Package ‘glrt’

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Type Package

Title Generalized Logrank Tests for Interval-censored Failure Time Data

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Description Functions to conduct four generalized logrank tests and a score test under a proportional hazards model

License GPL-2

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R topics documented:

`glrt-package` *Generalized logrank tests for interval-censored failure time data*

Description

Functions to conduct four nonparametric generalized logrank tests and a score test under a proportional hazards model

Details

Package:	glrt
Type:	Package
Version:	2.0
Date:	2014-12-24
License:	GPL-2
LazyLoad:	yes

The main function is `gLRT`, in which a method is selected. Depending on the method specified, one of the five functions (`gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`, `ScoreTest`) is called to perform a generalized logrank test or a scor test. Before computing the test statistic in each test, function `ModifiedEMICM` is called to compute an NPMLE of the common survival function under the null hypothesis that all treatments have the same survival function except for in `gLRT4`, where `ModifiedEMICM` is used to estimate the survival function of each treatment group.

Author(s)

Qiang Zhao and Jianguo Sun

Maintainer: Qiang Zhao <qiang.zhao@txstate.edu>

References

Q. Zhao and J. Sun (2004), "Generalized Log-rank Test for Mixed-Censored Failure Time Data", Statistics in Medicine, 23: 1621-1629.

J. Sun, Q. Zhao, and X. Zhao (2005), "Generalized Log-rank Test for Interval-Censored Data", Scandinavian Journal of Statistics, 32: 45-57.

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

X. Zhao, R. Duan, Q. Zhao, and J. Sun (2013), "A New Class of Generalized Log Rank Tests for Interval-censored Failure Time Data", Computational Statistics and Data Analysis. 60: 123-131.

Finkelstein, DM (1986), "A Proportional Hazards Model for Interval-censored Failure Time Data", Biometrics, 42: 845-854.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`gLRT`, `gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`, `ScoreTest`, `ModifiedEMICM`

`Aintmap` *Create A matrix and intmap*

Description

This function is borrowed from package `interval` by Professor Michael Fay and used in function `ModifiedEMICM` to provide an NPMLE of a survival function. The A matrix is an n by m matrix of zeros and ones, where each row represents one of n failure times, and each column represents a possible interval for the nonparametric maximum likelihood estimate (NPMLE). The function `Aintmap` creates an A matrix and associated intmap from left and right intervals (`L` and `R`) which may not include the boundary of the interval (using `Lin` or `Rin`). The matrix intmap denotes the intervals of the potential jumps in the distribution of the NPMLE, and its attribute LRin denotes whether to include each of the interval or not.

Usage

```
Aintmap(L, R, Lin = NULL, Rin = NULL)
```

Arguments

`L`	numeric vector of left endpoints of censoring interval
`R`	numeric vector of right endpoints of censoring interval
`Lin`	logical vector, should L be included in the interval? (see details)
`Rin`	logical vector, should R be included in the interval? (see details)

Value

A list with two objects:

`A`	an n by m matrix of 0 and 1s
`intmap`	the associated intmap

Author(s)

Michael Fay

See Also

`ModifiedEMICM`

Examples

```
Aintmap(c(2,3,3,7),c(3,5,5,8),Lin=c(FALSE,TRUE,FALSE,FALSE),
Rin=c(TRUE,FALSE,TRUE,FALSE))
```

`AlphaCross` *Compute a matrix of at-risk indicators*

Description

This function determines whether each observation in one group is at risk at different times or time intervals based on the observations of another group.

Note

It is used in `Teststat4` and not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

See Also

`Teststat4`

`Bisect` *An implementation of the bisection algorithm for root finding*

Description

Most of the optimization is `Icens` have a one dimensional root-finding component. Since the quantities involved are generally restricted to a subset of $[0, 1]$ we use bisection to find the roots. This function is borrowed from package `Icens`.

Details

We search from `pvec` in the direction `ndir` to obtain the new value of `pvec` that maximizes the likelihood.

Note

It is used in `ModifiedEMICMmac` and not to be called by the user.

