

Package: **hdcuremodels** (via r-universe)

March 21, 2025

Title Penalized Mixture Cure Models for High-Dimensional Data

Version 0.0.2

Date 2025-03-11

Description Provides functions for fitting various penalized parametric and semi-parametric mixture cure models with different penalty functions, testing for a significant cure fraction, and testing for sufficient follow-up as described in Fu et al (2022)<[doi:10.1002/sim.9513](https://doi.org/10.1002/sim.9513)> and Archer et al (2024)<[doi:10.1186/s13045-024-01553-6](https://doi.org/10.1186/s13045-024-01553-6)>. False discovery rate controlled variable selection is provided using model-X knock-offs.

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Encoding UTF-8

Depends R (>= 4.2.0)

Imports doParallel, flexsurv, flexsurvcure, foreach, ggplot2, ggpubr, glmnet, knockoff, mvnfast, parallel, plyr, methods, survival, withr

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RoxygenNote 7.3.2

Suggests knitr, rmarkdown, roxygen2, testthat (>= 3.0.0)

VignetteBuilder knitr

LazyData true

URL <https://github.com/kelliejarcher/hdcuremodels>

BugReports <https://github.com/kelliejarcher/hdcuremodels/issues>

Config/testthat/edition 3

Config/pak/sysreqs cmake make libicu-dev

Repository <https://kelliejarcher.r-universe.dev>

RemoteUrl <https://github.com/kelliejarcher/hdcuremodels>

RemoteRef HEAD

RemoteSha 55d82b91c8287d19babf52991440e2daba509eb5

Contents

amltest	2
amltrain	11
auc_mcm	21
coef.mixturecure	22
concordance_mcm	23
cureem	24
curegmifs	27
cure_estimate	30
cv_cureem	31
cv_curegmifs	35
generate_cure_data	39
nonzerocure_test	40
plot.mixturecure	42
predict.mixturecure	43
print.mixturecure	44
sufficient_fu_test	45
summary.mixturecure	46
Index	48

amltest	<i>AML test data</i>
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Description

Duration of complete response for 40 cytogenetically normal AML patients and a subset of 320 transcript expression from RNA-sequencing.

Usage

amltest

Format

A data frame with 40 rows (subjects) and 322 columns:

- cryr** duration of complete response in years
- relapse.death** censoring indicator: 1 = relapsed or died; 0 = alive at last follow-up
- ENSG00000001561** normalized expression for indicated transcript
- ENSG00000005249** normalized expression for indicated transcript
- ENSG00000006757** normalized expression for indicated transcript
- ENSG00000007062** normalized expression for indicated transcript
- ENSG00000007968** normalized expression for indicated transcript
- ENSG00000008283** normalized expression for indicated transcript

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Source

[doi:10.1186/s13045-024-01553-6](https://doi.org/10.1186/s13045-024-01553-6)

amltrain	<i>AML training data</i>
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Description

Duration of complete response for 306 cytogenetically normal AML patients and a subset of 320 transcript expression from RNA-sequencing.

Usage

amltrain

Format

A data frame with 306 rows (subjects) and 322 columns:

crrr duration of complete response in years

relapse.death censoring indicator: 1 = relapsed or died; 0 = alive at last follow-up

ENSG00000001561 normalized expression for indicated transcript

ENSG00000005249 normalized expression for indicated transcript

ENSG00000006757 normalized expression for indicated transcript

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ENSG00000213722 normalized expression for indicated transcript
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ENSG00000213967 normalized expression for indicated transcript
ENSG00000214016 normalized expression for indicated transcript
ENSG00000214425 normalized expression for indicated transcript
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ENSG00000220008 normalized expression for indicated transcript
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ENSG00000225138 normalized expression for indicated transcript
ENSG00000226471 normalized expression for indicated transcript
ENSG00000227097 normalized expression for indicated transcript
ENSG00000227191 normalized expression for indicated transcript
ENSG00000227615 normalized expression for indicated transcript
ENSG00000228049 normalized expression for indicated transcript
ENSG00000229153 normalized expression for indicated transcript
ENSG00000230076 normalized expression for indicated transcript
ENSG00000231160 normalized expression for indicated transcript
ENSG00000231721 normalized expression for indicated transcript
ENSG00000233927 normalized expression for indicated transcript
ENSG00000233974 normalized expression for indicated transcript
ENSG00000234883 normalized expression for indicated transcript
ENSG00000236876 normalized expression for indicated transcript
ENSG00000237298 normalized expression for indicated transcript
ENSG00000237892 normalized expression for indicated transcript
ENSG00000238160 normalized expression for indicated transcript

ENSG00000239437 normalized expression for indicated transcript
ENSG00000241399 normalized expression for indicated transcript
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ENSG00000241529 normalized expression for indicated transcript
ENSG00000244405 normalized expression for indicated transcript
ENSG00000247627 normalized expression for indicated transcript
ENSG00000249592 normalized expression for indicated transcript
ENSG00000250116 normalized expression for indicated transcript
ENSG00000250251 normalized expression for indicated transcript
ENSG00000251079 normalized expression for indicated transcript
ENSG00000253210 normalized expression for indicated transcript
ENSG00000253276 normalized expression for indicated transcript
ENSG00000254415 normalized expression for indicated transcript
ENSG00000259276 normalized expression for indicated transcript
ENSG00000260727 normalized expression for indicated transcript
ENSG00000261377 normalized expression for indicated transcript
ENSG00000264885 normalized expression for indicated transcript
ENSG00000264895 normalized expression for indicated transcript
ENSG00000267136 normalized expression for indicated transcript
ENSG00000267551 normalized expression for indicated transcript
ENSG00000267702 normalized expression for indicated transcript
ENSG00000268001 normalized expression for indicated transcript
ENSG00000268573 normalized expression for indicated transcript
ENSG00000270554 normalized expression for indicated transcript
ENSG00000270562 normalized expression for indicated transcript
ENSG00000271646 normalized expression for indicated transcript
ENSG00000273018 normalized expression for indicated transcript
ENSG00000273033 normalized expression for indicated transcript

Source

[doi:10.1186/s13045-024-01553-6](https://doi.org/10.1186/s13045-024-01553-6)

auc_mcm

*AUC for cure prediction using mean score imputation***Description**

This function calculates the AUC for cure prediction using the mean score imputation (MSI) method proposed by Asano et al.

