Package ‘MIICD’

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Type Package
Title Data Augmentation and Multiple Imputation for Interval Censored Data
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Description Implements data augmentation schemes with multiple imputation steps for proportional hazards regression with interval censored data or proportional subdistribution hazards regression for interval censored competing risks data. The main functions allow to estimate survival function, cumulative incidence function, Cox and Fine & Gray regression coefficients and associated variance-covariance matrix. MIICD functions call Surv, survfit and coxph from survival package, FGR from riskRegression package, and mvrnorm from the MASS package.
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bcos

A data frame with 94 observations on the following 3 variables:

- left
- right
- treatment

The data comes from the Interval library by Michael P. Fay.

Author(s)

Michael P. Fay

References


Examples

head(bcos)
DA.ci

Cumulative incidence estimation for interval censored competing risks data using data augmentation and multiple imputation

Description

Uses data augmentation and multiple imputation to compute the cumulative incidence function with interval censored competing risks data

Usage

DA.ci(k, m, data, status, trans, cens.code, conf.int = F, alpha = 0.05)

Arguments

k An integer, indicates the number of iteration to perform
m An integer, indicates the number of imputation to perform at each iteration
data The input data (see details)
status The name of the column where status are to be found
trans Denomination of the event of interest in the status column
cens.code Censor indicator in the status column of the data
conf.int Logical, computes the confidence interval
alpha Parametrize the confidence interval width

Details

This function uses data augmentation and multiple imputation approach to estimate a cumulative incidence function for interval censored competing risks data. Estimates are computed using Rubin’s rules (Rubin (1987)). The cumulative incidence is computed as the mean of cumulative incidences over imputations. The variance is computed at each point by combining the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputations. At each iteration, the cumulative incidence is updated and multiple imputation is performed using the updated estimate. If conf.int is required, the log-log transformation is used to compute the lower confidence interval.

Print and plot methods are available to handle results.

The data must contain at least three columns: left, right and status. For interval censored data, the left and right columns indicates lower and upper bounds of intervals, respectively. Inf in the right column stands for right censored observations. When an observation is right censored, the status column must contain the censor indicator specified by cens.code. The transition of interest must be specified by the trans parameter.

Value

est A data frame with estimates
... Other objects
Author(s)
Marc Delord <<mdelord@gmail.com>>

References

See Also
Surv, survfit

Examples
res <- DA.ci(k = 10, m = 10, status = 'status', trans = 1, data = ICCRD, conf.int = TRUE, cens.code = 0, alpha = 0.05)
res # print(res)
plot(res)

```
DA.surv
Survival estimation for interval censored data using data augmentation and multiple imputation
```

Description
Uses data augmentation and multiple imputation to compute the survival function with interval censored data

Usage
DA.surv(k, m, data, conf.int = FALSE, alpha = 0.05)

Arguments

- **k**
  - An integer, indicates the number of iteration to perform

- **m**
  - An integer, indicates the number of imputation to perform at each iteration

- **data**
  - The input data (see details)

- **conf.int**
  - Logical, computes the confidence interval

- **alpha**
  - Parametrize the confidence interval width
Details

This function uses data augmentation and multiple imputation approach to estimate the survival function interval censored data. Estimates are computed using Rubin’s rules (Rubin (1987)). The survival is computed as the mean of survival over imputations. The variance is computed at each point by combining the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputation. At each iteration, the survival function is updated and multiple imputation is performed using the updated estimate. If conf.inf is required, the log-log transformation is used to compute the lower confidence interval.

Print and plot methods are available to handle results.

The data must contain at least two columns: left and right. For interval censored data, the left and right columns indicate lower and upper bounds of intervals, respectively. Inf in the right column stands for right censored observations.

Value

est A data frame with estimates

Author(s)

Marc Delord <<mdelord@gmail.com>>

References


See Also

Surv, survfit

Examples

res< DA.surv(k = 10, m = 10, data = ICCRD, conf.int = TRUE, alpha = 0.05 )
res
plot(res)
ICCRD

ICCRD: interval censored competing risks data

Description

Interval censored competing risks data. A data frame with 150 observations. the columns are:

• left -> lower bound of the interval
• right -> upper bound of the interval
• status -> cause of failure (1 or 2)
• treatment -> treatment (1 or 2)
• cov2 -> another covariate (continuous)

Details

This dataset is given for demonstration purpose. 2 causes of failure are given, only cause 1 is interval censored. Right censored observations are indicated by 0 in the status column.

