available data.

Value
An object with S3 class "multiview", "*", where "*" is "elnet", "lognet", "multnet", "fishnet" (poisson), "coxnet" or "mrelnet" for the various types of models.

call the call that produced this object
a0 Intercept sequence of length length(lambda)
beta For "elnet", "lognet", "fishnet" and "coxnet" models, a nvars x length(lambda) matrix of coefficients, stored in sparse column format ("CsparseMatrix"). For "multnet" and "mgaussian", a list of nc such matrices, one for each class.
lambda The actual sequence of glmnet::glmnet() lambda values used. When alpha=0, the largest lambda reported does not quite give the zero coefficients reported (lambda=inf would in principle). Instead, the largest lambda for alpha=0.001 is used, and the sequence of lambda values is derived from this.
lambda The sequence of lambda values
mvlambda The corresponding sequence of multiview lambda values
dev.ratio The fraction of (null) deviance explained (for "elnet", this is the R-square). The deviance calculations incorporate weights if present in the model. The deviance is defined to be 2*(loglike_sat - loglike), where loglike_sat is the log-likelihood for the saturated model (a model with a free parameter per observation). Hence dev.ratio=1-dev/nulldev.
nulldev Null deviance (per observation). This is defined to be 2*(loglike_sat -loglike(Null)); The NULL model refers to the intercept model, except for the Cox, where it is the 0 model.
df The number of nonzero coefficients for each value of lambda. For "multnet", this is the number of variables with a nonzero coefficient for any class.
dfmat For "multnet" and "mrelnet" only. A matrix consisting of the number of nonzero coefficients per class
dim dimension of coefficient matrix (ices)
nobs  number of observations
npasses  total passes over the data summed over all lambda values
offset  a logical variable indicating whether an offset was included in the model
jerr  error flag, for warnings and errors (largely for internal debugging).

See Also

print, coef, coef_ordered, predict, and plot methods for "multiview", and the "cv.multiview" function.

Examples

# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 10), 100, 10)
y = runif(100)
fit1 = multiview(list(x=x,z=z), y, rho = 0)
print(fit1)

# extract coefficients at a single value of lambda
coef(fit1, s = 0.01)

# extract ordered (standardized) coefficients at a single value of lambda
coef_ordered(fit1, s = 0.01)

# make predictions
predict(fit1, newx = list(x[1:10,],z[1:10,]), s = c(0.01, 0.005))

# make a path plot of features for the fit
plot(fit1, label=TRUE)

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x,z=z), by, family = binomial(), rho=0.5)
predict(fit2, newx = list(x[1:10,],z[1:10,]), s = c(0.01, 0.005), type="response")
coef_ordered(fit2, s = 0.01)
plot(fit2, label=TRUE)

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x,z=z), py, family = poisson(), rho=0.5)
predict(fit3, newx = list(x[1:10,],z[1:10,]), s = c(0.01, 0.005), type="response")
coef_ordered(fit3, s = 0.01)
plot(fit3, label=TRUE)
**multiview.control**  
*Internal multiview parameters*

**Description**

View and/or change the factory default parameters in multiview

**Usage**

```r
multiview.control(fdev = 1e-05,
                  devmax = 0.999,
                  eps = 1e-06,
                  big = 9.9e+35,
                  mnlam = 5,
                  pmin = 1e-09,
                  exmx = 250,
                  prec = 1e-10,
                  mxit = 100,
                  itrace = 0,
                  epsnr = 1e-06,
                  mxitnr = 25,
                  factory = FALSE)
```

**Arguments**

- **fdev**: minimum fractional change in deviance for stopping path; factory default = 1.0e-5
- **devmax**: maximum fraction of explained deviance for stopping path; factory default = 0.999
- **eps**: minimum value of lambda.min.ratio (see multiview); factory default = 1.0e-6
- **big**: large floating point number; factory default = 9.9e35. Inf in definition of upper.limit is set to big
- **mnlam**: minimum number of path points (lambda values) allowed; factory default = 5
- **pmin**: minimum probability for any class. factory default = 1.0e-9. Note that this implies a pmax of 1-pmin.
- **exmx**: maximum allowed exponent. factory default = 250.0
- **prec**: convergence threshold for multi response bounds adjustment solution. factory default = 1.0e-10
- **mxit**: maximum iterations for multiresponse bounds adjustment solution. factory default = 100
- **itrace**: If 1 then progress bar is displayed when running multiview and cv.multiview. factory default = 0
- **factory**:
multiview.cox.fit

epsnr convergence threshold for multiview.fit. factory default = 1.0e-6
mxitnr maximum iterations for the IRLS loop in multiview.fit. factory default = 25
factory If TRUE, reset all the parameters to the factory default; default is FALSE

Details

If called with no arguments, multiview.control() returns a list with the current settings of these parameters. Any arguments included in the call sets those parameters to the new values, and then silently returns. The values set are persistent for the duration of the R session.

Value

A list with named elements as in the argument list

See Also

multiview

Examples

multiview.control(fdev = 0) #continue along path even though not much changes
multiview.control() # view current settings
multiview.control(factory = TRUE) # reset all the parameters to their default

multiview.cox.fit    Fit a Cox regression model with elastic net regularization for a single value of lambda

Description

Fit a Cox regression model via penalized maximum likelihood for a single value of lambda. Can deal with (start, stop] data and strata, as well as sparse design matrices.