Usage

```
auc_mcm(object, newdata, cure_cutoff = 5, model_select = "AIC")
```

Arguments

object	a mixturecure object resulting from curegmifs, cureem, cv_curegmifs, cv_cureem.
newdata	an optional data.frame that minimally includes the incidence and/or latency variables to use for predicting the response. If omitted, the training data are used.
cure_cutoff	cutoff value for cure, used to produce a proxy for the unobserved cure status; default is 5.
model_select	a case-sensitive parameter for models fit using curegmifs or cureem any step along the solution path can be selected. The default is model_select = "AIC" which calculates the predicted values using the coefficients from the model having the lowest AIC. Other options are model_select = "mAIC" for the modified AIC, model_select = "cAIC" for the corrected AIC, model_select = "BIC", model_select = "mBIC" for the modified BIC, model_select = "EBIC" for the extended BIC, model_select = "logLik" for the step that maximizes the log-likelihood, or any numeric value from the solution path. This option has no effect for objects fit using cv_curegmifs or cv_cureem.

Value

Returns the AUC value for cure prediction using the mean score imputation (MSI) method.

References

Asano, J., Hirakawa, H., Hamada, C. (2014) Assessing the prediction accuracy of cure in the Cox proportional hazards cure model: an application to breast cancer data. *Pharmaceutical Statistics*, **13**:357–363.

See Also

[concordance_mcm](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
testing <- temp$testing
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
auc_mcm(fit, model_select = "cAIC")
auc_mcm(fit, newdata = testing)
```

coef.mixturecure	<i>Extract model coefficients from a fitted mixture cure object</i>
------------------	---

Description

coef.mixturecure is a generic function which extracts the model coefficients from a fitted mixture cure model object fit using curegmifs, cureem, cv_curegmifs, or cv_cureem.

Usage

```
## S3 method for class 'mixturecure'
coef(object, model_select = "AIC", ...)
```

Arguments

object	a mixturecure object resulting from curegmifs, cureem, cv_curegmifs, or cv_cureem.
model_select	a case-sensitive parameter for models fit using curegmifs or cureem any step along the solution path can be selected. The default is model_select = "AIC" which calculates the predicted values using the coefficients from the model having the lowest AIC. Other options are model_select = "mAIC" for the modified AIC, model_select = "cAIC" for the corrected AIC, model_select = "BIC", model_select = "mBIC" for the modified BIC, model_select = "EBIC" for the extended BIC, model_select = "logLik" for the step that maximizes the log-likelihood, or any numeric value from the solution path. This option has no effect for objects fit using cv_curegmifs or cv_cureem.
...	other arguments.

Value

a list of estimated parameters extracted from the model object using the model selection criterion

See Also

[curegmifs](#), [cureem](#), [summary.mixturecure](#), [plot.mixturecure](#), [predict.mixturecure](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
coef(fit)
```

concordance_mcm

C-statistic for mixture cure models

Description

This function calculates the C-statistic using the cure status weighting (CSW) method proposed by Asano and Hirakawa.

Usage

```
concordance_mcm(object, newdata, cure_cutoff = 5, model_select = "AIC")
```

Arguments

object	a mixturecure object resulting from <code>curegmifs</code> , <code>cureem</code> , <code>cv_curegmifs</code> , <code>cv_cureem</code> .
newdata	an optional data.frame that minimally includes the incidence and/or latency variables to use for predicting the response. If omitted, the training data are used.
cure_cutoff	cutoff value for cure, used to produce a proxy for the unobserved cure status; default is 5.
model_select	a case-sensitive parameter for models fit using <code>curegmifs</code> or <code>cureem</code> any step along the solution path can be selected. The default is <code>model_select = "AIC"</code> which calculates the predicted values using the coefficients from the model having the lowest AIC. Other options are <code>model_select = "mAIC"</code> for the modified AIC, <code>model_select = "cAIC"</code> for the corrected AIC, <code>model_select = "BIC"</code> , <code>model_select = "mBIC"</code> for the modified BIC, <code>model_select = "EBIC"</code> for the extended BIC, <code>model_select = "logLik"</code> for the step that maximizes the log-likelihood, or any numeric value from the solution path. This option has no effect for objects fit using <code>cv_curegmifs</code> or <code>cv_cureem</code> .

Value

value of C-statistic for the cure models.

References

Asano, J. and Hirakawa, H. (2017) Assessing the prediction accuracy of a cure model for censored survival data with long-term survivors: Application to breast cancer data. *Journal of Biopharmaceutical Statistics*, **27**:6, 918–932.

See Also

[auc_mcm](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
testing <- temp$testing
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
concordance_mcm(fit, model_select = "cAIC")
concordance_mcm(fit, newdata = testing, model_select = "cAIC")
```

cureem

Fit penalized mixture cure model using the E-M algorithm

Description

Fits a penalized parametric and semi-parametric mixture cure model (MCM) using the E-M algorithm with user-specified penalty parameters. The lasso (L1), MCP, and SCAD penalty is supported for the Cox MCM while only lasso is currently supported for parametric MCMs.

Usage

```
cureem(
  formula,
  data,
  subset,
  x_latency = NULL,
  model = c("cox", "weibull", "exponential"),
  penalty = c("lasso", "MCP", "SCAD"),
  penalty_factor_inc = NULL,
  penalty_factor_lat = NULL,
  thresh = 0.001,
  scale = TRUE,
  maxit = NULL,
  inits = NULL,
```



