Package ‘pcoxtime’

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Type Package

Title Penalized Cox Proportional Hazard Model for Time-Dependent Covariates

Version 1.0.4

Description Fits penalized models for both time-independent and time-dependent survival data. It fully implements elastic net and uses proximal gradient descent to solve the optimization problem. The package is an implementation of Steve Cygu and Benjamin M. Bolker. (2021) <arXiv:2102.02297>.

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- coef.pcoxtime

Extract coefficient estimates of pcoxtime object

Description

This function extracts the estimates for all the coefficients.

Usage

```r
## S3 method for class 'pcoxtime'
coef(object, ...)
```

```r
## S3 method for class 'pcoxtime'
coefficients(object, ...)
```

Arguments

- `object` fitted `pcoxtime` model object
- `...` for future implementations

Details

The call that produced `pcoxtime` is printed, followed by coefficient estimates.
Value

A vector of coefficient estimates.
A vector of coefficient estimates.

### Description

This function extracts cross-validation estimates for a particular lambda.

### Usage

```r
## S3 method for class 'pcoxtimecv'
coef(object, lambda, ...)

## S3 method for class 'pcoxtimecv'
coefficients(object, lambda, ...)
```

### Arguments

- `object`: `pcoxtimecv` object
- `lambda`: the value of lambda for which to return the coefficient estimates. It can be any of the character string, "min", "optimal" or "best" for optimal lambda; "1se" for 1 standard error lambda; or any numeric value for lambda. See details.
- `...`: for future implementations

### Details

Extract the coefficient estimates for optimal lambda-alpha pair or based on specified the value of lambda for an optimal alpha. If the value of lambda specified is not exact (not in lambdas), the nearest value is used, based on nearest <- function(values, value){values[which(abs(values-value)==min(abs(values-value)))]. It requires that `pcoxtimecv` is run with `refit = TRUE`.

### Value

A data frame of coefficient estimates.
A vector of coefficient estimates.
concordScore.pcoxtime  Compute the concordance statistic for the pcoxtime model

Description
The function computes the agreement between the observed response and the predictor.

Usage
## S3 method for class 'pcoxtime'
concordScore(fit, newdata = NULL, stats = FALSE, reverse = TRUE, ...)

Arguments

- `fit` fitted `pcoxtime`.
- `newdata` optional data frame containing the variables appearing on the right hand side of `pcoxtime` formula.
- `stats` logical. If TRUE all the related concordance statistics are returned.
- `reverse` if TRUE (default) then assume that larger x values predict smaller response values y; a proportional hazards model is the common example of this.
- `...` additional arguments passed to `concordance`.

Details
Computes Harrell's C index for predictions for `pcoxtime` object and takes into account censoring. See `concordance`.

Value
an object containing the concordance, followed by the number of pairs that agree, disagree, are tied, and are not comparable.

Examples

```r
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}

# Penalized
lam <- 0.1
alp <- 0.5
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior , data = veteran
, lambda = lam
, alpha = alp
```
c1 <- concordScore(pfit1)
c1

# Unpenalized
lam <- 0
alp <- 1
pfit2 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
, data = veteran
, lambda = lam
, alpha = alp
)
c2 <- concordScore(pfit2)
c2

extractoptimal.pcoxtimecv

Extract optimal parameter values

Description

Extract cross-validation summaries and data frames.

Usage

## S3 method for class 'pcoxtimecv'
extractoptimal(object, what = c("optimal", "cvm", "coefs"), ...)

Arguments

object  pcoxtimecv object
what     the summary or data frame to extract. Currently, three options are available: what = "optimal" extracts a data frame showing optimal parameter values, what = "cvm" extracts the data frame containing the mean cross-validation error for various lambda-alpha combination, and what = "coef", requires refit = TRUE in pcoxtimecv, extracts a data frame containing the coefficient estimates for various lambda-alpha combination.
...
for future implementations

Details

Extract cross-validation summaries based on the optimal parameters or data frames containing all the summaries for all the parameter values.

Value

A data frame depending on the specification described above.
Compute survival curve and cumulative hazard from a pcoxtime model

Description
Compute the predicted survivor and cumulative hazard function for a penalized Cox proportional hazard model.

