

Package ‘SurvGME’

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Type Package

Title Analysis of Survival Data under Graphical and Measurement Error Models

Version 0.1.0

Description The estimation method proposed by Chen and Yi (2021) [doi:10.1111/biom.13331](https://doi.org/10.1111/biom.13331) is extended to the analysis of survival data, accommodating commonly used survival models while accounting for measurement error and network structures among covariates.

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Author Li-Pang Chen [aut, cre],
Grace Y. Yi [aut]

Maintainer Li-Pang Chen <lchen723@nccu.edu.tw>

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SurvGME-package

Survival analysis with graphical and measurement error models

Description

This package extends the estimation method of Chen and Yi (2021) <doi:10.1111/biom.13331> to analyze survival data, supporting commonly used survival models while accounting for measurement error and network structures in covariates.

Details

The R package SurvGME (Survival analysis with Graphical and Measurement Error models) provides functions for implementing estimation methods for commonly used survival models that account for network structures and measurement error in covariates. The functions offer multiple options for users, including the specification of measurement error level and hyperparameters for the implementation of the simulation-extrapolation (SIMEX) method. In addition, the package provides estimated variances of the estimators and tools for visualizing the identified network structures in covariates.

Author(s)

Chen, L.-P. and Yi, G. Y.

Maintainer: Li-Pang Chen <lchen723@nccu.edu.tw>

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

bootstrap*The bootstrapp method for computing the variances of the estimators*

Description

This function uses the bootstrap method to compute the variances of the estimators and the associated p-values.

Usage

```
bootstrap(surv, status, X, Sigma_e, Psi, K, r, dist, shape, scale, order, B, model)
```

Arguments

surv	An n -dimensional vector of observed times
status	An n -dimensional vector of censoring indicators
X	An $n \times p$ matrix of the covariates, where p is greater than or equal to 2
Sigma_e	A $p \times p$ positive definite covariance matrix
Psi	A user-specified sequence for generating synthetic data in the simulation step of the SIMEX method
K	A user-specified integer used for simulating data in the simulation step of the SIMEX method
r	A user-specified constant greater than 0 and smaller than or equal to 1. When $r=1$, the transformation model reduces to the proportional odds model.
dist	A user-specified distribution for the noise term in the AFT model. Options include Weibull distributions (<code>weibull</code>), exponential distributions (<code>exponential</code>), logistic distributions (<code>logistic</code>), and normal distributions (<code>normal</code>).
shape	A user-specified value for the shape parameter in the distribution (<code>dist</code>)
scale	A user-specified value for the scale parameter in the distribution (<code>dist</code>)
order	A positive integer (no smaller than 1) specifying the order of the polynomial functions used in the extrapolation step of the SIMEX method
B	A user-specified positive integer specifying the number of bootstrap replications
model	The specification of the survival model. Options include the Cox proportional hazards model (<code>model == "PH"</code>), the additive hazards model (<code>model == "AH"</code>), the accelerated failure time model (<code>model == "AFT"</code>), and the transformation model (<code>model == "TM"</code>).

Details

This function integrates four sub-functions (SIMEX_PH, SIMEX_AH, SIMEX_AFT, and SIMEX_TM) to compute the variances and p-values of the estimators using the bootstrap method, under the the Cox proportional hazards model, the additive hazards model, the accelerated failure time model, and the transformation model.

Value

est_beta	A p -dimensional vector of the estimators associated with the covariates
est_theta	A $p \times p$ matrix of the estimators associated with the pairwise interaction of covariates
var(beta)	A p -dimensional vector containing estimated variances for each estimator $\hat{\beta}_j$
var(theta)	A $p \times p$ matrix containing estimated variances for each estimator $\hat{\theta}_{sv}$
p-value_beta	A p -dimensional vector containing the p-value for each estimator $\hat{\beta}_j$
p-value_theta	A $p \times p$ matrix containing the p-value for each estimator $\hat{\theta}_{sv}$