Usage

multiview.cox.fit(
  x_list,
  x,
  y,
  rho,
  weights,
  lambda,
  alpha = 1,
  offset = rep(0, nobs),
  thresh = 1e-10,
  maxit = 1e+05,
penalty.factor = rep(1, nvars),
exclude = c(),
lower.limits = -Inf,
upper.limits = Inf,
warm = NULL,
from.cox.path = FALSE,
save.fit = FALSE,
trace.it = 0
)

Arguments

x_list a list of x matrices with same number of rows nobs
x the cbinded matrices in x_list
y the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
rho the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.
weights observation weights. Can be total counts if responses are proportion matrices. Default is 1 for each observation
lambda A single value for the lambda hyperparameter.
alpha The elasticnet mixing parameter, with 0 ≤ α ≤ 1. The penalty is defined as
(1 − α)/2||β||_2^2 + α||β||_1.
alpha=1 is the lasso penalty, and alpha=0 the ridge penalty.
offset A vector of length nobs that is included in the linear predictor (a nobs x nc matrix for the "multinomial" family). Useful for the "poisson" family (e.g., log of exposure time), or for refining a model by starting at a current fit. Default is NULL. If supplied, then values must also be supplied to the predict function.
thresh Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null deviance. Defaults value is 1E-7.
maxit Maximum number of passes over the data for all lambda values; default is 10^5.
penalty.factor Separate penalty factors can be applied to each coefficient. This is a number that multiplies lambda to allow differential shrinkage. Can be 0 for some variables, which implies no shrinkage, and that variable is always included in the model. Default is 1 for all variables (and implicitly infinity for variables listed in exclude). Note: the penalty factors are internally rescaled to sum to nvars, and the lambda sequence will reflect this change.
exclude Indices of variables to be excluded from the model. Default is none. Equivalent to an infinite penalty factor for the variables excluded (next item). Users can supply instead an exclude function that generates the list of indices. This function is most generally defined as function(x_list, y, ...), and is called
inside multiview to generate the indices for excluded variables. The ... argument is required, the others are optional. This is useful for filtering wide data, and works correctly with cv.multiview. See the vignette 'Introduction' for examples.

lower.limits Vector of lower limits for each coefficient; default -Inf. Each of these must be non-positive. Can be presented as a single value (which will then be replicated), else a vector of length nvars.

upper.limits Vector of upper limits for each coefficient; default Inf. See lower.limits.

warm Either a glmnetfit object or a list (with names beta and a0 containing coefficients and intercept respectively) which can be used as a warm start. Default is NULL, indicating no warm start. For internal use only.

from.cox.path Was multiview.cox.fit() called from multiview.path()? Default is FALSE. This has implications for computation of the penalty factors.

save.fit Return the warm start object? Default is FALSE.

trace.it If trace.it=1, then a progress bar is displayed; useful for big models that take a long time to fit.

Details

WARNING: Users should not call multiview.cox.fit directly. Higher-level functions in this package call multiview.cox.fit as a subroutine. If a warm start object is provided, some of the other arguments in the function may be overriden.

multiview.cox.fit solves the elastic net problem for a single, user-specified value of lambda. multiview.cox.fit works for Cox regression models, including (start, stop] data and strata. It solves the problem using iteratively reweighted least squares (IRLS). For each IRLS iteration, multiview.cox.fit makes a quadratic (Newton) approximation of the log-likelihood, then calls elnet.fit to minimize the resulting approximation.

In terms of standardization: multiview.cox.fit does not standardize x and weights. penalty.factor is standardized so that they sum up to nvars.

Value

An object with class "coxnet", "glmnetfit" and "glmnet". The list returned contains more keys than that of a "glmnet" object.

a0 Intercept value, NULL for "cox" family.

beta A nvars x 1 matrix of coefficients, stored in sparse matrix format.

df The number of nonzero coefficients.

dim Dimension of coefficient matrix.

lambda Lambda value used.

dev.ratio The fraction of (null) deviance explained. The deviance calculations incorporate weights if present in the model. The deviance is defined to be 2*(loglike_sat - loglike), where loglike_sat is the log-likelihood for the saturated model (a model with a free parameter per observation). Hence dev.ratio=1-dev/nulldev.
nulldev  | Null deviance (per observation). This is defined to be 2*(loglike_sat -loglike(Null)). The null model refers to the 0 model.
npasses  | Total passes over the data.
jerr     | Error flag, for warnings and errors (largely for internal debugging).
offset   | A logical variable indicating whether an offset was included in the model.
call     | The call that produced this object.
nobs     | Number of observations.
warm_fit | If save.fit=TRUE, output of C++ routine, used for warm starts. For internal use only.
family   | Family used for the model, always "cox".
converged| A logical variable: was the algorithm judged to have converged?
boundary | A logical variable: is the fitted value on the boundary of the attainable values?
obj_function | Objective function value at the solution.

---

**multiview.cox.path**  
Fit a Cox regression model with elastic net regularization for a path of lambda values

**Description**

Fit a Cox regression model via penalized maximum likelihood for a path of lambda values. Can deal with (start, stop] data and strata, as well as sparse design matrices.

**Usage**

```r
multiview.cox.path(
  x_list,
  x,
  y,
  rho = 0,
  weights = NULL,
  lambda = NULL,
  offset = NULL,
  alpha = 1,
  nlambda = 100,
  lambda.min.ratio = ifelse(nobs < nvars, 0.01, 1e-04),
  standardize = TRUE,
  intercept = TRUE,
  thresh = 1e-07,
  exclude = integer(0),
  penalty.factor = rep(1, nvars),
  lower.limits = -Inf,
  upper.limits = Inf,
  maxit = 1e+05,
```
multiview.cox.path