Usage
```r
## S3 method for class 'pcoxtime'
pcoxsurvfit(fit, newdata, ...)

## S3 method for class 'pcoxtime'
pcoxbasehaz(fit, centered = TRUE)
```

Arguments
- **fit**: fitted `pcoxtime` object
- **newdata**: a data frame containing the variables appearing on the right hand side of `pcoxtime` formula.
- **...**: for future implementations
- **centered**: if TRUE (default), return data from a predicted survival function at the mean values of the predictors, if FALSE returns prediction for all predictors equal to zero (baseline hazard).

Details
`pcoxsurvfit` and `pcoxbasehaz` functions produce survival curves and estimated cumulative hazard, respectively, for the fitted `pcoxtime` model. They both return the estimated survival probability and the estimated cumulative hazard, which are both Breslow estimate.

The `pcoxbasehaz` is an alias for `pcoxsurvfit` which simply computed the predicted survival estimates (baseline).

If the `newdata` argument is missing, the "average" survival or cumulative hazard estimates are produced with the predictor values equal to means of the data set. See `survfit.coxph` for warning against this. If the `newdata` is specified, then the returned object will contain a matrix of both survival and cumulative hazard estimates with each column for each row in the `newdata`.

Value
`pcoxsurvfit` and `pcoxbasehaz` return S3 objects of class `pcoxsurvfit.pcoxtime` and `pcoxbasehaz.pcoxtime`, respectively:
- **n**: number of observations used in the fit.
- **events**: total number of events of interest in the fit.
- **time**: time points defined by the risk set.
n.risk  the number of individuals at risk at time t.
n.event the number of events that occur at time t.
n.censor the number of subjects who exit the risk set, without an event, at time t.
surv    a vector or a matrix of estimated survival function.
cumhaz, hazard a vector or a matrix of estimated cumulative hazard.
call    the call that produced the object.

See Also

pcoxtime, plot.pcoxsurvfit

Examples

data(heart, package="survival")
lam <- 0.1
alp <- 0.8
pfit <- pcoxtime(Surv(start, stop, event) ~ age + year + surgery + transplant
, data = heart
, lambda = lam
, alpha = alp
)

# Survival estimate
psurv <- pcoxsurvfit(pfit)
print(psurv)

# Baseline survival estimate
bsurv <- pcoxbasehaz(pfit, centered = FALSE)

---

pcoxtheme  Set theme for pcoxtime plots

Description

Sets a theme for pcoxtime and other ggplot objects

Usage

pcoxtheme()

Value

No return value, called for side effects (setting pcotime plotting theme).
Examples

```r
library(ggplot2)
pcoxtheme()
data(heart, package="survival")
lam <- 0.02
alp <- 1
pfit <- pcoxtime(Surv(start, stop, event) ~ age + year + surgery + transplant,
data = heart,
lambda = lam,
alph = alp)

# Plot survival curves
psurv <- pcoxsurvfit(pfit)
plot(psurv)
```

---

**pcoxtime**  
*Fit penalized Cox model*

---

**Description**

Fits a Cox model with either lasso, ridge or elasticnet penalty for both time-independent and time-dependent (varying) covariates survival data.

**Usage**

```r
pcoxtime(
  formula,
data,
  alpha = 1,
nlambda = 1,
maxiter = 1e+05,
tol = 1e-08,
quietly = FALSE,
lambmax = FALSE,
origin_scale = TRUE,
contrasts.arg = NULL,
xlevs = NULL,
naction = na.omit,
...
)
```

**Arguments**

- `formula`: object of class formula describing the model. The response is specified similar to `Surv` function from package `survival`. The terms (predictors) are specified on the right of "~" in the formula.
- `data`: optional data frame containing variables specified in the formula.
pcoxtime

alpha elasticnet mixing parameter, with $0 \leq \alpha \leq 1$. See details

lambda tuning parameter for the lasso penalization, with $\lambda \geq 0$. $\lambda = 0$ fits unpenalized Cox model. See details

maxiter maximum number of iterations to convergence. Default is $1e4$. Consider increasing it if the model does not converge.

tol convergence threshold for proximal gradient gradient descent. Each proximal update continues until the relative change in all the coefficients (i.e. $\sqrt{\sum (\beta_{k+1} - \beta_k)^2/\text{stepsize}}$) is less than tol. The default value is $1e-8$.