```

    lambda_inc = 0.1,
    lambda_lat = 0.1,
    gamma_inc = 3,
    gamma_lat = 3,
    ...
)

```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The response must be a survival object as returned by the <code>Surv</code> function while the variables on the right side of the formula are the covariates that are included in the incidence portion of the model.
data	a <code>data.frame</code> in which to interpret the variables named in the formula or in the subset argument.
subset	an optional expression indicating which subset of observations to be used in the fitting process, either a numeric or factor variable should be used in subset, not a character variable. All observations are included by default.
x_latency	specifies the variables to be included in the latency portion of the model and can be either a matrix of predictors, a model formula with the right hand side specifying the latency variables, or the same <code>data.frame</code> passed to the <code>data</code> parameter. Note that when using the model formula syntax for <code>x_latency</code> it cannot handle <code>x_latency = ~ ..</code> .
model	type of regression model to use for the latency portion of mixture cure model. Can be "cox", "weibull", or "exponential" (default is "cox").
penalty	type of penalty function. Can be "lasso", "MCP", or "SCAD" (default is "lasso").
penalty_factor_inc	vector of binary indicators representing the penalty to apply to each incidence coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all incidence variables.
penalty_factor_lat	vector of binary indicators representing the penalty to apply to each latency coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all latency variables.
thresh	small numeric value. The iterative process stops when the differences between successive expected penalized complete-data log-likelihoods for both incidence and latency components are less than this specified level of tolerance (default is 10^{-3}).
scale	logical, if TRUE the predictors are centered and scaled.
maxit	integer specifying the maximum number of passes over the data for each lambda. If not specified, 100 is applied when <code>penalty = "lasso"</code> and 1000 is applied when <code>penalty = "MCP"</code> or <code>penalty = "SCAD"</code> .
inits	an optional list specifying the initial value for the incidence intercept (<code>itct</code>), a numeric vector for the unpenalized incidence coefficients (<code>b_u</code>), and a numeric vector for unpenalized latency coefficients (<code>beta_u</code>). For parametric models, it

should also include a numeric value for the rate parameter (λ) when `model = "weibull"` or `model = "exponential"`, and a numeric value for the shape parameter (α) when `model = "weibull"`. When `model = "cox"`, it should also include a numeric vector for the latency survival probabilities $S_u(t_i|w_i)$ for $i=1,\dots,N$ (`survprob`). Penalized coefficients are initialized to zero. If `inits` is not specified or improperly specified, initialization is automatically provided by the function.

<code>lambda_inc</code>	numeric value for the penalization parameter λ for variables in the incidence portion of the model.
<code>lambda_lat</code>	numeric value for the penalization parameter λ for variables in the latency portion of the model.
<code>gamma_inc</code>	numeric value for the penalization parameter γ for variables in the incidence portion of the model when <code>penalty = "MCP"</code> or <code>penalty = "SCAD"</code> (default is 3).
<code>gamma_lat</code>	numeric value for the penalization parameter γ for variables in the latency portion of the model when <code>penalty = "MCP"</code> or <code>penalty = "SCAD"</code> (default is 3).
<code>...</code>	additional arguments.

Value

<code>b_path</code>	Matrix representing the solution path of the coefficients in the incidence portion of the model. Row is step and column is variable.
<code>beta_path</code>	Matrix representing the solution path of the coefficients in the latency portion of the model. Row is step and column is variable.
<code>b0_path</code>	Vector representing the solution path of the intercept in the incidence portion of the model.
<code>logLik_inc</code>	Vector representing the expected penalized complete-data log-likelihood for the incidence portion of the model for each step in the solution path.
<code>logLik_lat</code>	Vector representing the expected penalized complete-data log-likelihood for the latency portion of the model for each step in the solution path.
<code>x_incidence</code>	Matrix representing the design matrix of the incidence predictors.
<code>x_latency</code>	Matrix representing the design matrix of the latency predictors.
<code>y</code>	Vector representing the survival object response as returned by the <code>Surv</code> function
<code>model</code>	Character string indicating the type of regression model used for the latency portion of mixture cure model ("weibull" or "exponential").
<code>scale</code>	Logical value indicating whether the predictors were centered and scaled.
<code>method</code>	Character string indicating the EM algorithm was used in fitting the mixture cure model.
<code>rate_path</code>	Vector representing the solution path of the rate parameter for the Weibull or exponential density in the latency portion of the model.
<code>alpha_path</code>	Vector representing the solution path of the shape parameter for the Weibull density in the latency portion of the model.
<code>call</code>	the matched call.

References

Archer, K. J., Fu, H., Mrozek, K., Nicolet, D., Mims, A. S., Uy, G. L., Stock, W., Byrd, J. C., Hiddemann, W., Braess, J., Spiekermann, K., Metzeler, K. H., Herold, T., Eisfeld, A.-K. (2024) Identifying long-term survivors and those at higher or lower risk of relapse among patients with cytogenetically normal acute myeloid leukemia using a high-dimensional mixture cure model. *Journal of Hematology & Oncology*, **17**:28.

See Also

[cv_cureem](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 80, j = 100, n_true = 10, a = 1.8)
training <- temp$training
fit <- cureem(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "cox", penalty = "lasso", lambda_inc = 0.1,
  lambda_lat = 0.1, gamma_inc = 6, gamma_lat = 10
)
```

curegmifs

Fit penalized parametric mixture cure model using the GMIFS algorithm

Description

Fits a penalized Weibull or exponential mixture cure model using the generalized monotone incremental forward stagewise (GMIFS) algorithm and yields solution paths for parameters in the incidence and latency portions of the model.

Usage

```
curegmifs(
  formula,
  data,
  subset,
  x_latency = NULL,
  model = c("weibull", "exponential"),
  penalty_factor_inc = NULL,
  penalty_factor_lat = NULL,
  epsilon = 0.001,
  thresh = 1e-05,
  scale = TRUE,
  maxit = 10000,
  inits = NULL,
```

```

    verbose = TRUE,
    suppress_warning = FALSE,
    ...
)

```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The response must be a survival object as returned by the <code>Surv</code> function while the variables on the right side of the formula are the covariates that are included in the incidence portion of the model.
data	a data.frame in which to interpret the variables named in the formula or in the subset argument.
subset	an optional expression indicating which subset of observations to be used in the fitting process, either a numeric or factor variable should be used in subset, not a character variable. All observations are included by default.
x_latency	specifies the variables to be included in the latency portion of the model and can be either a matrix of predictors, a model formula with the right hand side specifying the latency variables, or the same data.frame passed to the data parameter. Note that when using the model formula syntax for x_latency it cannot handle <code>x_latency = ~ ..</code>
model	type of regression model to use for the latency portion of mixture cure model. Can be "weibull" or "exponential"; default is "weibull".
penalty_factor_inc	vector of binary indicators representing the penalty to apply to each incidence coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all incidence variables.
penalty_factor_lat	vector of binary indicators representing the penalty to apply to each latency coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all latency variables.
epsilon	small numeric value reflecting the incremental value used to update a coefficient at a given step (default is 0.001).
thresh	small numeric value. The iterative process stops when the differences between successive expected penalized complete-data log-likelihoods for both incidence and latency components are less than this specified level of tolerance (default is 10^{-5}).
scale	logical, if TRUE the predictors are centered and scaled.
maxit	integer specifying the maximum number of steps to run in the iterative algorithm (default is 10^4).
inits	an optional list specifying the initial value for the incidence intercept (<code>itct</code>), a numeric vector for the unpenalized incidence coefficients (<code>b_u</code>), and a numeric vector for unpenalized latency coefficients (<code>beta_u</code>), a numeric value for the rate parameter (<code>lambda</code>), and a numeric value for the shape parameter (<code>alpha</code>) when <code>model = "weibull"</code> . If not supplied or improperly supplied, initialization is automatically provided by the function.

verbose	logical, if TRUE running information is printed to the console (default is FALSE).
suppress_warning	logical, if TRUE, suppresses echoing the warning that the maximum number of iterations was reached so that the algorithm may not have converged. Instead, warning is returned as part of the output with this message.
...	additional arguments.