trace.it = 0,
nvars,
nobs,
xm,
x,
control,
v,
vnames,
is.offset

Arguments

x_list  a list of x matrices with same number of rows nobs
x       the cbinded matrices in x_list
y       the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
rho     the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.
weights observation weights. Can be total counts if responses are proportion matrices. Default is 1 for each observation
lambda  A user supplied lambda sequence, default NULL. Typical usage is to have the program compute its own lambda sequence. This sequence, in general, is different from that used in the glmnet::glmnet() call (named lambda) Supplying a value of lambda overrides this. WARNING: use with care. Avoid supplying a single value for lambda (for predictions after CV use stats::predict() instead. Supply instead a decreasing sequence of lambda values as multiview relies on its warms starts for speed, and its often faster to fit a whole path than compute a single fit.
offset  A vector of length nobs that is included in the linear predictor (a nobs x nc matrix for the "multinomial" family). Useful for the "poisson" family (e.g. log of exposure time), or for refining a model by starting at a current fit. Default is NULL. If supplied, then values must also be supplied to the predict function.
alpha   The elasticnet mixing parameter, with 0 ≤ α ≤ 1. The penalty is defined as
        (1 − α)/2||β||_2^2 + α||β||_1.
        alpha=1 is the lasso penalty, and alpha=0 the ridge penalty.
nlambda The number of lambda values - default is 100.
lambda.min.ratio
        Smallest value for lambda, as a fraction of lambda.max, the (data derived) entry value (i.e. the smallest value for which all coefficients are zero). The default depends on the sample size nobs relative to the number of variables nvars. If nobs > nvars, the default is 0.0001, close to zero. If nobs < nvars, the default is 0.01. A very small value of lambda.min.ratio will lead to a saturated fit in
the nobs < nvars case. This is undefined for "binomial" and "multinomial" models, and glmnet will exit gracefully when the percentage deviance explained is almost 1.

**standardize** Logical flag for x variable standardization, prior to fitting the model sequence. The coefficients are always returned on the original scale. Default is standardize=TRUE. If variables are in the same units already, you might not wish to standardize. See details below for y standardization with family="gaussian".

**intercept** Should intercept(s) be fitted (default TRUE)

**thresh** Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null deviance. Defaults value is 1E-7.

**exclude** Indices of variables to be excluded from the model. Default is none. Equivalent to an infinite penalty factor for the variables excluded (next item). Users can supply instead an exclude function that generates the list of indices. This function is most generally defined as function(x_list, y, ...), and is called inside multiview to generate the indices for excluded variables. The ... argument is required, the others are optional. This is useful for filtering wide data, and works correctly with cv.multiview. See the vignette 'Introduction' for examples.

**penalty.factor** Separate penalty factors can be applied to each coefficient. This is a number that multiplies lambda to allow differential shrinkage. Can be 0 for some variables, which implies no shrinkage, and that variable is always included in the model. Default is 1 for all variables (and implicitly infinity for variables listed in exclude). Note: the penalty factors are internally rescaled to sum to nvars, and the lambda sequence will reflect this change.

**lower.limits** Vector of lower limits for each coefficient; default -Inf. Each of these must be non-positive. Can be presented as a single value (which will then be replicated), else a vector of length nvars

**upper.limits** Vector of upper limits for each coefficient; default Inf. See lower.limits

**maxit** Maximum number of passes over the data for all lambda values; default is 10^5.

**trace.it** If trace.it=1, then a progress bar is displayed; useful for big models that take a long time to fit.

**nvars** the number of variables (total)

**nobs** the number of observations

**xm** the column means vector (could be zeros if standardize = FALSE)

**xs** the column std dev vector (could be 1s if standardize = FALSE)

**control** the multiview control object

**vp** the variable penalties (processed)

**vnames** the variable names

**is.offset** a flag indicating if offset is supplied or not

**Details**

Sometimes the sequence is truncated before nlambda values of lambda have been used. This happens when cox.path detects that the decrease in deviance is marginal (i.e. we are near a saturated fit).
Value

An object of class "coxnet" and "glmnet".

\[ a0 \]
Intercept value, NULL for "cox" family.

\[ \text{beta} \]
A \( nvars \times \text{length}(\lambda) \) matrix of coefficients, stored in sparse matrix format.

\[ \text{df} \]
The number of nonzero coefficients for each value of lambda.

\[ \text{dim} \]
Dimension of coefficient matrix.

\[ \text{lambda} \]
The actual sequence of lambda values used. When alpha=0, the largest lambda reported does not quite give the zero coefficients reported (\( \lambda=\text{inf} \) would in principle). Instead, the largest lambda for \( \alpha=0.001 \) is used, and the sequence of lambda values is derived from this.

\[ \text{dev.ratio} \]
The fraction of (null) deviance explained. The deviance calculations incorporate weights if present in the model. The deviance is defined to be \( 2*(\text{loglike}_{\text{sat}} - \text{loglike}) \), where \( \text{loglike}_{\text{sat}} \) is the log-likelihood for the saturated model (a model with a free parameter per observation). Hence \( \text{dev.ratio} = 1 - \text{dev}/\text{nulldev} \).

\[ \text{nulldev} \]
Null deviance (per observation). This is defined to be \( 2*(\text{loglike}_{\text{sat}} - \text{loglike}(\text{Null})) \). The null model refers to the 0 model.

\[ \text{npasses} \]
Total passes over the data summed over all lambda values.

\[ \text{jerr} \]
Error flag, for warnings and errors (largely for internal debugging).

\[ \text{offset} \]
A logical variable indicating whether an offset was included in the model.

\[ \text{call} \]
The call that produced this object.

\[ \text{nobs} \]
Number of observations.