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```
library(MASS)
library(glmnet)
library(survival)
library(ahaz)
n = 200
p = 4
Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,3]*Z[,4] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0,0.6,0,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

bootstrap(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10, order=2,B=5, model="PH")
```

SIMEX_AFT

SIMEX-based variable selection and network identification under AFT models

Description

This function implements the SIMEX method for the penalized likelihood function to correct for measurement error effects, select informative covariates, and identify the network structure of covariates under accelerated failure time (AFT) models.

Usage

```
SIMEX_AFT(surv, status, X, Sigma_e, Psi, K, dist, shape, scale, order)
```

Arguments

surv	An n -dimensional vector of observed times
status	An n -dimensional vector of censoring indicators
X	An $n \times p$ matrix of the covariates, where p is greater than or equal to 2
Sigma_e	A $p \times p$ positive definite covariance matrix
Psi	A user-specified sequence for generating synthetic data in the simulation step of the SIMEX method
K	A user-specified integer used for simulating data in the simulation step of the SIMEX method

dist	A user-specified distribution for the noise term in the AFT model. Options include Weibull distributions (<code>weibull</code>), exponential distributions (<code>exponential</code>), logistic distributions (<code>logistic</code>), and normal distributions (<code>normal</code>).
shape	A user-specified value for the shape parameter in the distribution (<code>dist</code>)
scale	A user-specified value for the scale parameter in the distribution (<code>dist</code>)
order	A positive integer (no smaller than 1) specifying the order of the polynomial functions used in the extrapolation step of the SIMEX method

Details

This function implements the SIMEX method to correct for measurement error effects and maximizes the penalized likelihood function under AFT models to perform variable selection, network detection, and estimation of the parameters.

Value

est_beta	A p -dimensional vector of the estimators associated with the covariates
est_theta	A $p \times p$ matrix of the estimators associated with the pairwise interaction of covariates

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```
library(MASS)
library(glmnet)
library(survival)
library(ahaz)
n = 200
p = 4
Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,3]*Z[,4] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0,0.6,0,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

est_AFT = SIMEX_AFT(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10,
  dist="weibull", shape=4, scale=2, order=2)
```

SIMEX_AH	<i>SIMEX-based variable selection and network identification under additive hazards models</i>
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Description

This function implements the SIMEX method for the penalized likelihood function to correct for measurement error effects, select informative covariates, and identify the network structure of covariates under additive hazards (AH) models.

Usage

```
SIMEX_AH(surv, status, X, Sigma_e, Psi, K, order)
```

Arguments

surv	An n -dimensional vector of observed times
status	An n -dimensional vector of censoring indicators
X	An $n \times p$ matrix of the covariates, where p is greater than or equal to 2
Sigma_e	A $p \times p$ positive definite covariance matrix
Psi	A user-specified sequence for generating synthetic data in the simulation step of the SIMEX method
K	A user-specified integer used for simulating data in the simulation step of the SIMEX method
order	A positive integer (no smaller than 1) specifying the order of the polynomial functions used in the extrapolation step of the SIMEX method

Details

This function implements the SIMEX method to correct for measurement error effects and maximizes the penalized likelihood function under AH models to perform variable selection, network detection, and estimation of the parameters.

Value

est_beta	A p -dimensional vector of the estimators associated with the covariates
est_theta	A $p \times p$ matrix of the estimators associated with the pairwise interaction of covariates

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```

library(MASS)
library(glmnet)
library(survival)
library(ahaz)
n = 200
p = 4
Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,3]*Z[,4] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0,0.6,0,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

est_AH = SIMEX_AH(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10, order=2)

```

SIMEX_PH	<i>SIMEX-based variable selection and network identification under Cox proportional hazards models</i>
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Description

This function implements the SIMEX method for the penalized likelihood function to correct for measurement error effects, select informative covariates, and identify the network structure of covariates under Cox proportional hazards (PH) models.

Usage