Examples

head(ICCRD)

MI.ci

Cumulative incidence estimation for interval censored competing risks data using multiple imputation

Description

Uses multiple imputation to compute a cumulative incidence function for interval censored competing risks data

Usage

MI.ci(m, status, trans, data, conf.int = TRUE, cens.code, alpha = 0.05, ntimes = NULL)

Arguments

m An integer, indicates the number of imputation to perform at each iteration
status The name of the column where status are to be found
trans Denomination of the event of interest in the status column
data The input data (see details)
conf.int Logical, computes the confidence interval
cens.code Censor indicator in the status column of the data
alpha Parametrize the confidence interval width
ntimes Number of time points where the estimates should be computed (experimental)
Details

This function uses the multiple imputation approach to estimate the cumulative incidence function for interval censored competing risks data.

Estimates are computed using Rubin’s rules (Rubin (1987)). Estimate of the cumulative incidence is computed as the mean of cumulative incidences over imputations. The variance is computed at each point by combining the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputation. If conf.int is required, the log-log transformation is used to compute the lower confidence interval.

Print and plot methods are available to handle results.

The data must contain at least three columns: left, right and status. For interval censored data, the left and right columns indicate the lower and the upper bounds of the intervals respectively. Inf in the right column stands for right censored observations. When an observation is right censored, the status column must contain the censor indicator specified by cens.code. The transition of interest must be specified by the trans parameter.

Value

est A data frame with estimates
   ... Other objects

Author(s)

Marc Delord <<mdelord@gmail.com>>

References


See Also

Surv, survfit

Examples

res <- MI.ci(m = 10, status = 'status', trans = 1, data = ICRD,
conf.int = TRUE, cens.code = 0, alpha = 0.05)
res
plot(res)
**Description**

Uses multiple imputation to compute the survival function with interval censored data.

**Usage**

```
MI.surv(m, data, conf.int = TRUE, alpha = 0.05)
```

**Arguments**

- `m`: An integer, indicates the number of imputation to perform at each iteration.
- `data`: The input data (see details).
- `conf.int`: Logical, computes the confidence interval.
- `alpha`: Parametrize the confidence interval width.

**Details**

This function uses the multiple imputation approach to estimate the survival function for interval censored data. Estimates are computed using Rubin’s rules (Rubin (1987)). Survival function estimate is computed as the mean of survival over imputations. The variance is computed at each point by combining the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputation. If `conf.int` is required, the log-log transformation is used to compute the lower confidence interval.

Print and plot methods are available to handle results.

The data must contain at least two columns: `left` and `right`. For interval censored data, the `left` and the `right` columns indicates lower and upper bounds of intervals respectively. `Inf` in the `right` column stands for right censored observations.

**Value**

- `est`: A data frame with estimates.

**Author(s)**

Marc Delord `<mdelord@gmail.com>`
MIICD

References


See Also

Surv, survfit

Examples

res<-$MI.surv( m = 10 , data = ICCRD , conf.int = TRUE )
res
plot( res )
#plot( res , fun = 'event')

MIICD Data Augmentation and Multiple Imputation for Interval Censored Data

Description

This is version 2.0 of the MIICD package: bugs have been corrected and 2 sets of functions have been added to the previous MIICD functions. Proposed functions apply data augmentation and/or the multiple imputation approach of Pan (2000) to handle interval censored data with the Cox proportional hazards regression and interval censored competing risks data with the Fine & Gray proportional subdistribution hazards regression. 3 main sets of function are proposed:

- MI.surv and MI.ci: these functions use the multiple imputation approach to compute the survival function and the cumulative incidence function with confidence intervals, for interval censored data and interval censored competing risks data respectively. print and plot methods are available.
- DA.surv and DA.ci: these functions use data augmentation scheme with multiple imputation at each iteration to compute the survival function and the cumulative incidence function with confidence intervals, for interval censored data and interval censored competing risks data respectively. print and plot methods are available.
- MIICD.coxph and MIICD.crrreg: both functions use data augmentation schemes with multiple imputation at each iteration to handle interval censored data with the Cox proportional hazards regression, and interval censored competing risks data with the Fine and Gray subdistribution hazard regression.
MIICD

- MIICD.coxph compute the baseline survival function and Cox regression parameters.
- MIICD.creg compute the baseline cumulative incidence function and Fine & Gray regression parameters.