Examples

```r
set.seed(2)
nobs <- 100; nvars <- 15
xvec <- rnorm(nobs * nvars)
xvec[sample.int(nobs * nvars, size = 0.4 * nobs * nvars)] <- 0
x <- matrix(xvec, nrow = nobs)
beta <- rnorm(nvars / 3)
fx <- x[, seq(nvars / 3)] %*% beta / 3
ty <- rexp(nobs, exp(fx))
tcens <- rbinom(n = nobs, prob = 0.3, size = 1)
jsurv <- survival::Surv(ty, tcens)
fit1 <- glmnet:::cox.path(x, jsurv)

# works with sparse x matrix
x_sparse <- Matrix::Matrix(x, sparse = TRUE)
fit2 <- glmnet:::cox.path(x_sparse, jsurv)

# example with (start, stop] data
set.seed(2)
start_time <- runif(100, min = 0, max = 5)
stop_time <- start_time + runif(100, min = 0.1, max = 3)
status <- rbinom(n = nobs, prob = 0.3, size = 1)
```
multiview.fit

```r
jsurv.ss <- survival::Surv(start_time, stop_time, status)
fit3 <- glmnet:::cox.path(x, jsurv.ss)

# example with strata
jsurv.ss2 <- glmnet::stratifySurv(jsurv.ss, rep(1:2, each = 50))
fit4 <- glmnet:::cox.path(x, jsurv.ss2)
```

---

**multiview.fit**  
*Fit a GLM with elastic net regularization for a single value of lambda*

### Description

Fit a generalized linear model via penalized maximum likelihood for a single value of lambda. Can deal with any GLM family.

### Usage

```r
multiview.fit(
  x_list,
  x,
  y,
  rho,
  weights,
  lambda,
  alpha = 1,
  offset = rep(0, nobs),
  family = gaussian(),
  intercept = TRUE,
  thresh = 1e-07,
  maxit = 1e+05,
  penalty.factor = rep(1, nvars),
  exclude = c(),
  lower.limits = -Inf,
  upper.limits = Inf,
  warm = NULL,
  from.multiview.path = FALSE,
  save.fit = FALSE,
  trace.it = 0,
  user_lambda = FALSE
)
```

### Arguments

- **x_list**  
  a list of x matrices with same number of rows nobs
- **x**  
  the column-binded entries of x_list
- **y**  
  the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
rho
the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.

weights
observation weights. Can be total counts if responses are proportion matrices. Default is 1 for each observation

lambda
A single value for the lambda hyperparameter.

alpha
The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$. The penalty is defined as

$$(1 - \alpha)/2||\beta||^2_2 + \alpha||\beta||_1.$$ 

alpha=1 is the lasso penalty, and alpha=0 the ridge penalty.

offset
A vector of length nobs that is included in the linear predictor (a nobs x nc matrix for the "multinomial" family). Useful for the "poisson" family (e.g. log of exposure time), or for refining a model by starting at a current fit. Default is NULL. If supplied, then values must also be supplied to the predict function.

family
A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. Default is stats::gaussian. (See stats::family for details on family functions.)

intercept
Should intercept(s) be fitted (default TRUE)

thresh
Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than thresh times the null deviance. Defaults value is 1E-7.

maxit
Maximum number of passes over the data; default is 10^5. (If a warm start object is provided, the number of passes the warm start object performed is included.)

penalty.factor
Separate penalty factors can be applied to each coefficient. This is a number that multiplies lambda to allow differential shrinkage. Can be 0 for some variables, which implies no shrinkage, and that variable is always included in the model. Default is 1 for all variables (and implicitly infinity for variables listed in exclude). Note: the penalty factors are internally rescaled to sum to nvars, and the lambda sequence will reflect this change.

exclude
Indices of variables to be excluded from the model. Default is none. Equivalent to an infinite penalty factor for the variables excluded (next item). Users can supply instead an exclude function that generates the list of indices. This function is most generally defined as function(x_list, y, ...), and is called inside multiview to generate the indices for excluded variables. The ... argument is required, the others are optional. This is useful for filtering wide data, and works correctly with cv.multiview. See the vignette 'Introduction' for examples.

lower.limits
Vector of lower limits for each coefficient; default -Inf. Each of these must be non-positive. Can be presented as a single value (which will then be replicated), else a vector of length nvars

upper.limits
Vector of upper limits for each coefficient; default Inf. See lower.limits
**multiview.fit**

- **warm**: Either a multiview object or a list (with names beta and a0 containing coefficients and intercept respectively) which can be used as a warm start. Default is NULL, indicating no warm start. For internal use only.

- **from.multiview.path**: Was multiview.fit() called from multiview.path()? Default is FALSE. This has implications for computation of the penalty factors.

- **save.fit**: Return the warm start object? Default is FALSE.

- **trace.it**: Controls how much information is printed to screen. If trace.it = 2, some information about the fitting procedure is printed to the console as the model is being fitted. Default is trace.it = 0 (no information printed). (trace.it = 1 not used for compatibility with multiview.path.)

- **user_lambda**: a flag indicating if user supplied the lambda sequence

**Details**

**WARNING**: Users should not call multiview.fit directly. Higher-level functions in this package call multiview.fit as a subroutine. If a warm start object is provided, some of the other arguments in the function may be overridden.

multiview.fit solves the elastic net problem for a single, user-specified value of lambda. multiview.fit works for any GLM family. It solves the problem using iteratively reweighted least squares (IRLS). For each IRLS iteration, multiview.fit makes a quadratic (Newton) approximation of the log-likelihood, then calls elnet.fit to minimize the resulting approximation.

In terms of standardization: multiview.fit does not standardize x and weights. penalty.factor is standardized so that to sum to nvars.

**Value**

An object with class "multiview". The list returned contains more keys than that of a "multiview" object.