quietly logical. If TRUE, iteration progress printed.

lambmax logical. Sufficiently large, $\lambda_{\text{max}}$, that sets $\beta = 0$ for regularization path. If TRUE, $\lambda_{\text{max}}$ is returned.

origin_scale logical. If TRUE (default), the estimated coefficients are returned on the original covariate scale. Otherwise, FALSE, coefficients are standardized.

contrasts.arg an optional list. See the contrasts.arg of model.matrix.default.

xlevs a named list of character vectors giving the full set of levels to be assumed for each factor. See model.frame.

na.action a function which indicates what should happen when the data contain NAs. See model.frame.

... additional arguments not implemented.

Details

The algorithm estimates the coefficients based on observed survival data, with either time-independent or time-dependent covariates, through penalized partial log-likelihood

$$\text{pen } \ell(\beta)_{\alpha,\lambda} = -\ell(\beta) + P_{\alpha,\lambda}(\beta)$$

using elasticnet (which combines both lasso and ridge penalty)

$$\lambda \left( \alpha \sum_{i=1}^{p} |\beta_i| + 0.5(1 - \alpha) \sum_{i=1}^{p} \beta_i^2 \right)$$

when $\alpha = 1$ ($\alpha$) is the lasso penalty, and $\alpha = 0$ is the ridge penalty. $\lambda = 0$ fits the standard Cox proportional hazard model.

User can provide a particular lambda. Typical usage is to use the pcoxtimecv to select the optimal lambda first.

The routine to handle time-dependent covariates is similar to that implemented in coxph: if there are tied event times, Breslow approximation is used.
Value

An S3 object of class `pcoxtime`:

- **coef**: a named vector of coefficients. If any of the coefficients violates KKT conditions, the model will print a warning but still return coefficient estimates.
- **min.nloglik**: estimated log-likelihood at convergence.
- **min.dev**: the deviation satisfying the tol stopping criteria.
- **iter.dev**: deviations between previous and current coefficient estimate at each iteration.
- **convergence**: convergence message containing the number of iterations.
- **n**: the number of observations used in the fit.
- **n.risk**: the number of individuals at risk at time \( t \).
- **n.event**: the number of events that occur at time \( t \).
- **n.censor**: the number of subjects who exit the risk set, without an event, at time \( t \).
- **time**: time points defined by the risk set.
- **Y**: Surv object defining the event times and event status.
- **data**: data frame used.
- **timevarlabel, eventvarlabel**: time and event variables, respectively.
- **predictors**: a vector of predictors/covariates in the model.
- **lambda, alpha**: lambda and alpha used, respectively.
- **formula**: model formula used in the fit.
- **means**: vector of column means of the X matrix. Subsequent survival curves are adjusted to this value.
- **assign, xlevels, terms**: See `model.frame` for assign, xlevels, contrasts and terms.

See Also

- `coxph`, `pcoxtimecv`

Examples

```r
# Time-independent covariates
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}
## Fit unpenalized Cox using pcoxtime
lam <- 0 # Should fit unpenalized Cox model
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
  , data = veteran
  , lambda = lam
  , alpha = 1
```
pcoxtimecv

Cross-validation for pcoxtime

Description

Performs k-fold cross-validation for pcoxtime, plots solution path plots, and returns optimal value of lambda (and optimal alpha if more than one is given).

Usage

pcoxtimecv(
  formula,
  data,
  alphas = 1,
  lambdas = NULL,
  nlambdas = 100,
  lammin_fract = NULL,
)
```r
lamfract = 0.6,
nfolds = 10,
foldids = NULL,
devtype = "vv",
refit = FALSE,
maxiter = 1e+05,
tol = 1e-08,
quietly = FALSE,
seed = NULL,
nclusters = 1,
na.action = na.omit,
...
)
```