Author(s)

Alain Vandal and Robert Gentleman

References

Any book on optimization.

See Also

`ModifiedEMICMmac`

`CensorType` *Determine types of censoring based on censoring intervals*

Description

This function determines types of censoring based on censoring intervals. It is called by function `gLRT1`, `gLRT2`, `gLRT3`, and `gLRT4`.

Usage

```
CensorType(A, inf)
```

Arguments

`A`	a matrix containing the end points of censoring intervals in the first two columns
`inf`	value representing infinity

Value

`cens`	a vector of censoring types with value 1 for left-censoring, 2 for interval-censoring, 3 for right-censoring, and 4 for exact observation

Author(s)

Qiang Zhao and Jianguo Sun

Examples

```
A = matrix(c(1, 3, 0, 4, 3, 100, 3, 3), ncol=2, byrow=TRUE)
CensorType(A, 100)
```

`Chisqstat3` *Compute the chi-square test statistic and degrees of freedom for test gLRT3*

Description

This function computes the chi-square test statistic and degrees of freedom for test `gLRT3`. The degree of freedom depends on whether there are exact observations and proportions of exact observations in each treatment.

Usage

```
Chisqstat3(U, V, counts)
```

Arguments

`U`	k-vector of the test statistic in `gLRT3`, where k is number of treatments.
`V`	estimated k by k covariance matrix of `U`
`counts`	a k by 2 matrix containing number of exact and non-exact observations for each treatment

Value

`chisq`	chi-square test statistic
`df`	degrees of freedom used.

Note

This is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

`cmv` *Interval-censored data for times to cytomegalovirus (CMV) shedding in blood and urine*

Description

The `cmv` data frame is based on an AIDS clinic trial on HIV-infected individuals. The data involve 204 patients who are classified into two groups based on whether patient's CD4 count is below 75 cells per μl or not. Among the 204 patients, 111 of them had a CD4 count below 75.

Usage

```
data(cmv)
```

Format

A data frame with 204 observations on the following 6 variables.

`patient` patient id

`lb` left end point of an censoring interval for time to CMV shedding in blood

`rb` right end point of an censoring interval for time to CMV shedding in blood

`lu` left end point of an censoring interval for time to CMV shedding in urine

`ru` right end point of an censoring interval for time to CMV shedding in urine

`cd4ind` group indicator if patient's baseline CD4 count is below 75 (1 for below 75 and 0 otherwise)

Details

The survival times are time to the presence of CMV in blood and ullrine, respectively. The censoring intervals are in the format of $(l_b, r_b]$ and $(l_u, r_u]$. For CMV in blood, there are 7 left-censored, 23 interval-censored, and 174 right-censored, but no exact observations. For CMV in urine, there are 49 left-censored, 67 interval-censored, and 88 right-censored, but no exact observations.

Source

J. Sun (2006), "The Statistical Analysis of Interval-censored Failure Time Data", Springer.

References

W. B. Goggins and D. M. Finkelstein (2000), "A proportional hazards model for multivariate interval-censored failure time data", Biometrics, 56: 940-943.

`cosmesis` *Interval-censored data for time taken until cosmetic deterioration of breast cosmesis*

Description

The cosmesis data frame has 95 rows and 3 columns.

Usage

```
data(cosmesis)
```

Format

A data frame with the following 3 variables.

`L` left end point of the cosmetic deterioration interval

`R` right end point of the cosmetic deterioration interval

`Trt` treatment indicator. It is zero for those that received radiotherapy

Source

Borrowed from package `Icens` by Alain Vandal and Robert Gentleman.

References

A semiparametric model for regression analysis of interval-censored failure time data, D. M. Finkelstein and R. A. Wolfe, 1985, Biometrics.

`diabetes` *Interval-censored data for time from onset of diabetes to the onset of diabetic nephronpathy*

Description

The `diabetes` data frame is based on a study conducted at the Steno Memorial Hospital in Denmark from 1933-1984. The data involve 731 patients (454 males and 277 females) and have 595 exact, 136 interval-censored, and no right-censored observations.