- **a0**: Intercept value.
- **beta**: A nvars by 1 matrix of coefficients, stored in sparse matrix format.
- **df**: The number of nonzero coefficients.
- **dim**: Dimension of coefficient matrix.
- **lambda**: Lambda value used.
- **lambda_scale**: The multiview lambda scale factor
- **dev.ratio**: The fraction of (null) deviance explained. The deviance calculations incorporate weights if present in the model. The deviance is defined to be 2*(loglike_sat - loglike), where loglike_sat is the log-likelihood for the saturated model (a model with a free parameter per observation). Hence dev.ratio=1-dev/nulldev.
- **nulldev**: Null deviance (per observation). This is defined to be 2*(loglike_sat -loglike(Null)). The null model refers to the intercept model.
- **npasses**: Total passes over the data.
- **jerr**: Error flag, for warnings and errors (largely for internal debugging).
- **offset**: A logical variable indicating whether an offset was included in the model.
call  The call that produced this object.
nobs  Number of observations.
warm_fit  If save.fit = TRUE, output of C++ routine, used for warm starts. For internal use only.
family  Family used for the model.
converged  A logical variable: was the algorithm judged to have converged?
boundary  A logical variable: is the fitted value on the boundary of the attainable values?
obj_function  Objective function value at the solution.

multiview.path  Fit a GLM with elastic net regularization for a path of lambda values

Description
Fit a generalized linear model via penalized maximum likelihood for a path of lambda values. Can deal with any GLM family.

Usage
multiview.path(
  x_list,
  y,
  rho = 0,
  weights = NULL,
  lambda,
  nlambda,
  user_lambda = FALSE,
  alpha = 1,
  offset = NULL,
  family = gaussian(),
  standardize = TRUE,
  intercept = TRUE,
  thresh = 1e-07,
  maxit = 1e+05,
  penalty.factor = rep(1, nvars),
  exclude = integer(0),
  lower.limits = -Inf,
  upper.limits = Inf,
  trace.it = 0,
  x,
  nvars,
  nobs,
  xm,
  xs,
  control,
Arguments

- **x_list**: a list of x matrices with same number of rows nobs
- **y**: the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
- **rho**: the weight on the agreement penalty, default 0. $\rho=0$ is a form of early fusion, and $\rho=1$ is a form of late fusion. We recommend trying a few values of $\rho$ including 0, 0.1, 0.25, 0.5, and 1 first; sometimes $\rho$ larger than 1 can also be helpful.
- **weights**: observation weights. Can be total counts if responses are proportion matrices. Default is 1 for each observation
- **lambda**: A user supplied lambda sequence, default NULL. Typical usage is to have the program compute its own lambda sequence. This sequence, in general, is different from that used in the `glmnet::glmnet()` call (named `lambda`) Supplying a value of `lambda` overrides this. WARNING: use with care. Avoid supplying a single value for `lambda` (for predictions after CV use `stats::predict()` instead. Supply instead a decreasing sequence of `lambda` values as multiview relies on its warm starts for speed, and its often faster to fit a whole path than compute a single fit.
- **nlambda**: The number of lambda values - default is 100.
- **user_lambda**: a flag indicating if user supplied the lambda sequence
- **alpha**: The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$. The penalty is defined as
  \[(1 - \alpha)/2||\beta||^2_2 + \alpha||\beta||_1.\]
  $\alpha=1$ is the lasso penalty, and $\alpha=0$ the ridge penalty.
- **offset**: A vector of length nobs that is included in the linear predictor (a nobs x nc matrix for the "multinomial" family). Useful for the "poisson" family (e.g. log of exposure time), or for refining a model by starting at a current fit. Default is NULL. If supplied, then values must also be supplied to the predict function.
- **family**: A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. Default is `stats::gaussian`. (See `stats::family` for details on family functions.)
- **standardize**: Logical flag for x variable standardization, prior to fitting the model sequence. The coefficients are always returned on the original scale. Default is `standardize=TRUE`. If variables are in the same units already, you might not wish to standardize. See details below for y standardization with `family="gaussian"`.
- **intercept**: Should intercept(s) be fitted (default TRUE)
- **thresh**: Convergence threshold for coordinate descent. Each inner coordinate-descent loop continues until the maximum change in the objective after any coefficient update is less than `thresh` times the null deviance. Defaults value is `1E-7`
**multiview.path**

```
maxit          Maximum number of passes over the data for all lambda values; default is 10^5.
penalty.factor Separate penalty factors can be applied to each coefficient. This is a number
               that multiplies lambda to allow differential shrinkage. Can be 0 for some vari-
               ables, which implies no shrinkage, and that variable is always included in the
               model. Default is 1 for all variables (and implicitly infinity for variables listed
               in exclude). Note: the penalty factors are internally rescaled to sum to nvars,
               and the lambda sequence will reflect this change.
exclude        Indices of variables to be excluded from the model. Default is none. Equivalent
to an infinite penalty factor for the variables excluded (next item). Users can
supply instead an exclude function that generates the list of indices. This func-
tion is most generally defined as function(x_list, y, ...), and is called
inside multiview to generate the indices for excluded variables. The ... argu-
ment is required, the others are optional. This is useful for filtering wide data,
and works correctly with cv.multiview. See the vignette 'Introduction' for
examples.
lower.limits   Vector of lower limits for each coefficient; default -Inf. Each of these must be
               non-positive. Can be presented as a single value (which will then be replicated),
               else a vector of length nvars
upper.limits   Vector of upper limits for each coefficient; default Inf. See lower.limits
trace.it       If trace.it=1, then a progress bar is displayed; useful for big models that take
               a long time to fit.
x              the cbinded matrices in x_list
nvars          the number of variables (total)
nobs           the number of observations
xm             the column means vector (could be zeros if standardize = FALSE)
xs             the column std dev vector (could be 1s if standardize = FALSE)
control        the multiview control object
vp              the variable penalities (processed)
vnames         the variable names
start_val      the result of first call to get_start
is.offset      a flag indicating if offset is supplied or not
```

**Details**

`multiview.path` solves the elastic net problem for a path of lambda values. It generalizes `multiview::multiview` in that it works for any GLM family.

Sometimes the sequence is truncated before `nlambda` values of lambda have been used. This happens when `multiview.path` detects that the decrease in deviance is marginal (i.e. we are near a saturated fit).

