Package ‘MIICD’

May 27, 2017

Type Package
Title Multiple Imputation for Interval Censored Data
Version 2.4
Depends R (>= 2.13.0)
Date 2017-05-27
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Description Implements multiple imputation for proportional hazards regression with interval censored data or proportional sub-distribution 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 the 'survival' package, 'crprep' from the 'mstate' package, and 'mvrnorm' from the 'MASS' package.

LazyData true
License GPL-3
Imports survival, MASS, mstate
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NeedsCompilation no
Repository CRAN
Date/Publication 2017-05-27 16:20:01 UTC

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bcos

bcos : breast cosmesis data

Description
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)

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 the cumulative incidence function for interval censored competing risks data.

Usage

mi.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
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

Details

This function uses a 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 indicate lower and upper bounds of intervals, respectively.
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**

Delord, M. & Genin, E. Multiple Imputation for Competing Risks Regression with Interval Censored Data Journal of Statistical Computation and Simulation, 2015


**See Also**

Surv, survfit

**Examples**

res <- MI.ci(k = 5, m = 5, status = 'status', trans = 1, data = ICCRD, conf.int = TRUE, cens.code = 0, alpha = 0.05)
res
print(res)
plot(res)
MI.surv

Survival estimation for interval censored data using multiple imputation

Description

Uses multiple imputation schemes to compute the survival function when data are interval censored

Usage

MI.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 multiple imputation aproach to estimate the survival function when data are interval censored. 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.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 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

Delord, M. & Genin, E. Multiple Imputation for Competing Risks Regression with Interval Censored Data Journal of Statistical Computation and Simulation, 2015


See Also

Surv, survfit

Examples

```r
res<-MI.surv(k = 5, m = 5, data = ICCRD, conf.int = TRUE, alpha = 0.05)
res
plot(res)
```

### MIICD.coxph

Cox regression for interval censored data using multiple imputation

#### Description

Uses the 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`
- `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?
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)

Details

This function uses 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

Delord, M. & Genin, E. Multiple Imputation for Competing Risks Regression with Interval Censored Data Journal of Statistical Computation and Simulation, 2015


See Also

Surv, survfit, coxph, mvrnorm
**Examples**

```r
res <- MIICD.coxph(formula = ~ treatment, k = 5, m = 5, data = bcos, verbose = FALSE)
plot(res)
# diagnostic plot for coefficients and associated standard error
plot(res, type = 'coef', coef = 1)
plot(res, type = 'sigma', coef = 1)
```

**MIICD.crreg**

*Fine & Gray regression for interval censored competing risks data using multiple imputation*

**Description**

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

**Usage**

```r
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`.
- `verbose`: Logical, display the results?
- `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).
- `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).

**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 3^rd is indicated by the status parameter and one for the covariate to be tested. 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 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

Delord, M. & Genin, E. Multiple Imputation for Competing Risks Regression with Interval Censored Data Journal of Statistical Computation and Simulation, 2015

See Also

Surv, survfit, FGR, mvrnorm
plot.MIICD_crreg

Examples

```r
res <- MIICD.crreg(formula = ~ treatment, k = 5, m = 5, status = 'status',
    trans = 1, data = ICCRD, cens.code = 0, method = 'ANDA', 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)
```

Description

plot method for MIICD_coxph objects

Usage

```r
## 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` 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

Description

plot method for MIICD_crreg objects

Usage

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

Arguments

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

**plot.MI_ci**  
**plot method for MI_ci objects**

Description

plot method for MI_ci objects

Usage

```r
## 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 axix
- **...**  
  other arguments

**plot.MI_surv**  
**plot method for MI_surv objects**

Description

plot method for MI_surv objects

Usage

```r
## S3 method for class 'MI_surv'
plot(x, xlab = "time", ylab = "survival", fun = c("surv", "event"), ...)
```
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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