Usage

```
data(diabetes)
```

Format

A data frame with 731 observations on the following 3 variables.

`left`	left end point of an censoring interval
`right`	right end point of an censoring interval
`gender`	gender indicator (1 for male and 0 for female)

Details

The survival time is time from onset of diabetes to the onset of diabetic nephronpathy, a major complication of Type I diabetes.

Source

Kindly provided by Professor P. K. Andersen.

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

`gLRT` *Do one of the four generalized logrank tests or a score test for interval-censored data*

Description

The `gLRT` function conducts four k(>=2)-sample tests for interval-censored survival data. Four of them are different nonparametric generalized logrank tests, and the other is a score test under a proportional hazards model. They are two-sided tests. The null hypothesis is that all k survival functions of the failure time are identical, and the alternative hypothesis hypothesis is that not all survival functions are the same. This function calls one of functions (`gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`, `ScoreTest`) based on the method specified. However, each of these tests can be called individually to perform a test. Note that `gLRT2` and `gLRT4` do not allow exact observations. `gLRT4` only allows $k = 2$ and is no longer called `ScoreTest` as in Zhao (2012).

Usage

```
gLRT(A, k = 2, method = c("glrt1", "glrt2", "glrt3", "glrt4", "score"),
M = 50, rho = 0, gamma = 0, EMstep = TRUE, ICMstep = TRUE, tol = 1e-06,
maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format (`L`, `R`] in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3.
`k`	number of treatments. The default is 2.
`method`	a character string specifying the test to be performed: "glrt1", "glrt2", "glrt3", "glrt4", and "score".
`M`	number of multiple imputations used in estimating the covariance in function `gLRT1`. The default is 50.
`rho`	non-negative parameter in $[0, 1]$ of the link function used for calculating the test statistics in `gLRT2`, `gLRT3`, and `gLRT4`. It is the same as b in Zhao, Duan, Zhao, and Sun (2013). The default is 0.
`gamma`	non-negative parameter in $[0, 1]$ of the link function used for calculating the test statistics in `gLRT2`, `gLRT3`, and `gLRT4`. It is the same as c in Zhao, Duan, Zhao, and Sun (2013). The default is 0.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating a distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

For all tests, it is assumed that the censoring interval for each observation takes the form $(L_i, R_i]$. For exact observations, $L_i = R_i$; for left-censored observations, $L_i = 0$; and for right-censored observations, $R_i = inf$, infinity or a large number representing infinity.

Exact observations are not allowed in `gLRT2`. If no exactly observations exist, `gLRT3` reduces to `gLRT2` in terms of chi-square statistic and p-value.

When `method="glrt1"` is selected, `gLRT1` is called to perform the test proposed by Zhao and Sun (2004). When `method="glrt2"` is selected, `gLRT2` is called to perform the test proposed by Sun, Zhao, and Zhao (2005). When `method="glrt3"` is selected, `gLRT3` is called to perform the test proposed by Zhao, Zhao, Sun, and Kim (2008). When `method="score"` is selected, `ScoreTest` is called to perform a score test under a proportional hazards model proposed by Finkelstein (1986). For the above methods, the NPMLE of the common distribution function under the null hypothesis is computed by function `ModifiedEMICM`. When `method="glrt4"` is selected, `gLRT4` is called to perform the test proposed by Zhao, Duan, Zhao, and Sun (2013) where `ModifiedEMICM` is applied to each of the two groups.

The link function used in `gLRT2`, `gLRT3`, and `gLRT4` is $\xi(x) = xlog(x)x^{\rho}(1-x)^{\gamma}$.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	the estimated covariance of the test statistic `u` (NA for `gLRT4`)
`chisq/fstat`	the chi-square or f (for `gLRT4`) statistic
`df`	the degrees of freedom of the chis-square test or f-test
`p`	p-value of the test

Author(s)

Qiang Zhao and Jianguo Sun

References

Q. Zhao and J. Sun (2004), "Generalized Log-rank Test for Mixed-Censored Failure Time Data", Statistics in Medicine, 23: 1621-1629.

J. Sun, Q. Zhao, and X. Zhao (2005), "Generalized Log-rank Test for Interval-Censored Data", Scandinavian Journal of Statistics, 32: 45-57.

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

X. Zhao, R. Duan, Q. Zhao, and J. Sun (2013), "A New Class of Generalized Log Rank Tests for Interval-censored Failure Time Data", Computational Statistics and Data Analysis. 60: 123-131.

Finkelstein, DM (1986), "A Proportional Hazards Model for Interval-censored Failure Time Data", Biometrics, 42: 845-854.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`, `ScoreTest`

Examples