Value

b_path	Matrix representing the solution path of the coefficients in the incidence portion of the model. Row is step and column is variable.
beta_path	Matrix representing the solution path of the coefficients in the latency portion of the model. Row is step and column is variable.
b0_path	Vector representing the solution path of the intercept in the incidence portion of the model.
rate_path	Vector representing the solution path of the rate parameter for the Weibull or exponential density in the latency portion of the model.
logLik	Vector representing the log-likelihood for each step in the solution path.
x_incidence	Matrix representing the design matrix of the incidence predictors.
x_latency	Matrix representing the design matrix of the latency predictors.
y	Vector representing the survival object response as returned by the Surv function
model	Character string indicating the type of regression model used for the latency portion of mixture cure model ("weibull" or "exponential").
scale	Logical value indicating whether the predictors were centered and scaled.
alpha_path	Vector representing the solution path of the shape parameter for the Weibull density in the latency portion of the model.
call	the matched call.
warning	message indicating whether the maximum number of iterations was achieved which may indicate the model did not converge.

References

Fu, H., Nicolet, D., Mrozek, K., Stone, R. M., Eisfeld, A. K., Byrd, J. C., Archer, K. J. (2022) Controlled variable selection in Weibull mixture cure models for high-dimensional data. *Statistics in Medicine*, **41**(22), 4340–4366.

See Also

[cv_curegmifs](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training

fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000, epsilon = 0.01,
  verbose = FALSE
)
```

cure_estimate	<i>Estimate cured fraction</i>
---------------	--------------------------------

Description

Estimates the cured fraction using a Kaplan-Meier fitted object.

Usage

```
cure_estimate(object)
```

Arguments

object a survfit object.

Value

estimated proportion of cured observations

See Also

[survfit](#), [sufficient_fu_test](#), [nonzerocure_test](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
km_fit <- survfit(Surv(Time, Censor) ~ 1, data = training)
cure_estimate(km_fit)
```

cv_cureem

Fit penalized mixture cure model using the E-M algorithm with cross-validation for parameter tuning

Description

Fits a penalized parametric and semi-parametric mixture cure model (MCM) using the E-M algorithm with with k-fold cross-validation for parameter tuning. The lasso (L1), MCP and SCAD penalty are supported for the Cox MCM while only lasso is currently supported for parametric MCMs. When FDR controlled variable selection is used, the model-X knockoffs method is applied and indices of selected variables are returned.

Usage

```
cv_cureem(
  formula,
  data,
  subset,
  x_latency = NULL,
  model = c("cox", "weibull", "exponential"),
  penalty = c("lasso", "MCP", "SCAD"),
  penalty_factor_inc = NULL,
  penalty_factor_lat = NULL,
  fdr_control = FALSE,
  fdr = 0.2,
  grid_tuning = FALSE,
  thresh = 0.001,
  scale = TRUE,
  maxit = NULL,
  inits = NULL,
  lambda_inc_list = NULL,
  lambda_lat_list = NULL,
  nlambda_inc = NULL,
  nlambda_lat = NULL,
  gamma_inc = 3,
  gamma_lat = 3,
  lambda_min_ratio_inc = 0.1,
  lambda_min_ratio_lat = 0.1,
  n_folds = 5,
  measure_inc = c("c", "auc"),
  one_se = FALSE,
  cure_cutoff = 5,
  parallel = FALSE,
  seed = NULL,
  verbose = TRUE,
  ...
)
```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The response must be a survival object as returned by the Surv function while the variables on the right side of the formula are the covariates that are included in the incidence portion of the model.
data	a data.frame in which to interpret the variables named in the formula or in the subset argument.
subset	an optional expression indicating which subset of observations to be used in the fitting process, either a numeric or factor variable should be used in subset, not a character variable. All observations are included by default.
x_latency	specifies the variables to be included in the latency portion of the model and can be either a matrix of predictors, a model formula with the right hand side specifying the latency variables, or the same data.frame passed to the data parameter. Note that when using the model formula syntax for x_latency it cannot handle <code>x_latency = ~ ..</code> .
model	type of regression model to use for the latency portion of mixture cure model. Can be "cox", "weibull", or "exponential" (default is "cox").
penalty	type of penalty function. Can be "lasso", "MCP", or "SCAD" (default is "lasso").
penalty_factor_inc	vector of binary indicators representing the penalty to apply to each incidence coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all incidence variables.
penalty_factor_lat	vector of binary indicators representing the penalty to apply to each latency coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all latency variables.
fdr_control	logical, if TRUE, model-X knockoffs are used for FDR-controlled variable selection and indices of selected variables are returned (default is FALSE).
fdr	numeric value in (0, 1) range specifying the target FDR level to use for variable selection when fdr_control=TRUE (default is 0.2).
grid_tuning	logical, if TRUE a 2-D grid tuning approach is used to select the optimal pair of λ_b and λ_β penalty parameters for the incidence and latency portions of the model, respectively. Otherwise the λ_b and λ_β are selected from a 1-D sequence and are equal to one another (default is FALSE).
thresh	small numeric value. The iterative process stops when the differences between successive expected penalized complete-data log-likelihoods for both incidence and latency components are less than this specified level of tolerance (default is 10^{-3}).
scale	logical, if TRUE the predictors are centered and scaled.
maxit	maximum number of passes over the data for each lambda. If not specified, 100 is applied when penalty = "lasso" and 1000 is applied when penalty = "MCP" or penalty = "SCAD".