**Arguments**

- **formula**: object of class formula describing the model. The response is specified similar to `Surv` function from package `survival`. The terms (predictors) are specified on the right of "~" in the formula.
- **data**: optional data frame containing variables specified in the formula.
- **alphas**: elasticnet mixing parameter, with 0 <= alphas <= 1. If a vector of alphas is supplied, cross-validation will be performed for each of the alphas and optimal value returned. The default is 1.
- **lambdas**: optional user-supplied sequence. If lambdas = NULL (default – highly recommended), the algorithm chooses its own sequence.
- **nlambdas**: the default number of lambdas values. Default is 100.
- **lammin_fract**: smallest value of lambda, as fraction of maximum lambda. If NULL, default, it depends on the number of observations (n) relative to the number of variables (p). If n > p, the default is 0.0001, otherwise 0.01. Increasing this value may lead to faster convergence.
- **lamfract**: proportion of regularization path to consider. If lamfract = 1, complete regularization path is considered. However, if 0.5 <= lamfract <1, only a proportion of the nlambdas considered. Choosing a smaller lamfract reduces computational time and potentially stable estimates for model with large number of predictors. See details.
- **nfolds**: number of folds. Default is 10. The smallest allowable is nfolds = 3.
- **foldids**: an optional sequence of values between 1 and nfolds specifying what fold each observation is in. This is important when comparing performance across models. If specified, nfolds can be missing.
- **devtype**: loss to use for cross-validation. Currently, two options are available but versions will implement `concordScore.pcoxtime` loss too. The two are, default (devtype = "vv") Verweij Van Houwelingen partial-likelihood deviance and basic cross-validated partial likelihood devtype = "basic". See Dai, B., and Breheny, P. (2019) for details.
- **refit**: logical. Whether to return solution path based on optimal lambda and alpha picked by the model. Default is refit = FALSE.
maximum number of iterations to convergence. Default is $1e5$. Consider increasing it if the model does not converge.

Convergence threshold for proximal gradient gradient descent. Each proximal update continues until the relative change in all the coefficients (i.e. $\sqrt{\sum (\beta_{k+1} - \beta_k)^2/\text{stepsize}}$ is less than tol. The default value is $1e-8$.

logical. If TRUE, refit progress is printed.

random seed. Default is NULL, which generated the seed internally.

number of cores to use to run the cross-validation in parallel. Default is nclusters = 1 which runs serial.

additional arguments not implemented.

The function fits pcoxtime folds + 1 (if refit = FALSE) or folds + 2 times (if refit = FALSE). In the former case, the solution path to display using plot.pcoxtimecv is randomly picked from all the cross-validation runs. However, in the later case, the solution path plot is based on the model refitted using the optimal parameters. In both cases, the function first runs plot.pcoxtimecv to compute the lambda sequence and then perform cross-validation on nfolds.

If more than one alphas is specified, say code(0.2, 0.5, 1), the pcoxtimecv will search (experimental) for optimal values for alpha with respect to the corresponding lambda values. In this case, optimal alpha and lambda sequence will be returned, i.e., the (alphas, lambdas) pair that corresponds to the lowest predicted cross-validated error (likelihood deviance).

For data sets with a very large number of predictors, it is recommended to only calculate partial paths by lowering the value of lamfrac. In other words, for $p > n$ problems, the near lambda = 0 solution is poorly behaved and this may account for over 99% of the function’s runtime. We therefore recommend always specifying lamfrac < 1 and increase if the optimal lambda suggests lower values.

An S3 object of class pcoxtimecv:

- lambda.min: the value of lambda that gives minimum cross-validated error.
- lambda.1se: largest value of lambda such that error is within 1 standard error of the minimum.
- alpha.optimal: optimal alpha corresponding to lambda.min.
- lambdas.optimal: the sequence of lambdas containing lambda.min.
- foldids: the fold assignment used.
- dfs: list of data frames containing mean cross-validated error summaries and estimated coefficients in each fold.
- fit: if refit = TRUE, summaries corresponding to the optimal alpha and lambdas. This is used to plot solution path.
References


See Also

plot.pcoxtimecv, pcoxtime

Examples

# Time-independent covariates
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}

cv1 <- pcoxtimecv(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
 , data = veteran
 , alphas = 1
 , refit = FALSE
 , lamfract = 0.6
 )
print(cv1)

# Train model using optimal alpha and lambda
fit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
 , data = veteran
 , alpha = cv1$alpha.optimal
 , lambda = cv1$lambda.min
 )
print(fit1)

# Time-varying covariates
data(heart, package="survival")
cv2 <- pcoxtimecv(Surv(start, stop, event) ~ age + year + surgery + transplant
 , data = heart
 , alphas = 1
 , refit = FALSE
 , lamfract = 0.6
 )
print(cv2)

# Train model
fit2 <- pcoxtime(Surv(start, stop, event) ~ age + year + surgery + transplant
 , data = heart
 , alpha = cv2$alpha.optimal
 , lambda = cv2$lambda.min
)
plot.pcoxsurvfit  

Plot survival and cumulative hazard curves

Description

Plot estimated survival and cumulative hazard curves for pcoxtime model.