**Value**

An object with class "multiview" "glmnetfit" and "glmnet"

```
a0                  Intercept sequence of length length(lambda).
```
**obj_function**

A function to compute the elastic net objective function value.

### Description

Returns the elastic net objective function value.

### Usage

```r
obj_function(
  y, 
  mu, 
  weights, 
  family, 
  lambda, 
  alpha, 
  coefficients, 
  vp, 
  view_components, 
  rho 
)
```
Arguments

- **y**: Quantitative response variable.
- **mu**: Model’s predictions for y.
- **weights**: Observation weights.
- **family**: A description of the error distribution and link function to be used in the model. This is the result of a call to a family function.
- **lambda**: A single value for the lambda hyperparameter.
- **alpha**: The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$.
- **coefficients**: The model’s coefficients (excluding intercept).
- **vp**: Penalty factors for each of the coefficients.
- **view_components**: a list of lists containing indices of coefficients and associated covariate (view) pairs
- **rho**: the fusion parameter

---

**pen_function**

*Elastic net penalty value*

---

Description

Returns the elastic net penalty value without the lambda factor.

Usage

```r
pen_function(coefficients, alpha = 1, vp = 1)
```

Arguments

- **coefficients**: The model’s coefficients (excluding intercept).
- **alpha**: The elasticnet mixing parameter, with $0 \leq \alpha \leq 1$.
- **vp**: Penalty factors for each of the coefficients.

Details

The penalty is defined as

$$(1 - \alpha)/2 \sum v_p \beta_j^2 + \alpha \sum v_p |\beta_j|.$$ 

Note the omission of the multiplicative lambda factor.
### Description

Produces a coefficient profile plot of the coefficient paths for a fitted "multiview" object. The paths are colored by the data views, from which the features come.

### Usage

```r
def S3 method for class 'multiview'
plot(x, col_palate = NULL, label = FALSE, ...)
```

### Arguments

- `x` A fitted "multiview" model.
- `col_paulet` A set of colors to use for indicating different views. If NULL, the function will use the color palette "Set1" from the `RColorBrewer` package.
- `label` If TRUE, label the curves with variable sequence. numbers.
- `...` Other graphical parameters to plot.

### Value

A NULL value as this function is really meant for its side-effect of generating a plot.

### Examples

```r
# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 10), 100, 10)
y = rnorm(100)
fit1 = multiview(list(x=x, z=z), y, rho = 0)
plot(fit1, label = TRUE)

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x, z=z), by, family = binomial(), rho=0.5)
plot(fit2, label = FALSE)

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x, z=z), py, family = poisson(), rho=0.5)
plot(fit3, label = TRUE)
```
**predict.cv.multiview**

Make predictions from a "cv.multiview" object.

**Description**

This function makes predictions from a cross-validated multiview model, using the stored "multiview" object, and the optimal value chosen for lambda.

**Usage**

```r
## S3 method for class 'cv.multiview'
predict(object, newx, s = c("lambda.1se", "lambda.min"), ...)
```

**Arguments**

- `object`: Fitted "cv.multiview" or object.
- `newx`: List of new view matrices at which predictions are to be made.
- `s`: Value(s) of the penalty parameter lambda at which predictions are required. Default is the value s="lambda.1se" stored on the CV object. Alternatively s="lambda.min" can be used. If s is numeric, it is taken as the value(s) of lambda to be used. (For historical reasons we use the symbol 's' rather than 'lambda' to reference this parameter)
  - `...`: Not used. Other arguments to predict.

**Details**

This function makes it easier to use the results of cross-validation to make a prediction.

**Value**

The object returned depends on the ...argument which is passed on to the predict method for multiview objects.

**Examples**

```r
# Gaussian
# Generate data based on a factor model
set.seed(1)
x = matrix(rnorm(100*10), 100, 10)
z = matrix(rnorm(100*10), 100, 10)
U = matrix(rnorm(100*5), 100, 5)
for (m in seq(5)){
  u = rnorm(100)
x[, m] = x[, m] + u
z[, m] = z[, m] + u
U[, m] = U[, m] + u}
x = scale(x, center = TRUE, scale = FALSE)
z = scale(z, center = TRUE, scale = FALSE)
```
beta_U = c(rep(0.1, 5))
y = U %*% beta_U + 0.1 * rnorm(100)
fit1 = cv.multiview(list(x=x,z=z), y, rho = 0.3)
predict(fit1, newx = list(x[1:5,],z[1:5,]), s = "lambda.min")

# Binomial
by = 1 * (y > median(y))
fit2 = cv.multiview(list(x=x,z=z), by, family = binomial(), rho = 0.9)
predict(fit2, newx = list(x[1:5,],z[1:5,]), s = "lambda.min", type = "response")

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = cv.multiview(list(x=x,z=z), py, family = poisson(), rho = 0.6)
predict(fit3, newx = list(x[1:5,],z[1:5,]), s = "lambda.min", type = "response")

---

**predict.multiview**  
Get predictions from a multiview fit object

**Description**

Gives fitted values, linear predictors, coefficients and number of non-zero coefficients from a fitted multiview object.

**Usage**

```r
## S3 method for class 'multiview'
predict(
  object,
  newx,
  s = NULL,
  type = c("link", "response", "coefficients", "class", "nonzero"),
  exact = FALSE,
  newoffset,
  ...)
```

**Arguments**

- `object`  
  Fitted "multiview" object.

- `newx`  
  list of new matrices for `x` at which predictions are to be made. Must be a list of matrices. This argument is not used for `type = c("coefficients","nonzero")`

- `s`  
  Value(s) of the penalty parameter lambda at which predictions are required. Default is the entire sequence used to create the model.
**type**

Type of prediction required. Type "link" gives the linear predictors (eta scale); Type "response" gives the fitted values (mu scale). Type "coefficients" computes the coefficients at the requested values for s. Type "nonzero" returns a list of the indices of the nonzero coefficients for each value of s. Type "class" returns class labels for binomial family only.