For both function, the Poor Man’s Data augmentation (PMDA) and the Asymptotic Normal Data Augmentation (ANDA) schemes are implemented (by using the method parameter) (Pan 2000; Wei and Tanner 1991; Tanner and Wong 1987a). print and plot methods are available.

MIICD functions call iteratively the coxph (library survival) or the FGR (library riskRegression) function on imputed datasets and derive multiple estimates from imputed data sets. Finally it combines multiple estimates following multiple imputation rules (Rubin 1987; Schenker and Welsh 1988; Tanner and Wong 1987b)) to update parameter estimates. When ANDA is chosen, mvrnorm (package MASS) is called.

Details

Package: MIICD
Type: Package
Version: 2.0
Date: 2015-02-11
License: GPL-3

Author(s)

Marc Delord <mdelord@gmail.com>, Maintainer: Marc Delord <mdelord@gmail.com>

References


See Also

Surv survfit coxph FGR mvrnorm
Examples

```r
res <- MIICD.coxph(formula = ~ treatment, data = bcos,
                    k = 10, m = 10, method = 'ANDA', verbose = FALSE)
res
plot(res)
plot(res, type = 'coef', coef = 1)
plot(res, type = 'sigma', coef = 1)
```

Description

Uses data augmentation and multiple imputation approach to compute the regression coefficient and its associated variance-covariance matrix, and the baseline survival estimates of a Cox proportional hazards regression for interval censored data.

Usage

```r
MIICD.coxph(formula, k, m, data, method = c("PMDA", "ANDA"),
             verbose = FALSE)
```

Arguments

- **formula**: A formula. The right hand side indicates names of covariables to be found in data.
- **k**: An integer, indicates the number of iteration to perform.
- **m**: An integer, indicates the number of imputation to perform at each iteration.
- **data**: The input data (see details).
- **method**: Which data augmentation scheme shall be used? Two algorithms are implemented: *The Poor man’s Data Augmentation scheme* and the *Asymptotic Normal Data Augmentation scheme* (the later may be preferred).
- **verbose**: Logical, display the results?

Details

This function uses data augmentation and multiple imputation approach to estimate regression coefficient, its variance-covariance matrix, and baseline survival estimates for a Cox proportional hazards regression for interval censored data.

Estimates are computed using Rubin’s rules (Rubin (1987)). Estimate of coefficient is computed as the mean of estimates over imputation. The variance-covariance matrix is computed as the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputation. At each iteration, the baseline survival function is updated and multiple imputation is performed using updated estimates.
Print and plot methods are available to handle results. The data must contain at least two columns: left and right. For interval censored data, the left and the right columns indicate lower and upper bounds of intervals respectively. inf in the right column stands for right censored observations.

Value
est A data frame with estimates

Author(s)
Marc Delord

References

See Also
Surv, survfit, coxph, mvrnorm

Examples
res <- MIICD.coxph(formula = ~ treatment, k = 10, m = 10, data = bcos, verbose = FALSE)
res
plot(res)
# diagnostic plot for coefficients and associated standard error
plot(res, type = 'coef', coef = 1)
plot(res, type = 'sigma', coef = 1)

MIICD.creg Fine & Gray regression for interval censored competing risks data using data augmentation and multiple imputation

Description
Uses data augmentation and multiple imputation approach to compute regression coefficient and its associated variance-covariance matrix, and baseline cumulative incidence estimates for competing risks interval censored competing risks data
Usage

MIICD.crreg(formula, k, m, status, trans, cens.code, data, method = c("PMDA", "ANDA"), verbose = FALSE)

Arguments

- **formula**: A formula. The right hand side indicates names of covariables to be found in data.
- **k**: An integer, indicates the number of iteration to perform.
- **m**: An integer, indicates the number of imputation to perform at each iteration.
- **status**: The name of the column where status are to be found.
- **trans**: Denomination of the event of interest in the status column.
- **cens.code**: Censor indicator in the status column of the data.
- **data**: The input data (see details).
- **method**: Which data augmentation scheme shall be used? Two algorithms are implemented: The Poor man’s Data Augmentation scheme and the Asymptotic Normal Data Augmentation scheme (the later may be preferred).
- **verbose**: Logical, display the results?

Details

This function uses data augmentation and multiple imputation approach to estimate regression coefficient, variance-covariance matrix and baseline cumulative incidence estimates in a competing risks proportional hazards regression model for interval censored competing risks data.