```
data(cosmesis)
gLRT(cosmesis, method="glrt1", M=20, inf=100)
gLRT(cosmesis, method="glrt2", rho=1, inf=100)

data(diabetes)
gLRT(diabetes, method="glrt3", gamma=1)
gLRT(diabetes, method="score")

data(cmv)
cmvBlood = cmv[,c(2,3,6)]
cmvUrine = cmv[, 4:6]
gLRT(cmvBlood, method="glrt4")
```

```
gLRT(cmvUrine, method="glrt4", rho=1, gamma=1)

# 3-sample test
data(cosmesis)
cosmesis[80:94, 3] = 2
gLRT(cosmesis, k=3, method="glrt3", rho=0, gamma=0, inf=100)
```

`gLRT1` *Conduct a generalized logrank test for interval-censored data*

Description

Function `gLRT1` conducts a k(>=2)-sample test for interval-censored survival data. The test is based on Zhao and Sun (2004). The null hypothesis is that all k survival functions of the failure time are the same, and the alternative hypothesis is that not all functions are the same.

Usage

```
gLRT1(A, k = 2, M = 50, EMstep = TRUE, ICMstep = TRUE, tol = 1e-06,
maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format $(L, R]$ in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3.
`k`	number of treatments. The default is 2.
`M`	number of multiple imputations used in estimating the covariance of the test statistic. The default is 50.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

Under the null hypothesis, the NPMLE of the common distribution function is computed by function `ModifiedEMICM`.

Censoring interval for each observation take the form $(L_i, R_i]$. For exact observations, $L_i = R_i$.

The estimated covariance of the test statistic depends on random resampling. It is normal that two runs of the test `gLRT1` yield different test results.

The chi-square test used in `gLRT1` has $k-1$ degrees of freedom.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	the estimated covariance of the test statistic
`chisq`	the chisquare test statistic
`df`	the degrees of freedom of the test
`p`	p-value of the test

Author(s)

Qiang Zhao and Jianguo Sun

References

Q. Zhao and J. Sun (2004), "Generalized Log-rank Test for Mixed-Censored Failure Time Data", Statistics in Medicine, 23: 1621-1629.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`gLRT`, `gLRT2`, `gLRT3`, `gLRT4`, `ScoreTest`

Examples

```
data(cosmesis)
gLRT1(cosmesis, inf=100)

data(diabetes)
gLRT1(diabetes, M=20)
```

`gLRT2` *Conduct a generalized logrank test for interval-censored data*

Description

The `gLRT2` function conducts a k(>=2)-sample test for interval-censored survival data. The test is based on Sun, Zhao, and Zhao (2005). The null hypothesis is that all k survival functions of the failure time are the same, and the alternative hypothesis is that not all functions are the same.

Usage

```
gLRT2(A, k = 2, rho = 0, gamma = 0, EMstep = TRUE, ICMstep = TRUE,
tol = 1e-06, maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format $(L, R]$ in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3.
`k`	number of treatments. The default is 2.
`rho`	non-negative parameter of the link function used for calculating the test statistics. The default is 0.
`gamma`	non-negative parameter of the link function used for calculating the test statistics. The default is 0.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the commondistribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

Under the null hypothesis, the NPMLE of the common distribution function is computed by function `ModifiedEMICM`.

Censoring interval for each observation take the form $(L_i, R_i]$. No exact observations are allowed, i.e., $L_i < R_i$.

The chi-square test used in `gLRT2` has k-1 degrees of freedom.

The link function used in `gLRT2` is $\xi(x) = xlog(x)x^\rho(1-x)^\gamma$.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	the estimated covariance of the test statistic
`chisq`	the chisquare test statistic
`df`	the degrees of freedom of the test
`p`	p-value of the test

Author(s)

Qiang Zhao and Jianguo Sun

References

J. Sun, Q. Zhao, and X. Zhao (2005), "Generalized Log-rank Test for Interval-Censored Data", Scandinavian Journal of Statistics, 32: 45-57.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`gLRT`, `gLRT1`, `gLRT3`, `gLRT4`, `ScoreTest`

Examples