**exact**

This argument is relevant only when predictions are made at values of s (lambda) **different** from those used in the fitting of the original model. If **exact**=FALSE (default), then the predict function uses linear interpolation to make predictions for values of s (lambda) that do not coincide with those used in the fitting algorithm. While this is often a good approximation, it can sometimes be a bit coarse. With **exact**=TRUE, these different values of s are merged (and sorted) with object$lambda, and the model is refit before predictions are made. In this case, it is required to supply the original data x= and y= as additional named arguments to predict() or coef(). The workhorse predict.multiview() needs to update the model, and so needs the data used to create it. The same is true of weights, offset, penalty.factor, lower.limits, upper.limits if these were used in the original call. Failure to do so will result in an error.

**newoffset**

If an offset is used in the fit, then one must be supplied for making predictions (except for type="coefficients" or type="nonzero").

**...**

This is the mechanism for passing arguments like x= when **exact**=TRUE; see exact argument.

**Value**

The object returned depends on type.

**Examples**

```r
# Gaussian
x = matrix(rnorm(100 * 20), 100, 20)
z = matrix(rnorm(100 * 20), 100, 20)
y = rnorm(100)
fit1 = multiview(list(x=x,z=z), y, rho = 0)
predict(fit1, newx = list(x[1:10, ],z[1:10, ]), s = c(0.01, 0.005))

# Binomial
by = sample(c(0,1), 100, replace = TRUE)
fit2 = multiview(list(x=x,z=z), by, family = binomial(), rho=0.5)
predict(fit2, newx = list(x[1:10, ],z[1:10, ]), s = c(0.01, 0.005), type = "response")

# Poisson
py = matrix(rpois(100, exp(y)))
fit3 = multiview(list(x=x,z=z), py, family = poisson(), rho=0.5)
predict(fit3, newx = list(x[1:10, ],z[1:10, ]), s = c(0.01, 0.005), type = "response")
```
### reshape_x_to_xlist

**Description**

Return a new list of x matrices of same shapes as those in x_list

**Usage**

```r
reshape_x_to_xlist(x, x_list)
```

**Arguments**

- `x` - the column-binded entries of x_list
- `x_list` - a list of x matrices with same number of rows nobs

### response.coxnet

**Description**

Internal function to make the response y passed to glmnet suitable for coxnet (i.e. glmnet with family = "cox"). Sanity checks are performed here too.

**Usage**

```r
response.coxnet(y)
```

**Arguments**

- `y` - Response variable. Either a class "Surv" object or a two-column matrix with columns named 'time' and 'status'.

**Details**

If y is a class "Surv" object, this function returns y with no changes. If y is a two-column matrix with columns named 'time' and 'status', it is converted into a "Surv" object.

**Value**

A class "Surv" object.
**select_matrix_list_columns**

Select x_list columns specified by (conformable) list of indices

**Description**

Select x_list columns specified by (conformable) list of indices

**Usage**

```r
select_matrix_list_columns(x_list, indices)
```

**Arguments**

- `x_list` a list of x matrices with same number of rows nobs
- `indices` a vector of indices in 1:nvars

**Value**

a list of x matrices

---

**to_nvar_index**

Translate from column indices in list of x matrices to indices in 1:nvars. No sanity checks for efficiency

**Description**

Translate from column indices in list of x matrices to indices in 1:nvars. No sanity checks for efficiency

**Usage**

```r
to_nvar_index(x_list, index_list)
```

**Arguments**

- `x_list` a list of x matrices with same number of rows nobs
- `index_list` a list of column indices for each matrix, including possibly column indices of length 0

**Value**

a vector of indices between 1 and nvars = sum of ncol(x) for x in x_list
to_xlist_index

Translate indices in 1:nvars to column indices in list of x matrices.
No sanity checks

Description

Translate indices in 1:nvars to column indices in list of x matrices. No sanity checks

Usage

to_xlist_index(x_list, index)

Arguments

x_list a list of x matrices with same number of rows nobs
index vector of indices between 1 and nvars = sum of ncol(x) for x in x_list

Value

a conformed list of column indices for each matrix, including possibly column indices of length 0

view.contribution

Evaluate the contribution of data views in making prediction

Description

Evaluate the contribution of each data view in making prediction. The function has two options. If force is set to NULL, the data view contribution is benchmarked by the null model. If force is set to a list of data views, the contribution is benchmarked by the model fit on this list of data views, and the function evaluates the marginal contribution of each additional data view on top of this benchmarking list of views. The function returns a table showing the percentage improvement in reducing error as compared to the benchmarking model made by each data view.

Usage

view.contribution(
  x_list,
  y,
  family = gaussian(),
  rho,
  s = c("lambda.min", "lambda.1se"),
  eval_data = c("train", "test"),
  weights = NULL,
  type.measure = c("default", "mse", "deviance", "class", "auc", "mae", "C"),
  x_list_test = NULL,
Arguments