Usage

```r
## S3 method for class 'pcoxsurvfit'
plot(
  x,
  ..., 
  type = c("surv", "cumhaz"), 
  lsize = 0.3, 
  lcol = "black", 
  compare = FALSE
)
```

Arguments

- `x` : a `pcoxsurvfit.pcoxtime` or `pcoxbasehaz.pcoxtime` object.
- `...` : for future implementations
- `type` : type of curve to generate. Either `type = "surv"` for survival curves or `type = "cumhaz"` for cumulative hazard curve.
- `lsize` : line size for the curves.
- `lcol` : colour for the curves.
- `compare` : logical. Whether to return plot with labels to add additional geom object for comparison. Default is FALSE.

Details

Depending on the specification in `pcoxsurvfit.pcoxtime`, this function plots either average or individual survival or cumulative hazard curves. The plot is a `ggplot` object, hence can be be customized further, see example below.

Value

a `ggplot` object.
Examples

```r
library(ggplot2)
data(heart, package="survival")
lam <- 0.02
alp <- 1
pfit <- pcoxtime(Surv(start, stop, event) ~ age + year + surgery + transplant
, data = heart
, lambda = lam
, alpha = alp
)

# Plot survival curves
psurv <- pcoxsurvfit(pfit)
plot(psurv)

# Baseline survival curve
bsurv <- pcoxbasehaz(pfit, centered = FALSE)
plot(bsurv)

# Compare overall and baseline cumulative hazard
p1 <- plot(psurv, type = "cumhaz", compare = TRUE)
df2 <- data.frame(time = bsurv$time, cumhaz = bsurv$hazard)
p2 <- (p1
+ geom_step(data = df2, aes(x = time, y = cumhaz, group = 1, col = "baseline"))
+ scale_colour_manual(name = "C. hazard"
, values = c("#E41A1C", "#000000")
, labels = c("baseline", "overall")
)
)
print(p2)
```

---

**plot.pcoxtme cv**

*Plot solution path for pcoxtme cv*

Description

Plots the cross-validation curve, and upper and lower standard deviation curves, as a function of the optimal lambdas. Also, plots the solution path as a function of optimal lambdas (or randomly picked fold, if `refit = FALSE`) or 11-norm.

Usage

```r
## S3 method for class 'pcoxtme cv'
plot(
  x,
  ..., 
  type = c("cve", "fit"),
)```
plot.pcoxtimetcv

xvar = c("lambda", "l1"),
show_nzero = FALSE,
seed = 1234,
geom = c("point", "line"),
g.size = 0.2,
g.col = "red",
bar.col = g.col,
scales = "free_x",
show_min_cve = TRUE
)

Arguments

x          fitted pcoxtimetcv object.
...         for future implementations

type       which plot to return. type = "cve" (default) return a cross-validation curve and 
type = "fit" returns coefficient profiles (solution path). See details.

xvar       only if type = "fit". Plot coefficients a function of either lambda (xvar = 
            "lambda") or 11-norm (xvar = "l1").

show_nzero logical. Whether to show number of nonzero coefficients on the plot. Default is 
            show_nzero = FALSE. Still experimental for type = "cve".

seed       random number generator. Important if refit = FALSE in pcoxtimetcv.

geom       geom ("point" or "line") for partial likelihood

g.size     size specification for points/lines

g.col      colour specification for points/lines

bar.col    colour specification for error bars

scales     should scales be "fixed", "free", "free_x" or "free_y"?

show_min_cve whether or not to show the alpha which gives minimum cross-validation error. 
            Ignored if a single alpha is specified. This replaced "Optimal" in the version 
            1.01.1 and below.

Details

To plot solution path corresponding to optimal alpha and lambda, set refit = TRUE in pcoxtimetcv. 
The plot is a ggplot object, hence can be be customized further.

Value

a ggplot object.

Examples

library(ggplot2)
# Time-varying covariates
## Not run:
```
data(heart, package="survival")
# Using a vector of alphas = (0.8, 1)
cv1 <- pcoxtimecv(Surv(start, stop, event) ~ age + year + surgery + transplant,
  data = heart,
  alphas = c(0.8, 1),
  refit = TRUE,
  lamfrac = 0.6,
  seed = 1234)
  # Plot cross-validation curves
plot(cv1, type = "cve")