inits	an optional list specifying the initial value for the incidence intercept (itct), a numeric vector for the unpenalized incidence coefficients (b_u), and a numeric vector for unpenalized latency coefficients (beta_u). For parametric models, it should also include a numeric value for the rate parameter (lambda) when model = "weibull" or model = "exponential", and a numeric value for the shape parameter (alpha) when model = "weibull". When model = "cox", it should also include a numeric vector for the latency survival probabilities $S_u(t_i w_i)$ for $i=1,...,N$ (survprob). Penalized coefficients are initialized to zero. If inits is not specified or improperly specified, initialization is automatically provided by the function.
lambda_inc_list	a numeric vector used to search for the optimal λ_b tuning parameter. If not supplied, the function computes a λ_b sequence based on nlambda_inc and lambda_min_ratio_inc. If grid_tuning=FALSE, the same sequence should be used for both λ_b and λ_β .
lambda_lat_list	a numeric vector used to search for the optimal λ_β tuning parameter. If not supplied, the function computes a λ_β sequence based on nlambda_lat and lambda_min_ratio_lat. If grid_tuning=FALSE, the same sequence should be used for both λ_b and λ_β .
nlambda_inc	an integer specifying the number of values to search for the optimal λ_b tuning parameter; default is 10 if grid_tuning=TRUE and 50 otherwise.
nlambda_lat	an integer specifying the number of values to search for the optimal λ_β tuning parameter; default is 10 if grid_tuning=TRUE and 50 otherwise.
gamma_inc	numeric value for the penalization parameter γ for variables in the incidence portion of the model when penalty = "MCP" or penalty = "SCAD" (default is 3).
gamma_lat	numeric value for the penalization parameter γ for variables in the latency portion of the model when penalty = "MCP" or penalty = "SCAD" (default is 3).
lambda_min_ratio_inc	numeric value in (0,1) representing the smallest value for λ_b as a fraction of lambda_max_inc, the data-derived entry value at which essentially all penalized variables in the incidence portion of the model have a coefficient estimate of 0 (default is 0.1).
lambda_min_ratio_lat	numeric value in (0,1) representing the smallest value for λ_β as a fraction of lambda_max_lat, the data-derived entry value at which essentially all penalized variables in the latency portion of the model have a coefficient estimate of 0 (default is 0.1).
n_folds	an integer specifying the number of folds for the k-fold cross-validation procedure (default is 5).
measure_inc	character string specifying the evaluation criterion used in selecting the optimal λ_b . Can be "c" or "auc"; default is "c". If measure_inc="c", the C-statistic using the cure status weighting (CSW) method proposed by Asano and Hirakawa (2017) is used to select both λ_b and λ_β . If measure_inc="auc", the AUC for cure prediction using the mean score imputation (MSI) method proposed by Asano et al. (2014) is used to select λ_b while the C-statistic with CSW is used for λ_β .

one_se	logical, if TRUE then the one standard error rule is applied for selecting the optimal parameters. The one standard error rule selects the most parsimonious model having evaluation criterion no more than one standard error worse than that of the best evaluation criterion (default is FALSE).
cure_cutoff	numeric value representing the cutoff time value that represents subjects not experiencing the event by this time are cured. This value is used to produce a proxy for the unobserved cure status when calculating C-statistic and AUC (default is 5 representing 5 years). Users should be careful to note the time scale of their data and adjust this according to the time scale and clinical application.
parallel	logical. If TRUE, parallel processing is performed for K-fold CV using foreach and the doParallel package is required.
seed	optional integer representing the random seed. Setting the random seed fosters reproducibility of the results.
verbose	logical, if TRUE running information is printed to the console (default is FALSE).
...	additional arguments.

Value

b0	Estimated intercept for the incidence portion of the model.
b	Estimated coefficients for the incidence portion of the model.
beta	Estimated coefficients for the latency portion of the model.
alpha	Estimated shape parameter if the Weibull model is fit.
rate	Estimated rate parameter if the Weibull or exponential model is fit.
logLik_inc	Expected penalized complete-data log-likelihood for the incidence portion of the model.
logLik_lat	Expected penalized complete-data log-likelihood for the latency portion of the model.
selected_lambda_inc	Value of λ_b selected using cross-validation. NULL when <code>fdr_control</code> is TRUE.
selected_lambda_lat	Value of λ_β selected using cross-validation. NULL when <code>fdr_control</code> is TRUE.
max_c	Maximum C-statistic achieved.
max_auc	Maximum AUC for cure prediction achieved; only output when <code>measure_inc="auc"</code> .
selected_index_inc	Indices of selected variables for the incidence portion of the model when <code>fdr_control=TRUE</code> . If no variables are selected, <code>int(0)</code> will be returned.
selected_index_lat	Indices of selected variables for the latency portion of the model when <code>fdr_control=TRUE</code> . If no variables are selected, <code>int(0)</code> will be returned.
call	the matched call.

References

Archer, K. J., Fu, H., Mrozek, K., Nicolet, D., Mims, A. S., Uy, G. L., Stock, W., Byrd, J. C., Hiddemann, W., Braess, J., Spiekermann, K., Metzeler, K. H., Herold, T., Eisfeld, A.-K. (2024) Identifying long-term survivors and those at higher or lower risk of relapse among patients with cytogenetically normal acute myeloid leukemia using a high-dimensional mixture cure model. *Journal of Hematology & Oncology*, **17**:28.

See Also

[cureem](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 200, j = 25, n_true = 5, a = 1.8)
training <- temp$training
fit.cv <- cv_cureem(Surv(Time, Censor) ~ .,
  data = training,
  x_latency = training, fdr_control = FALSE,
  grid_tuning = FALSE, nlambda_inc = 10, nlambda_lat = 10,
  n_folds = 2, seed = 23, verbose = TRUE
)
fit.cv.fdr <- cv_cureem(Surv(Time, Censor) ~ .,
  data = training,
  x_latency = training, model = "weibull", penalty = "lasso",
  fdr_control = TRUE, grid_tuning = FALSE, nlambda_inc = 10,
  nlambda_lat = 10, n_folds = 2, seed = 23, verbose = TRUE
)
```

cv_curegmifs

Fit a penalized parametric mixture cure model using the GMIFS algorithm with cross-validation for model selection

Description

Fits a penalized Weibull or exponential mixture cure model using the generalized monotone incremental forward stagewise (GMIFS) algorithm with k-fold cross-validation to select the optimal iteration step along the solution path. When FDR controlled variable selection is used, the model-X knockoffs method is applied and indices of selected variables are returned.

Usage