```
data(cosmesis)
gLRT2(cosmesis, rho=0, gamma=1, inf=100)
```

`gLRT3` *Conduct a generalized logrank test for interval-censored data*

Description

Function `gLRT3` conducts a k(>=2)-sample test for interval-censored survival data. The test is based on Zhao, Zhao, Sun, and Kim (2008). The null hypothesis is that all $k$hel survival functions of the failure time are the same, and the alternative hypothesis is that not all functions are the same.

Usage

```
gLRT3(A, k = 2, rho = 0, gamma = 0, EMstep = TRUE, ICMstep = TRUE,
tol = 1e-06, maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format $(L, R]$ in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3.
`k`	number of treatments. The default is 2.
`rho`	non-negative parameter of the link function used for calculating the test statistics. The default is 0.
`gamma`	non-negative parameter of the link function used for calculating the test statistics. The default is 0.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

Under the null hypothesis, the NPMLE of the common distribution function is computed by function `ModifiedEMICM`.

Censoring interval for each observation take the form $(L_i, R_i]$. For exact observations, $L_i = R_i$.

The chi-square test in `gLRT3` has either k or $k - 1$ degrees of freedom depending on the existence and proportion of exact observations in each treatment. See Zhao, Zhao, Sun, and Kim (2008) for more details.

The link function used in `gLRT3` is $\xi(x) = xlog(x)x^{\rho}(1 - x)^{\gamma}$.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	the estimated covariance of the test statistic
`chisq`	the chisquare test statistic
`df`	the degrees of freedom of the test
`p`	p-value of the test

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`gLRT`, `gLRT1`, `gLRT2`, `gLRT4`, `ScoreTest`

Examples

```
data(cosmesis)
gLRT3(cosmesis, rho=1, inf=100)

data(diabetes)
gLRT3(diabetes, gamma=0)
```

`gLRT4` *Conduct a generalized logrank test for interval-censored data*

Description

Function `gLRT4` conducts a k(=2)-sample test for interval-censored survival data. The test is based on Zhao, Duan, Zhao, and Sun (2013). The null hypothesis is that the two survival functions of the failure time are the same, and the alternative hypothesis is that the two functions are not the same.

Usage

```
gLRT4(A, k = 2, rho = 0, gamma = 0, EMstep = TRUE, ICMstep = TRUE,
tol = 1e-06, maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format $(L, R]$ in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3. No exact observations (i.e., $L = R$) are allowed.
`k`	number of treatments. Only $k = 2$ is allowed.
`rho`	non-negative parameter in [0, 1] of the link function used for calculating the test statistics. It is the same as b in Zhao, Duan, Zhao, and Sun (2013). The default is 0.
`gamma`	non-negative parameter in [0, 1] of the link function used for calculating the test statistics. It is the same as c in Zhao, Duan, Zhao, and Sun (2013). The default is 0.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

The NPMLE of the distribution function for each treatment group is computed by function `ModifiedEMICM`.

The f-test in `gLRT4` is based on an F distribution with degrees of freedom 1 and 1.

The link function used in `gLRT4` is $\xi(x) = xlog(x)x^{\rho}(1-x)^{\gamma} = xlog(x)x^{b}(1-x)^{c}$.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	`NA` is returned
`fstat`	the f-test statistic
`df`	the numerator and denominator degrees of freedom of the f-test, i.e., (1, 1)
`p`	p-value of the f-test

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, R. Duan, Q. Zhao, and J. Sun (2013), "A New Class of Generalized Log Rank Tests for Interval-censored Failure Time Data", Computational Statistics and Data Analysis. 60: 123-131.

See Also

`gLRT`, `gLRT1`, `gLRT2`, `gLRT3`, `ScoreTest`

Examples