# Plot
plot(cv1, type = "fit")

## End(Not run)
```

---

## plot.Score

### Prediction performance

**Description**

Plots predictive performance of `pcoxtime` in comparison to other models. It uses risk scoring from `Score`. `pcoxtime` also supports performance measure scoring by R package `pec`. See examples.

### Usage

```
## S3 method for class 'Score'
plot(x, ..., type = c("roc", "auc", "brier"), pos = 0.3)
```

### Arguments

- **x**  
  `Score` object. See examples.
- **...**  
  for future implementations.
- **type**  
  metric to return. Choices are "roc", "auc", "brier".
- **pos**  
  spacing between the lines.

### Details

Implements plot method for `Score` for time-dependent Brier score, AUC and ROC. However, currently, no support for time-dependent covariate models.

### Value

A `ggplot` object.
Examples

```r
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}

# pcoxtime
lam <- 0.1
alp <- 1
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior,
                   data = veteran,
                   lambda = lam,
                   alpha = alp)

# coxph
cfit1 <- coxph(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior,
               data = veteran,
               method = "breslow",
               x = TRUE,
               y = TRUE)

# Evaluate model performance at 90, 180, 365 time points
score_obj <- Score(list("coxph" = cfit1, "pcox" = pfit1),
                    Surv(time, status) ~ 1,
                    data = veteran,
                    plots = "roc",
                    metrics = c("auc", "brier"),
                    B = 10,
                    times = c(90, 180, 365))

# Plot AUC
plot(score_obj, type = "auc")
# Plot ROC
plot(score_obj, type = "roc")
# Plot brier
plot(score_obj, type = "brier")

# Prediction error using pec package
## Not run:
if (require("pec")) {
  pec_fit <- pec(list("coxph" = cfit1, "pcox" = pfit1),
                 Surv(time, status) ~ 1,
                 data = veteran,
                 splitMethod = "Boot632plus",
                 keep.matrix = TRUE)
  plot(pec_fit)
}
```
plot.varimp  

Generic method for plotting variable importance

Description
Plots variable importance for `pcoxtime` fit.

Usage

```r
## S3 method for class 'varimp'
plot(x, ..., pos = 0.5, drop_zero = TRUE)
```

Arguments
- `x`: A `varimp` object.
- `...`: For future implementations.
- `pos`: Spacing between labels.
- `drop_zero`: If `TRUE` only nonzero estimates are shown.

See Also
`varimp`

predict.pcoxtime  

Prediction for `pcoxtime` model

Description
Compute fitted values and model terms for the `pcoxtime` model.

Usage