```
cv_curegmifs(
  formula,
  data,
  subset,
  x_latency = NULL,
```

```

model = c("weibull", "exponential"),
penalty_factor_inc = NULL,
penalty_factor_lat = NULL,
fdr_control = FALSE,
fdr = 0.2,
epsilon = 0.001,
thresh = 1e-05,
scale = TRUE,
maxit = 10000,
inits = NULL,
n_folds = 5,
measure_inc = c("c", "auc"),
one_se = FALSE,
cure_cutoff = 5,
parallel = FALSE,
seed = NULL,
verbose = TRUE,
...
)

```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The response must be a survival object as returned by the Surv function while the variables on the right side of the formula are the covariates that are included in the incidence portion of the model.
data	a data.frame in which to interpret the variables named in the formula or in the subset argument.
subset	an optional expression indicating which subset of observations to be used in the fitting process, either a numeric or factor variable should be used in subset, not a character variable. All observations are included by default.
x_latency	specifies the variables to be included in the latency portion of the model and can be either a matrix of predictors, a model formula with the right hand side specifying the latency variables, or the same data.frame passed to the data parameter. Note that when using the model formula syntax for x_latency it cannot handle <code>x_latency = ~ ..</code> .
model	type of regression model to use for the latency portion of mixture cure model. Can be "weibull" or "exponential"; default is "weibull".
penalty_factor_inc	vector of binary indicators representing the penalty to apply to each incidence coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all incidence variables.
penalty_factor_lat	vector of binary indicators representing the penalty to apply to each latency coefficient: 0 implies no shrinkage and 1 implies shrinkage. If not supplied, 1 is applied to all latency variables.

fdr_control	logical, if TRUE, model-X knockoffs are used for FDR-controlled variable selection and indices of selected variables are returned (default is FALSE).
fdr	numeric value in (0, 1) range specifying the target FDR level to use for variable selection when fdr_control=TRUE (default is 0.2).
epsilon	small numeric value reflecting incremental value used to update a coefficient at a given step (default is 0.001).
thresh	small numeric value. The iterative process stops when the differences between successive expected penalized complete-data log-likelihoods for both incidence and latency components are less than this specified level of tolerance (default is 10^{-5}).
scale	logical, if TRUE the predictors are centered and scaled.
maxit	integer specifying the maximum number of steps to run in the iterative algorithm (default is 10^4).
inits	an optional list specifying the initial value for the incidence intercept (itct), a numeric vector for the unpenalized incidence coefficients (b_u), and a numeric vector for unpenalized latency coefficients (beta_u), a numeric value for the rate parameter (lambda), and a numeric value for the shape parameter (alpha) when model = "weibull". If not supplied or improperly supplied, initialization is automatically provided by the function.
n_folds	an integer specifying the number of folds for the k-fold cross-validation procedure (default is 5).
measure_inc	character string specifying the evaluation criterion used in selecting the optimal λ_b . Can be "c" or "auc"; default is "c". If measure_inc="c", the C-statistic using the cure status weighting (CSW) method proposed by Asano and Hirakawa (2017) is used to select both λ_b and λ_β . If measure_inc="auc", the AUC for cure prediction using the mean score imputation (MSI) method proposed by Asano et al. (2014) is used to select λ_b while the C-statistic with CSW is used for λ_β .
one_se	logical, if TRUE then the one standard error rule is applied for selecting the optimal parameters. The one standard error rule selects the most parsimonious model having evaluation criterion no more than one standard error worse than that of the best evaluation criterion (default is FALSE).
cure_cutoff	numeric value representing the cutoff time value that represents subjects not experiencing the event by this time are cured. This value is used to produce a proxy for the unobserved cure status when calculating C-statistic and AUC (default is 5 representing 5 years). Users should be careful to note the time scale of their data and adjust this according to the time scale and clinical application.
parallel	logical. If TRUE, parallel processing is performed for K-fold CV using foreach and the doParallel package is required.
seed	optional integer representing the random seed. Setting the random seed fosters reproducibility of the results.
verbose	logical, if TRUE running information is printed to the console (default is FALSE).
...	additional arguments.

Value

b0	Estimated intercept for the incidence portion of the model.
b	Estimated coefficients for the incidence portion of the model.
beta	Estimated coefficients for the latency portion of the model.
alpha	Estimated shape parameter if the Weibull model is fit.
rate	Estimated rate parameter if the Weibull or exponential model is fit.
logLik	Log-likelihood value.
selected.step.inc	Iteration step selected for the incidence portion of the model using cross-validation. NULL when <code>fdr_control</code> is TRUE.
selected.step.lat	Iteration step selected for the latency portion of the model using cross-validation. NULL when <code>fdr_control</code> is TRUE.
max.c	Maximum C-statistic achieved
max.auc	Maximum AUC for cure prediction achieved; only output when <code>measure_inc="auc"</code> .
selected_index_inc	Indices of selected variables for the incidence portion of the model when <code>fdr_control=TRUE</code> . If none selected, <code>int(0)</code> will be returned.
selected_index_lat	Indices of selected variables for the latency portion of the model when <code>fdr_control=TRUE</code> . If none selected, <code>int(0)</code> will be returned.
call	the matched call.

References

Fu, H., Nicolet, D., Mrozek, K., Stone, R. M., Eisfeld, A. K., Byrd, J. C., Archer, K. J. (2022) Controlled variable selection in Weibull mixture cure models for high-dimensional data. *Statistics in Medicine*, **41**(22), 4340–4366.

See Also

[curegmifs](#)
[curegmifs](#)

Examples

```
library(survival)
withr::local_seed(123)
temp <- generate_cure_data(n = 100, j = 15, n_true = 3, a = 1.8, rho = 0.2)
training <- temp$training

fit.cv <- cv_curegmifs(Surv(Time, Censor) ~ .,
  data = training,
  x_latency = training, fdr_control = FALSE,
  maxit = 450, epsilon = 0.01, n_folds = 2,
  seed = 23, verbose = TRUE
)
```

generate_cure_data	<i>Simulate data under a mixture cure model</i>
--------------------	---

Description

Simulate data under a mixture cure model

Usage