```
data(cmv)
cmvBlood = cmv[,c(2,3,6)]
cmvUrine = cmv[, 4:6]
gLRT4(cmvBlood)
gLRT4(cmvUrine, rho=1, gamma=1)
```

`Linkfunc` *A link function used in tests* `gLRT2`*,* `gLRT3`*, and* `gLRT4`

Description

A link function over (0, 1) used in `gLRT2`, `gLRT3`, and `gLRT4`, which is a function of the original link function $\xi(x) = xlog(x)x^{\rho}(1-x)^{\gamma}$.

Usage

```
Linkfunc(x, rho = 0, gamma = 0)
```

Arguments

`x`	a value between 0 and 1
`rho`	a non-negative parameter in $[0, 1]$
`gamma`	a non-negative parameter in $[0, 1]$

Details

This function $\eta(x) = 1 - \xi(1 - x)$.

Value

Function value is returned.

Note

This is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

See Also

`LinkfuncDir`

Examples

```
Linkfunc(0.2, rho=0, gamma=1)
```

`LinkfuncDir` *Direvative of the link function*

Description

Direvative of the link function $\eta(x), \eta'(x)$, used in `gLRT2`, `gLRT3`, and `gLRT4`,.

Usage

```
LinkfuncDir(x, rho = 0, gamma = 0)
```

Arguments

`x`	a value between 0 and 1
`rho`	a non-negative parameter in $[0, 1]$
`gamma`	a non-negative parameter in $[0, 1]$

Value

The first derivative of the function.

Note

This is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

See Also

`Linkfunc`

Examples

```
LinkfuncDir(0.2, rho=0, gamma=1)
```

`ModifiedEMICM` *Estimate the distribution function using the hybrid EM-ICM approach*

Description

A modified version of function `EMICM` in package `Icens` by incorporating function `Aintmap` in package `interval`. By defult, the function provides an NPMLE for the distribution function of the survival time.

Usage

```
ModifiedEMICM(A, EMstep = TRUE, ICMstep = TRUE, keepiter = FALSE,
tol = 1e-06, maxiter = 1000)
```

Arguments

`A`	an n by 2 matrix with containing the end points of censoring intervals of the format (Li, Ri].
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`keepiter`	TRUE/FALSE determining whether to keep the iteration states.
`tol`	the maximal L1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.

Details

After incorporating function `Aintmap`, function `ModifiedEMICM` often produces `intmap` with smaller size than function `EMICM`, especially when exact observations ($L_i = R_i$) exist. In addition, object `ppairs` is returned for later use in computing the test statistics in functions `gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`, and `ScoreTest`. Also, a bug was identified in using `EMICM` when ICMstep=F is specified. The problem is fixed by calling `ModifiedEMICMmac`, a modified version of function `EMICMmac` from package `Icens`.

Either EM, ICM, or both steps can be taken in the estimation. When `ICMstep = FALSE`, the function computes a self-consistent estimate, the same results as obtained from function `icfit` in package `interval`.

Value

An object containing the following components:

`pf`	Estimated probabilities
`sigma`	NPMLE/self-consistant estimate of the distribution function
`weights`	the diagonal of the likelihood functions's second derivative
`lastchange`	a vector of differences between the last two iterations
`numiter`	number of iterations performed
`iter`	only present if `keepiter` is true; state of sigma during the iteration
`intmap`	the real representation associated with the probabilities reported in `pf`
`startend`	the indices for L_i and R_i identifying the end points in `intmap` where a subject is at risk.

Author(s)

Qiang Zhao and Jianguo Sun

References

Function `EMICM` by Alain Vandal and Robert Gentleman .

J. A. Wellner and Y. Zhan (1997), "A hybrid algorithm for computation of the nonparametric maximum likelihood estimator from censored data", JASA.

See Also

`Aintmap`, `ModifiedEMICMmac`

Examples