```r
## S3 method for class 'pcoxtime'
predict(
  object,
  ..., 
  newdata = NULL,
  type = c("lp", "risk", "expected", "terms", "survival"),
  terms = object$predictors,
  na.action = na.pass
)
```
**Arguments**

object  
- fitted `pcoxtime` object

...  
- for future implementations.

newdata  
- optional data frame containing the variables appearing on the right hand side of `pcoxtime` formula. If absent, the predictions are for the data frame used in the original fit.

type  
- the type of predicted value. Either linear predictor ("lp"), the risk score ("risk" equivalently \( \exp(lp) \)), the expected number of events given the covariates and follow-up time ("expected"), the terms of linear predictor ("terms") and the survival probability for each individual ("survival").

terms  
- if `type = "terms"`, this argument can be used to specify which terms to be return. Default is all.

na.action  
- defines the missing value action for the `newdata`. If `newdata` is absent, then the behavior of missing is dictated by the `na.action` option of the original fit.

**Details**

The computation of these predictions similar to those in `predict.coxph`. Our current implementation does not incorporate stratification.

**Value**

a vector of predictions, depending on the type.

**Examples**

data(heart, package="survival")
lam <- 0.1
alp <- 0.8
pfit <- pcoxtime(Surv(start, stop, event) ~ age + year + surgery + transplant,
                   data = heart,
                   lambda = lam,
                   alpha = alp)
predict(pfit, type = "lp")
predict(pfit, type = "expected")
predict(pfit, type = "risk")
predict(pfit, type = "survival")
predict(pfit, type = "terms")
predictRisk.pcoxtime  Extract predictions from pcoxtime model

Description

Extract event probabilities from the fitted model.

Usage

## S3 method for class 'pcoxtime'
predictRisk(object, newdata, times, ...)

Arguments

- **object**: fitted pcoxtime.
- **newdata**: a data frame containing the variables appearing on the right hand side of pcoxtime formula.
- **times**: a vector of times in the range of the response, at which to return the survival probabilities.
- **...**: for future implementations.

Details

For survival outcome, the function predicts the risk, $1 - S(t|x)$, where $S(t|x)$ is the survival chance of an individual characterized by $x$.

Value

a matrix of probabilities with as many rows as the rows of the newdata and as many columns as number of time points (times).

Examples

```r
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}
# Penalized
lam <- 0.1
alp <- 0.5
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
, data = veteran
, lambda = lam
, alpha = alp
)
r1 <- predictRisk(pfit1, newdata = veteran[1:80,], times = 10)
```
## predictSurvProb.pcoxtime

*Predict survival probabilities at various time points*

### Description

The function extracts the survival probability predictions from a `pcoxtime` model.

### Usage

```r
## S3 method for class 'pcoxtime'
predictSurvProb(object, newdata, times, ...)
```

### Arguments

- **object**: fitted `pcoxtime`.
- **newdata**: a data frame containing the variables appearing on the right hand side of `pcoxtime` formula.
- **times**: a vector of times in the range of the response, at which to return the survival probabilities.
- **...**: for future implementations.

### Value

A matrix of probabilities with as many rows as the rows of the `newdata` and as many columns as number of time points (`times`).
Examples

```r
if (packageVersion("survival") >="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}
# Penalized
lam <- 0.1
alp <- 0.5
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
  , data = veteran
  , lambda = lam
  , alpha = alp
)
p1 <- predictSurvProb(pfit1, newdata = veteran[1:80,], times = 10)
# Unpenalized
lam <- 0
alp <- 1
pfit2 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
  , data = veteran
  , lambda = lam
  , alpha = alp
)
p2 <- predictSurvProb(pfit2, newdata = veteran[1:80,], times = 10)
plot(p1, p2, xlim=c(0,1), ylim=c(0,1)
  , xlab = "Penalized predicted survival chance at 10"
  , ylab="Unpenalized predicted survival chance at 10"
)
```

---

**print.pcoxbasehaz**

*Print baseline hazard function data frame*

**Description**

Print the head of baseline hazard function data frame.

**Usage**

```r
# S3 method for class 'pcoxbasehaz'
print(x, n = 5, ...)
```

**Arguments**

- `x` the result of a call to the `pcoxbasehaz.pcoxtime` function.
- `n` number of rows to print. Default is 5.
- `...` for future implementations
print.pcoxsurvfit

Details

Provide a summary of pcoxbasehaz.pcoxtime object.

Value

The call to the pcoxbasehaz.pcoxtime and the head of baseline hazard function data frame.

print.pcoxsurvfit

Print a short summary of survival function

Description

Print the number of observations and number of events.

Usage

## S3 method for class 'pcoxsurvfit'
print(x, ...)

Arguments

x the result of a call to the pcoxsurvfit.pcoxtime function.
... for future implementations

Details

Provide a summary of pcoxsurvfit.pcoxtime object.

Value

The call to the pcoxsurvfit.pcoxtime and the summary of the survival function.

print.pcoxtime

Print coefficients from a pcoxtime object

Description

This function prints a summary of the pcoxtime object.

Usage

## S3 method for class 'pcoxtime'
print(x, ..., nprint = 10)
Arguments

- x: fitted \texttt{pcoxtime} model object
- ...: for future implementations
- nprint: number of coefficients to print out

Details

The call that produced \texttt{pcoxtime} is printed, followed by coefficient estimates with their corresponding exponentiated values. Depending on the number of coefficients, \texttt{nprint} can be used to specify the number of coefficients to print out.

Value

A two column output, the first column is the coefficient estimate and the second column is the exponent of the coefficient estimate. Additional summary about the number of nonzero coefficients, the number of observations and the number of event of interest are also printed.

---

\texttt{print.pcoxtimecv} \hspace{1cm} \textit{Print cross-validated pcoxtime object}

Description

Print the summary of the result of cross-validation for a pcoxtime object.

Usage