```
SIMEX_PH(surv, status, X, Sigma_e, Psi, K, order)
```

Arguments

surv	An n -dimensional vector of observed times
status	An n -dimensional vector of censoring indicators
X	An $n \times p$ matrix of the covariates, where p is greater than or equal to 2
Sigma_e	A $p \times p$ positive definite covariance matrix
Psi	A user-specified sequence for generating synthetic data in the simulation step of the SIMEX method
K	A user-specified integer used for simulating data in the simulation step of the SIMEX method
order	A positive integer (no smaller than 1) specifying the order of the polynomial functions used in the extrapolation step of the SIMEX method

Details

This function implements the SIMEX method to correct for measurement error effects and maximizes the penalized likelihood function under Cox PH models to perform variable selection, network detection, and estimation of the parameters.

Value

`est_beta` A p -dimensional vector of the estimators associated with the covariates
`est_theta` A $p \times p$ matrix of the estimators associated with the pairwise interaction of covariates

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```
library(MASS)
library(glmnet)
library(survival)
n = 200
p = 4
Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,3]*Z[,4] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0,0.6,0,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

est_PH = SIMEX_PH(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10, order=2)
```

SIMEX_TM

SIMEX-based variable selection and network identification under the transformation models

Description

This function implements the SIMEX method for two estimating equations to correct for measurement error effects, select informative covariates, and identify the network structure of covariates under the transformation models.

Usage

```
SIMEX_TM(surv, status, X, Sigma_e, Psi, K, r, order)
```

Arguments

surv	An n -dimensional vector of observed times
status	An n -dimensional vector of censoring indicators
X	An $n \times p$ matrix of the covariates, where p is greater than or equal to 2
Sigma_e	A $p \times p$ positive definite covariance matrix
Psi	A user-specified sequence for generating synthetic data in the simulation step of the SIMEX method
K	A user-specified integer used for simulating data in the simulation step of the SIMEX method
r	A user-specified constant greater than 0 and smaller than or equal to 1. When $r=1$, the transformation model reduces to the proportional odds model.
order	A positive integer (no smaller than 1) specifying the order of the polynomial functions used in the extrapolation step of the SIMEX method

Details

This function implements the SIMEX method to correct for measurement error effects and solves two sets of estimating equations under the transformation models to perform variable selection, network detection, and estimation of the parameters.

Value

est_beta	A p -dimensional vector of the estimators associated with the covariates
est_theta	A $p \times p$ matrix of the estimators associated with the pairwise interaction of covariates

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```
library(MASS)
library(glmnet)
library(survival)
library(ahaz)
n = 50
p = 2
```

```

Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,1]*Z[,2] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0.6,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

est_TM = SIMEX_TM(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10,
  r=1, order=2)

```

VS_network

Reporting the estimation results and displaying the network structure

Description

This function reports the selected covariates and displays the estimated network structure.

Usage

```
VS_network(beta, theta, labels, label.size, node.size)
```

Arguments

beta	An estimate of $\hat{\beta}$ derived from the functions SIMEX_PH, SIMEX_AH, SIMEX_AFT, and SIMEX_TM
theta	An estimate of $\hat{\Theta}$ derived from the functions SIMEX_PH, SIMEX_AH, SIMEX_AFT, and SIMEX_TM
labels	A list of covariates names. By defaults, positive numerical labels are used.
label.size	A positive integer displaying the size of labels. The default is 6.
node.size	A positive integer displaying the size of nodes in the network. The default is 6.

Details

This function summarizes the selected covariates and displays the estimated network structure for visualization.

Value

selected_variables	A list of printed names of selected variables
graph	An estimated network structure

Author(s)

Chen, L.-P. and Yi, G. Y.

References

Chen, L.-P. and Yi, G. Y. (2021). Analysis of noisy survival data with graphical proportional hazards measurement error models. *Biometrics*, 77, 956–969.

Examples

```
library(MASS)
library(glmnet)
library(survival)
library(ahaz)
library(network)
library(sna)
library(scales)
set.seed(2025)
n = 200
p = 4
Z = mvrnorm(n,rep(0,p), diag(1,p))
T = exp(Z[,1]+Z[,2]+Z[,3]*Z[,4] + runif(n,0,1))
C = rexp(n,1)
Y = pmin(T,C)
delta = (T<C)*1
SA = diag(c(0,0.6,0,0.6),dim(Z)[2])
X = Z + mvrnorm(n,rep(0,p), SA)

est_PH = SIMEX_PH(Y, delta, X, Sigma_e = SA, Psi = seq(0,1,length=5), K=10, order=2)

VS_network(est_PH$est_beta, est_PH$est_theta,
           label.sizes=4, node.size=6)
```

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