```
data(diabetes)
ModifiedEMICM(diabetes[,1:2])

data(cosmesis)
ModifiedEMICM(cosmesis[,1:2])
```

`ModifiedEMICMmac` *An interval function in package "Icens"*

Description

A modified version of `EMICMmac` in package `Icens` to avoid the error when calling function `EMICM` when specifying ICMstep = FALSE. The error is caused by changing the type of an undeclared vector `weights`.

Note

It is used in `ModifiedEMICM` and not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

See Also

`ModifiedEMICM`

PMGA *Implement the pool monotone group algorithm*

Description

For isotonization problems some increase in speed and decrease in complexity can be achieved through the use of the pool monotone groups algorithm of Y.L. Zhang and M.A. Newton (1997). It isotonizes a weighted and ordered set of values. This function is borrowed from package `Icens`.

Usage

```
PMGA(est, ww=rep(1, length(est)))
```

Arguments

`est`	The vector of values, in the appropriate order.
`ww`	The weight vector.

Details

To be supplied at some later date.

Value

An Object containing the following components:

`est`	The isotonized estimates.
`ww`	The weight associated with the isotonized estimates.
`poolnum`	The number of values pooled in the current estimate.
`passes`	The number of passes which were required to isotonize the list.

Note

It is used in `ModifiedEMICMmac` and not to be called by the user.

Author(s)

Alain Vandal and Robert Gentleman

References

Y. L. Zhang and M. A. Newton (1997), http://www.stat.wisc.edu/~newton/newton.html.

See Also

`ModifiedEMICMmac`

`rescaleP` *Rescale* `pvec` *in function* `Bisect`

Description

An internal function borrowed from `Icens`.

Note

It is not to be called by the user.

Author(s)

Alain Vandal and Robert Gentleman

See Also

`Bisect`

`ScoreStat` *Compute the test statistic of the score test*

Description

The function computes the test statistic of the score test proposed by Finkelstein (1986).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

Finkelstein, DM (1986), "A Proportional Hazards Model for Interval-censored Failure Time Data", Biometrics, 42: 845-854.

See Also

`ScoreTest`

`ScoreTest` *Do a score test under the proportional hazards model for interval-censored data*

Description

The `ScoreTest` function conducts a k(>=2)-sample test for interval-censored survival data. The test is based on Finkelstein (1986). The null hypothesis is that all k survival functions of the failure time are the same, and the alternative hypothesis is that not all functions are the same. It is not referred as gLRT4 as in Zhao (2012).

Usage

```
ScoreTest(A, k = 2, EMstep = TRUE, ICMstep = TRUE, tol = 1e-06,
maxiter = 1000, inf = Inf)
```

Arguments

`A`	an n by 3 data matrix with the censoring interval of the format $(L, R]$ in columns 1 & 2 and treatmentment indicator ranging from 0 to $k-1$ in column 3.
`k`	number of treatments. The default is 2.
`EMstep`	a boolean variable indicating whether to take an EM step in the iteration when estimating the common distribution function. The default is TRUE.
`ICMstep`	a boolean variable indicating whether to take an ICM step in the iteration when estimating the common distribution function. The default is TRUE.
`tol`	the maximal L_1 distance between successive estimates before stopping iteration when estimating the common distribution function. The default is 1.0e-6.
`maxiter`	the maximal number of iterations to perform before stopping when estimating the common distribution function. The default is 1000.
`inf`	value used in data for infinity. The default is Inf.

Details

Under the null hypothesis that k survival functions are the same, the NPMLE of the common survival function is computed by function `ModifiedEMICM`.

The chi-square test in `ScoreTest` has $k-1$ degrees of freedom.

Value

The function returns an object containing the following components:

`method`	test procedure used
`u`	the test statistic
`v`	the estimated covariance of the test statistic
`chisq`	the chisquare test statistic
`df`	the degrees of freedom of the test
`p`	p-value of the test

Author(s)

Qiang Zhao and Jianguo Sun

References

Finkelstein, DM (1986), "A Proportional Hazards Model for Interval-censored Failure Time Data", Biometrics, 42: 845-854.

Q. Zhao (2012), "gLRT - A New R Package for Analyzing Interval-censored Survival Data", Interval-Censored Time-to-Event Data: Methods and Applications, CRC Press, 377-396.

See Also

`ModifiedEMICM`, `gLRT`, `gLRT1`, `gLRT2`, `gLRT3`, `gLRT4`

Examples