```
generate_cure_data(
  n = 400,
  j = 500,
  nonp = 2,
  train_prop = 0.75,
  n_true = 10,
  a = 1,
  rho = 0.5,
  itct_mean = 0.5,
  cens_ub = 20,
  alpha = 1,
  lambda = 2,
  same_signs = FALSE,
  model = "weibull"
)
```

Arguments

n	an integer denoting the total sample size.
j	an integer denoting the number of penalized predictors which is the same for both the incidence and latency portions of the model.
nonp	an integer less than j denoting the number of unpenalized predictors (which is the same for both the incidence and latency portions of the model).
train_prop	a numeric value in 0, 1 representing the fraction of n to be used in forming the training dataset.
n_true	an integer denoting the number of variables truly associated with the outcome (i.e., the number of covariates with nonzero parameter values) among the penalized predictors.
a	a numeric value denoting the effect size which is the same for both the incidence and latency portions of the model.
rho	a numeric value in 0, 1 representing the correlation between adjacent covariates in the same block. See details below.
itct_mean	a numeric value representing the expectation of the incidence intercept which controls the cure rate.
cens_ub	a numeric value representing the upper bound on the censoring time distribution which follows a uniform distribution on 0, cens_ub.

alpha	a numeric value representing the shape parameter in the Weibull density.
lambda	a numeric value representing the rate parameter in the Weibull density.
same_signs	logical, if TRUE the incidence and latency coefficients have the same signs.
model	type of regression model to use for the latency portion of mixture cure model. Can be "weibull", "GG", "Gompertz", "nonparametric", or "GG_baseline".

Value

training	training data.frame which includes Time, Censor, and covariates.
testing	testing data.frame which includes Time, Censor, and covariates.
parameters	a list including: the indices of true incidence signals (nonzero_b), indices of true latency signals (nonzero_beta), unpenalized incidence parameter values (b_u), unpenalized latency parameter values (beta_u), parameter values for the true incidence signals among penalized covariates (b_p_nz), parameter values for the true latency signals among penalized covariates (beta_p_nz), parameter value for the incidence intercept (itct)

Examples

```
library(survival)
withr::local_seed(1234)
data <- generate_cure_data(n = 200, j = 50, n_true = 10, a = 1.8, rho = 0.2)
training <- data$training
testing <- data$testing
fit <- cureem(Surv(Time, Censor) ~ .,
  data = training,
  x_latency = training, model = "cox", penalty = "lasso",
  lambda_inc = 0.05, lambda_lat = 0.05,
  gamma_inc = 6, gamma_lat = 10
)
```

nonzerocure_test	<i>Non-parametric pest for a non-zero cured fraction</i>
------------------	--

Description

Tests the null hypothesis that the proportion of observations susceptible to the event = 1 against the alternative that the proportion of observations susceptible to the event is < 1. If the null hypothesis is rejected, there is a significant cured fraction.

Usage

```
nonzerocure_test(object, reps = 1000, seed = NULL, plot = FALSE, b = NULL)
```


Arguments

object	a survfit object.
reps	number of simulations on which to base the p-value (default = 1000).
seed	optional random seed.
plot	logical. If TRUE a histogram of the estimated susceptible proportions over all simulations is produced.
b	optional. If specified the maximum observed time for the uniform distribution for generating the censoring times. If not specified, an exponential model is used for generating the censoring times (default).

Value

proportion_susceptible	estimated proportion of susceptibles
proportion_cured	estimated proportion of those cured
p_value	p-value testing the null hypothesis that the proportion of susceptibles = 1 (cured fraction = 0) against the alternative that the proportion of susceptibles < 1 (non-zero cured fraction)
time_95_percent_of_events	estimated time at which 95% of events should have occurred

References

Maller, R. A. and Zhou, X. (1996) *Survival Analysis with Long-Term Survivors*. John Wiley & Sons.

See Also

[survfit](#), [cure_estimate](#), [sufficient_fu_test](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
km_fit <- survfit(Surv(Time, Censor) ~ 1, data = training)
nonzerocure_test(km_fit)
```

plot.mixturecure	<i>Plot fitted mixture cure model</i>
------------------	---------------------------------------

Description

This function plots either the coefficient path, the AIC, the cAIC, the BIC, or the log-likelihood for a fitted curegmifs or cureem object. This function produces a lollipop plot of the coefficient estimates for a fitted cv_curegmifs or cv_cureem object.

Usage

```
## S3 method for class 'mixturecure'
plot(
  x,
  type = c("trace", "AIC", "BIC", "logLik", "cAIC", "mAIC", "mBIC", "EBIC"),
  xlab = NULL,
  ylab = NULL,
  main = NULL,
  ...
)
```

Arguments

x	a mixturecure object resulting from curegmifs or cureem, cv_curegmifs or cv_cureem.
type	a case-sensitive parameter with default "trace" which plots the coefficient path for the fitted object. Also available are "AIC", "cAIC", "mAIC", "BIC", "mBIC", "EBIC", and "logLik". This option has no effect for objects fit using cv_curegmifs or cv_cureem.
xlab	a default x-axis label will be used which can be changed by specifying a user-defined x-axis label.
ylab	a default y-axis label will be used which can be changed by specifying a user-defined y-axis label.
main	a default main title will be used which can be changed by specifying a user-defined main title. This option is not used for cv_curegmifs or cv_cureem fitted objects.
...	other arguments.

Value

this function has no returned value but is called for its side effects

See Also

[curegmifs](#), [cureem](#), [coef.mixturecure](#), [summary.mixturecure](#), [predict.mixturecure](#)

Examples

```

library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
plot(fit)

```

predict.mixturecure	<i>Predicted probabilities for susceptibles, linear predictor for latency, and risk class for latency for mixture cure fit</i>
---------------------	--

Description

This function returns a list that includes the predicted probabilities for susceptibles as well as the linear predictor for the latency distribution and a dichotomous risk for latency for a curegmifs, cureem, cv_curegmifs or cv_cureem fitted object.

Usage

```

## S3 method for class 'mixturecure'
predict(object, newdata, model_select = "AIC", ...)

```

Arguments

object	a mixturecure object resulting from curegmifs, cureem, cv_curegmifs, cv_cureem.
newdata	an optional data.frame that minimally includes the incidence and/or latency variables to use for predicting the response. If omitted, the training data are used.
model_select	a case-sensitive parameter for models fit using curegmifs or cureem any step along the solution path can be selected. The default is model_select = "AIC" which calculates the predicted values using the coefficients from the model having the lowest AIC. Other options are model_select = "mAIC" for the modified AIC, model_select = "cAIC" for the corrected AIC, model_select = "BIC", model_select = "mBIC" for the modified BIC, model_select = "EBIC" for the extended BIC, model_select = "logLik" for the step that maximizes the log-likelihood, or any numeric value from the solution path. This option has no effect for objects fit using cv_curegmifs or cv_cureem.
...	other arguments

Value

p_uncured	a vector of probabilities from the incidence portion of the fitted model representing the P(uncured).
linear_latency	a vector for the linear predictor from the latency portion of the model.
latency_risk	a dichotomous class representing low (below the median) versus high risk for the latency portion of the model.