Estimates are computed using Rubin’s rules (Rubin (1987)). Estimate of coefficient is computed as the mean of estimates over imputation. The variance-covariance matrix is computed as the within imputation variance and the between imputation variance augmented by an inflation factor to take into account the finite number of imputation. At each iteration, the baseline cumulative incidence function is updated and multiple imputation is performed using the updated estimates. Print and plot methods are available to handle results.

Print and plot methods are available to handle results.

The data must contain at least four columns. One named **left**, one named **right**, the name of the 3rd is indicated by the **status** parameter and one for the covariate to be tested. For interval censored data, the left and right columns indicates the lower and the upper bounds of the intervals respectively. Inf in the right column stands for right censored observations. When an observation is right censored, the status column must contain the censor indicator specified by **cens.code**. The transition of interest must be precised by the **trans** parameter.

Value

- **coef**: Final estimate of the coefficient.
- **vcov**: Final estimate of the variance-covariance matrix.
- **coef_seq**: Sequence of the coefficient estimate over iterations.
- **sigma_seq**: Sequence of the coefficient standard deviation over iterations.
df data frame containing the main results
... Other returned values

Author(s)
Marc Delord <<mdelord@gmail.com>>

References

See Also
Surv, survfit, FGR, mvrnorm

Examples

```r
# res <- MIICD.crreg(formula = ~ treatment, k = 10, m = 10, status = 'status',
# trans = 1, data = ICCRD, cens.code = 0, method = 'ANDA', verbose = FALSE )
# res
# plot(res)
# diagnostic plot for coefficients end associated standard error
# plot(res, type = 'coef', coef = 1)
# plot(res, type = 'sigma', coef = 1)
```

plot.DA_ci

---

plot method for DA_ci objects

Description
plot method for DA_ci objects

Usage

```r
## S3 method for class 'DA_ci'
plot(x, xlab = "Time", ylab = "Cumulative incidence", ...)
```
plot.DA_surv

Arguments
   x   A DA_ci object
  xlab   Label for x axis
   ylab   Label for y axis
     ... other arguments

plot.DA_surv  plot method for DA_surv objects

Description
   plot method for DA_surv objects

Usage
   ## S3 method for class 'DA_surv'
   plot(x, xlab = "Time", ylab = "Survival",
      fun = c("surv", "event"), ...)

Arguments
   x   a DA_surv object
  xlab   Label for x axis
   ylab   Label for y axis
   fun   If fun = event, 1 - the surv is drawn
     ... other arguments

plot.MIICD_coxph  plot method for MIICD_coxph objects

Description
   plot method for MIICD_coxph objects

Usage
   ## S3 method for class 'MIICD_coxph'
   plot(x, type = c("baseline", "coef", "sigma"),
      coef = 1, ylab = "Survival", xlab = "Time", ...)

Arguments
   x   a MIICD_coxph object
  type   "baseline", "coef", "sigma"
     coef   1
      ylab   Label for y axis
     xlab   Label for x axis
     ... other arguments
plot.MI_ci

Arguments

x a MIICD_coxph object
type type of diagnostic plot to display
coef An integer: the no of the coefficient to display
ylab Label for y axis
xlab Label for x axis
... other arguments

plot.MIICD_crreg plot method for MIICD_crreg objects

Description

plot method for MIICD_crreg objects

Usage

## S3 method for class 'MIICD_crreg'
plot(x, type = c("baseline", "coef", "sigma"),
     coef = 1, ylab = "Cumulative incidence", xlab = "Time", ...)

Arguments

x a MIICD_crreg object
type type of diagnostic plot to display
coef An integer: the no of the coefficient to display
ylab Label for y axis
xlab Label for x axis
... other arguments

plot.MI_ci plot method for MI_ci objects

Description

plot method for MI_ci objects

Usage

## S3 method for class 'MI_ci'
plot(x, xlab = "Time", ylab = "Cumulative incidence", ...)
Arguments

- **x**: A MI_ci object
- **xlab**: Label for x axis
- **ylab**: Label for y axis
- **...**: other arguments

Description

plot method for MI_surv objects

Usage

```r
## S3 method for class 'MI_surv'
plot(x, xlab = "Time", ylab = "Survival", fun = "surv",
     ...)```

Arguments

- **x**: A MI_surv object
- **xlab**: Label for x axis
- **ylab**: Label for y axis
- **fun**: If fun = event, 1 - the surv is drown
- **...**: other arguments
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