```
data(cosmesis)
ScoreTest(cosmesis, inf=100)

data(diabetes)
ScoreTest(diabetes)
```

`StartEnd` *Compute the indices for the end points of censoring intervals*

Description

The function computes the indices for the end points of censoring intervals over the intmaps when estimating a survival function when called in function `ModifiedEMICM`. It is also used in `Teststat4` of `gLRT4`.

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

See Also

`ModifiedEMICM`, `Teststat4`

`Teststat1` *Compute the test statistic in test gLRT1*

Description

The function computes the test statistics of the test proposed by Zhao and Sun (2004).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

Q. Zhao and J. Sun (2004), "Generalized Log-rank Test for Mixed-Censored Failure Time Data", Statistics in Medicine, 23: 1621-1629.

See Also

`gLRT1`

`Teststat2` *Compute the test statistic in test gLRT2*

Description

The function computes the test statistics of the test proposed by Sun, Zhao, and Zhao (2005).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

J. Sun, Q. Zhao, and X. Zhao (2005), "Generalized Log-rank Test for Interval-Censored Data", Scandinavian Journal of Statistics, 32: 45-57.

See Also

`gLRT2`

`Teststat3` *Compute the test statistic in test gLRT3*

Description

The function computes the test statistics of the test proposed by Zhao, Zhao, Sun, and Kim (2008).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

See Also

`gLRT3`

`Teststat4` *Compute the test statistic in test gLRT4*

Description

The function computes the test statistics of the test proposed by Zhao, Duan, Zhao, and Sun (2013).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, R. Duan, Q. Zhao, and J. Sun (2013), "A New Class of Generalized Log Rank Tests for Interval-censored Failure Time Data", Computational Statistics and Data Analysis. 60: 123-131.

See Also

`gLRT4`

`Var1` *Compute the estimate of the covariance of the statistic in test gLRT1*

Description

The function computes the estimate of the covariance of test statistics of the test proposed by Zhao and Sun (2004).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

Q. Zhao and J. Sun (2004), "Generalized Log-rank Test for Mixed-Censored Failure Time Data", Statistics in Medicine, 23: 1621-1629.

See Also

`gLRT1`

`Var2` *Compute the estimate of the covariance of the test statistic in test gLRT2*

Description

The function computes the estimate of the covariance of the test statistics of the test proposed by Sun, Zhao, and Zhao (2005).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

J. Sun, Q. Zhao, and X. Zhao (2005), "Generalized Log-rank Test for Interval-Censored Data", Scandinavian Journal of Statistics, 32: 45-57.

See Also

gLRT2

Var3 — *Compute the estimate of the covariance of the test statistic in test gLRT3*

Description

The function computes the estimate of the covariance of the test statistics of the test proposed by Zhao, Zhao, Sun, and Kim (2008).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

X. Zhao, Q. Zhao, J. Sun, Q. and J. S. Kim (2008), "Generalized Log-rank Tests for Partly Interval-Censored Failure Time Data", Biometrical Journal, 50 (3): 375-385.

See Also

gLRT3

VarScoreStat — *Compute the estimate of the covariance of the test statistic in the score test*

Description

The function computes the estimate of the covariance of the test statistic of the score test proposed by Finkelstein (1986).

Note

It is not to be called by the user.

Author(s)

Qiang Zhao and Jianguo Sun

References

Finkelstein, DM (1986), "A Proportional Hazards Model for Interval-censored Failure Time Data", Biometrics, 42: 845-854.

See Also

`ScoreTest`

Index