See Also

[curegmifs](#), [cureem](#), [coef.mixturecure](#), [summary.mixturecure](#), [plot.mixturecure](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
predict_train <- predict(fit)
names(predict_train)
testing <- temp$testing
predict_test <- predict(fit, newdata = testing)
```

print.mixturecure	<i>Print the contents of a mixture cure fitted object</i>
-------------------	---

Description

This function prints the first several incidence and latency coefficients and the rate (exponential and Weibull) and alpha (Weibull) when fitting a parametric MCM and returns the fitted object invisible to the user.

Usage

```
## S3 method for class 'mixturecure'
print(x, max = 6, ...)
```

Arguments

x	a mixturecure object resulting from curegmifs, cureem, cv_cureem, or cv_curegmifs.
max	maximum number of rows in a matrix or elements in a vector to display
...	other arguments.

Value

prints coefficient estimates for the incidence portion of the model and if included, prints the coefficient estimates for the latency portion of the model. Also prints rate for exponential and Weibull models and alpha for the Weibull mixture cure model. Returns all objects fit using `cureem`, `curegmifs`, `cv_cureem`, or `cv_curegmifs`.

Note

The contents of a `mixturecure` fitted object differ depending upon whether the EM (`cureem`) or GMIFS (`curegmifs`) algorithm is used for model fitting or if cross-validation is used. Also, the output differs depending upon whether `x_latency` is specified in the model (i.e., variables are included in the latency portion of the model fit) or only terms on the right hand side of the equation are included (i.e., variables are included in the incidence portion of the model).

See Also

[curegmifs](#), [cureem](#), [coef.mixturecure](#), [summary.mixturecure](#), [plot.mixturecure](#), [predict.mixturecure](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
print(fit)
```

sufficient_fu_test	<i>Test for sufficient follow-up</i>
--------------------	--------------------------------------

Description

Tests for sufficient follow-up using a Kaplan-Meier fitted object.

Usage

```
sufficient_fu_test(object)
```

Arguments

`object` a `survfit` object.

Value

p_value	p-value from testing the null hypothesis that there was not sufficient follow-up against the alternative that there was sufficient follow-up
n_n	total number of events that occurred at time $> \text{pmax}(0, 2 * (\text{last observed event time}) - (\text{last observed time}))$ and $<$ the last observed event time
N	number of observations in the dataset

References

Maller, R. A. and Zhou, X. (1996) *Survival Analysis with Long-Term Survivors*. John Wiley & Sons.

See Also

[survfit](#), [cure_estimate](#), [nonzerocure_test](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
km_fit <- survfit(Surv(Time, Censor) ~ 1, data = training)
sufficient_fu_test(km_fit)
```

summary.mixturecure	<i>Summarize a Fitted Mixture Cure Object.</i>
---------------------	--

Description

summary method for a mixturecure object fit using curegmifs, cureem, cv_curegmifs, or cv_cureem.

Usage

```
## S3 method for class 'mixturecure'
summary(object, ...)
```

Arguments

object	a mixturecure object resulting from curegmifs, cureem, cv_curegmifs, or cv_cureem.
...	other arguments.

Value

prints the number of non-zero coefficients from the incidence and latency portions of the fitted mixture cure model when using the minimum AIC to select the final model. When fitting a model using `curegmifs` or `cureem` the summary function additionally prints results associated with the following model selection methods: the step and value that maximizes the log-likelihood; the step and value that minimizes the AIC, modified AIC (mAIC), corrected AIC (cAIC), BIC, modified BIC (mBIC), and extended BIC (EBIC).

See Also

[curegmifs](#), [cureem](#), [coef.mixturecure](#), [plot.mixturecure](#), [predict.mixturecure](#)

Examples

```
library(survival)
withr::local_seed(1234)
temp <- generate_cure_data(n = 100, j = 10, n_true = 10, a = 1.8)
training <- temp$training
fit <- curegmifs(Surv(Time, Censor) ~ .,
  data = training, x_latency = training,
  model = "weibull", thresh = 1e-4, maxit = 2000,
  epsilon = 0.01, verbose = FALSE
)
summary(fit)
```

Index

- * **datasets**
 - amltest, [2](#)
 - amltrain, [11](#)
- * **htest**
 - nonzerocure_test, [40](#)
 - sufficient_fu_test, [45](#)
- * **methods**
 - coef.mixturecure, [22](#)
 - plot.mixturecure, [42](#)
 - predict.mixturecure, [43](#)
 - print.mixturecure, [44](#)
 - summary.mixturecure, [46](#)
- * **models**
 - cureem, [24](#)
 - curegmifs, [27](#)
 - cv_cureem, [31](#)
 - cv_curegmifs, [35](#)
- * **regression**
 - cureem, [24](#)
 - curegmifs, [27](#)
 - cv_cureem, [31](#)
 - cv_curegmifs, [35](#)
- * **univar**
 - auc_mcm, [21](#)
 - concordance_mcm, [23](#)
 - cure_estimate, [30](#)

amltest, [2](#)
amltrain, [11](#)
auc_mcm, [21](#), [24](#)

coef.mixturecure, [22](#), [42](#), [44](#), [45](#), [47](#)
coefficients (coef.mixturecure), [22](#)
concordance_mcm, [21](#), [23](#)
cure_estimate, [30](#), [41](#), [46](#)
cureem, [23](#), [24](#), [35](#), [42](#), [44](#), [45](#), [47](#)
curegmifs, [23](#), [27](#), [38](#), [42](#), [44](#), [45](#), [47](#)
cv_cureem, [27](#), [31](#)
cv_curegmifs, [29](#), [35](#)

generate_cure_data, [39](#)

nonzerocure_test, [30](#), [40](#), [46](#)

plot.mixturecure, [23](#), [42](#), [44](#), [45](#), [47](#)
predict.mixturecure, [23](#), [42](#), [43](#), [45](#), [47](#)
print.mixturecure, [44](#)

sufficient_fu_test, [30](#), [41](#), [45](#)
summary.mixturecure, [23](#), [42](#), [44](#), [45](#), [46](#)
survfit, [30](#), [41](#), [46](#)