```r
## S3 method for class 'pcoxtimecv'
print(x, ...)
```

Arguments

- x: \texttt{pcoxtimecv} object
- ...: for future implementations

Details

A summary of optimal lambda and alpha for training pcoxtime model.

Value

The call to the \texttt{pcoxtimecv} and the summary of the optimal alpha and lambdas.
## varimp.pcoxtime

*varimp.pcoxtime*  
*Compute variable or coefficient importance score*

### Description

Compute variable or coefficient importance score

### Usage

```r
## S3 method for class 'pcoxtime'
varimp(
  object,  # fitted pcoxtime.
  newdata,  # data frame containing the variables appearing on the right hand side of pcoxtime formula.
  type = c("coef", "perm", "model"),  # if type = "coef" or type = "model" absolute value of estimated coefficients is computed. If type = "perm" variable level importance is computed using permutation.
  relative = TRUE,  # logical. If TRUE the scores are divided by the absolute sum of the coefficients.
  nrep = 50,  # number of replicates for permutations. Default is nrep = 50.
  parallelize = FALSE,  # whether to run in parallel. Default is FALSE.
  nclusters = 1,  # number of cores to use if parallelize = TRUE.
  estimate = c("mean", "quantile"),  # character string specify which summary statistic to use for the estimates. Default is "mean".
  probs = c(0.025, 0.5, 0.975),  # numeric vector of probabilities with values in [0, 1].
  seed = NULL,  # a single value for for random number generation.
  ...  # for future implementation.
)
```

### Arguments

- **object**: fitted `pcoxtime`.
- **newdata**: data frame containing the variables appearing on the right hand side of `pcoxtime` formula.
- **type**: if `type = "coef"` or `type = "model"` absolute value of estimated coefficients is computed. If `type = "perm"` variable level importance is computed using permutation.
- **relative**: logical. If TRUE the scores are divided by the absolute sum of the coefficients.
- **nrep**: number of replicates for permutations. Default is `nrep = 50`.
- **parallelize**: whether to run in parallel. Default is `FALSE`.
- **nclusters**: number of cores to use if `parallelize = TRUE`.
- **estimate**: character string specify which summary statistic to use for the estimates. Default is "mean".
- **probs**: numeric vector of probabilities with values in [0, 1].
- **seed**: a single value for for random number generation.
- **...**: for future implementation.
Details

Absolute value of the coefficients (parameters) corresponding the pcoxtime object (type = "coef"). Otherwise, variable level importance is computed using permutation (type = "perm"). In the case of permutation: given predictors $x_1, x_2, \ldots, x_n$ used to predict the survival outcome, $y$. Suppose, for example, $x_1$ has low predictive power for the response. Then, if we randomly permute the observed values for $x_1$, then the prediction for $y$ will not change much. Conversely, if any of the predictors highly predicts the response, the permutation of that specific predictor will lead to a considerable change in the predictive measure of the model. In this case, we conclude that this predictor is important. In our implementation, Harrel’s concordance index is used to measure the prediction accuracy.

Value

a named vector of variable scores (estimate = "mean") or a data frame (estimate = "quantile").

Examples

```r
if (packageVersion("survival")>="3.2.9") {
  data(cancer, package="survival")
} else {
  data(veteran, package="survival")
}
# Penalized
lam <- 0.1
alp <- 0.5
pfit1 <- pcoxtime(Surv(time, status) ~ factor(trt) + karno + diagtime + age + prior
  , data = veteran
  , lambda = lam
  , alpha = alp
)
imp1 <- varimp(pfit1, veteran)
plot(imp1)
```
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