- **x_list**: a list of x matrices with same number of rows nobs
- **y**: the quantitative response with length equal to nobs, the (same) number of rows in each x matrix
- **family**: A description of the error distribution and link function to be used in the model. This is the result of a call to a family function. Default is stats::gaussian. (See stats::family for details on family functions.)
- **rho**: the weight on the agreement penalty, default 0. rho=0 is a form of early fusion, and rho=1 is a form of late fusion. We recommend trying a few values of rho including 0, 0.1, 0.25, 0.5, and 1 first; sometimes rho larger than 1 can also be helpful.
- **s**: Value(s) of the penalty parameter lambda at which predictions are required. Default is the value s="lambda.1se" stored on the CV object. Alternatively s="lambda.min" can be used. If s is numeric, it is taken as the value(s) of lambda to be used. (For historical reasons we use the symbol 's' rather than 'lambda' to reference this parameter)
- **eval_data**: If train, we evaluate the contribution of data views based on training data using cross validation error; if test, we evaluate the contribution of data views based on test data. Default is train. If set to test, users need to provide the test data, i.e. x_list_test and y_test.
- **weights**: Observation weights; defaults to 1 per observation
- **type.measure**: loss to use for cross-validation. Currently five options, not all available for all models. The default is type.measure="deviance", which uses squared-error for gaussian models (a.k.a type.measure="mse" there), deviance for logistic and poisson regression, and partial-likelihood for the Cox model. type.measure="class" applies to binomial and multinomial logistic regression only, and gives misclassification error. type.measure="auc" is for two-class logistic regression only, and gives area under the ROC curve. type.measure="mse" or type.measure="mae" (mean absolute error) can be used by all models except the "cox"; they measure the deviation from the fitted mean to the response. type.measure="C" is Harrel's concordance measure, only available for cox models.
- **x_list_test**: A list of x matrices in the test data for evaluation.
- **test_y**: The quantitative response in the test data with length equal to the number of rows in each x matrix of the test data.
- **nfolds**: number of folds - default is 10. Although nfolds can be as large as the sample size (leave-one-out CV), it is not recommended for large datasets. Smallest value allowable is nfolds=3
foldid  
an optional vector of values between 1 and nfold identifying what fold each observation is in. If supplied, nfold can be missing.

force  
If NULL, the data view contribution is benchmarked by the null model. If users want to benchmark by the model fit on a specified list of data views, force needs to be set to this list of benchmarking data views, i.e. a list of x matrices. The function then evaluates the marginal contribution of each additional data, i.e. the data views in x_list but not in force, on top of the benchmarking views.

...  
Other arguments that can be passed to multiview

Value

a data frame consisting of the view, error metric, and percentage improvement.

Examples

```r
set.seed(3)
# Simulate data based on the factor model
x = matrix(rnorm(200*20), 200, 20)
z = matrix(rnorm(200*20), 200, 20)
w = matrix(rnorm(200*20), 200, 20)
U = matrix(rep(0, 200*10), 200, 10) # latent factors
for (m in seq(10)){
  u = rnorm(200)
x[, m] = x[, m] + u
z[, m] = z[, m] + u
w[, m] = w[, m] + u
U[, m] = U[, m] + u}
beta_U = c(rep(2, 5),rep(-2, 5))
y = U %*% beta_U + 3 * rnorm(100)

# Split training and test sets
smp_size_train = floor(0.9 * nrow(x))
train_ind = sort(sample(seq_len(nrow(x)), size = smp_size_train))
test_ind = setdiff(seq_len(nrow(x)), train_ind)
train_X = scale(x[train_ind, ])
test_X = scale(x[test_ind, ])
train_Z <- scale(z[train_ind, ])
test_Z <- scale(z[test_ind, ])
train_W <- scale(w[train_ind, ])
test_W <- scale(w[test_ind, ])
train_y <- y[train_ind, ]
test_y <- y[test_ind, ]
foldid = sample(rep_len(1:10, dim(train_X)[1]))

# Benchmarked by the null model:
rho = 0.3
view.contribution(x_list=list(x=train_X,z=train_Z), train_y, rho = rho,
  eval_data = 'train', family = gaussian())
view.contribution(x_list=list(x=train_X,z=train_Z), train_y, rho = rho,
  eval_data = 'test', family = gaussian(),
  x_list_test=list(x=test_X,z=test_Z), test_y=test_y)
```
# Force option -- benchmarked by the model train on a specified list of data views:
view.contribution(x_list=list(x=train_X,z=train_Z,w=train_W), train_y, rho = rho,
        eval_data = 'train', family = gaussian(), force=list(x=train_X))

---

**weighted_mean_sd**

*Helper function to compute weighted mean and standard deviation*

**Description**

Helper function to compute weighted mean and standard deviation. Deals gracefully whether x is sparse matrix or not.

**Usage**

```r
weighted_mean_sd(x, weights = rep(1, nrow(x)))
```

**Arguments**

- `x`  
  Observation matrix.
- `weights`  
  Optional weight vector.

**Value**

A list with components.

- `mean`  
  vector of weighted means of columns of x
- `sd`  
  vector of weighted standard deviations of columns of x
Index

* models
  multiview-package, 3
  multiview.control, 25
* package
  multiview-package, 3
* regression
  multiview-package, 3
  multiview.control, 25

coef.cv.multiview, 3
coef.multiview, 4
coef_ordered, 5
coef_ordered.cv.multiview, 6
coef_ordered.multiview, 7
collapse_named_lists, 9
cox_obj_function, 9
cv.multiview, 10
dev_function, 14
elemnet.fit, 15
family, 19
get_cox_lambda_max, 17
get_eta, 18
get_start, 19
glmnet::glmnet(), 11, 20, 22, 23, 30, 37
make_row, 20
multiview, 20
multiview-package, 3
multiview.control, 25
multiview.cox.fit, 26
multiview.cox.path, 29
multiview.fit, 33
multiview.path, 36
obj_function, 39
pen_function, 40
plot.multiview, 41
predict.cv.multiview, 42
predict.multiview, 43
reshape_x_to_xlist, 45
response.coxnet, 45
select_matrix_list_columns, 46
stats::family, 11, 21, 34, 37, 48
stats::gaussian, 11, 21, 34, 37, 48
stats::predict(), 22, 30, 37
to_nvar_index, 46
to_xlist_index, 47
view.contribution, 47
weighted_mean_sd, 50