

Package ‘kmi’

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Title Kaplan-Meier multiple imputation for the analysis of cumulative incidence functions in the competing risks setting

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Depends survival, mitools

Description The package performs a Kaplan-Meier multiple imputation to recover the missing potential censoring information from competing risks events, so that standard right-censored methods could be applied to the imputed data sets to perform analyses of the cumulative incidence functions.

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kmi-package

Kaplan-Meier multiple imputation for the analysis of cumulative incidence functions in the competing risks setting

Description

The package performs a Kaplan-Meier multiple imputation to recover the missing potential censoring information from competing risks events, so that standard right-censored methods could be applied to the imputed data sets to perform analyses of the cumulative incidence functions.

Details

Package: kmi
 Version: 0.3-2
 Date: 2009
 Depends: survival, mitools
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Index:

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print.summary.cox.kmi	Print method for summary.cox.kmi objects
summary.cox.kmi	Summary method for cox.kmi objects

The `kmi` function performs the imputation, while `cox.kmi` is a wrapper of the `coxph` function that performs the Cox analysis for the subdistribution hazard on each imputed data set, then pools the results.

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References

Ruan, P.K. and Gray, R.J. (2008). Analyses of cumulative incidence functions via non-parametric multiple imputation. *Statistics in Medicine*, 27(27):5709–5724.

Fine, J.P. and Gray, R.J. (1999). A Proportional Hazards Model for the Subdistribution of a Competing Risk. *Journal of the American Statistical Association*. 94(446):496–509.

`cox.kmi`*Cox proportional hazards model applied to imputed data sets*

Description

This function fits Cox proportional hazards models to each imputed data set to estimate the regression coefficients in a proportional subdistribution hazards model, and pools the results.

Usage

```
cox.kmi(formula, imp.data, df.complete = Inf, ...)
```

Arguments

<code>formula</code>	A formula object, with the response on the left of a <code>~</code> operator, and the terms on the right. The response must be a survival object as returned by the Surv function.
<code>imp.data</code>	An object of class <code>kmi</code> .
<code>df.complete</code>	Complete data degrees of freedom.
<code>...</code>	Further arguments for the coxph function.

Details

Fits a Cox proportional hazards model on each imputed data set to estimate the regression coefficients in a proportional subdistribution hazards model, and pools the results, using the [MIcombine](#) function of the `mitools` package.

Value

An object of class `cox.kmi` including the following components:

<code>coefficients</code>	Pooled regression coefficient estimates
<code>variance</code>	Pooled variance estimate
<code>nimp</code>	Number of multiple imputations
<code>df</code>	degrees of freedom
<code>call</code>	The matched call
<code>individual.fit</code>	A list of <code>coxph</code> objects. One for each imputed data set.

Author(s)

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See Also

[coxph](#), [MIcombine](#), [print.cox.kmi](#), [summary.cox.kmi](#)

Examples

```

data(icu.pneu)

set.seed(1313)
imp.dat <- kmi(Surv(entry, exit, status) ~ 1, data = icu.pneu,
              etype = event, id = id, failcode = 3, nimp = 5)

fit.kmi <- cox.kmi(Surv(entry, exit, event == 3) ~ pneu, imp.dat)

summary(fit.kmi)

### Now using the censoring-complete data
fit <- coxph(Surv(entry, adm.cens.exit, event == 3) ~ pneu, icu.pneu)

summary(fit)

```

icu.pneu

Hospital acquired pneumonia in ICU

Description

This data set is a random sample drawn from the SIR-3 study that aimed at analysing the effect of nosocomial infections on the length of ICU stay. Patients were included in the study if they had stayed at least 1 day in the unit. The sample includes information to assess the effect of nosocomial pneumonia on the length of stay. The endpoint is either discharge alive from the ICU or dead in the unit. These data are censoring complete as the censoring time is known for all patients.

Usage

```
data(icu.pneu)
```

Format

A data frame with 1421 observations on the following 6 variables.

id Individual patient id.

entry Entry time into the study.

exit Failure time.

status Censoring status. 0 if the observation is censored, 1 otherwise.

event Event type. 2 is discharge alive, 3 is death in ICU.

pneu Nosocomial pneumonia indicator.

adm.cens.exit Exit times for patients discharged alive are replaced by their administrative censoring times.

Source

Beyersmann, J., Gastmeier, P., Grundmann, H., Baerwolff, S., Geffers, C., Behnke, M., Rueden, H., and Schumacher, M. Use of multistate models to assess prolongation of intensive care unit stay due to nosocomial infection. *Infection Control and Hospital Epidemiology*, 27:493-499, 2006.

References

Beyersmann, J. and Schumacher, M. (2008). Time-dependent covariates in the proportional hazards model for competing risks. *Biostatistics*, 9:765–776.

Examples

```
data(icu.pneu)
```

kmi

Kaplan-Meier Multiple Imputation for Competing Risks

Description

The function performs a non parametric multiple imputation that aims at recovering the missing potential censoring times from competing events.

Usage

```
kmi(formula, data, id = NULL, etype, failcode = 1, nimp = 10,
    epsilon = 1, bootstrap = FALSE, nboot = 10)
```

Arguments

<code>formula</code>	A <code>formula</code> object, that must have a <code>Surv</code> object on the left of a <code>~</code> operator. The right hand side should be 1.
<code>data</code>	A <code>data.frame</code> in which to interpret the variables given in the formula, <code>etype</code> and <code>id</code> . It is mandatory.
<code>id</code>	Used to identify individual subjects when one subject can have several rows of data, e.g., with time-dependent covariates. Set to <code>NULL</code> when there is only one row of data per subject.
<code>etype</code>	Variable specifying the type of competing event. When <code>status == 1</code> in formula, <code>etype</code> describes the type of event, otherwise, for censored observation, (<code>status == 0</code>), the value of <code>etype</code> is ignored.
<code>failcode</code>	Indicates the failure cause of interest. Imputation will be performed on the other competing events. Default is 1.
<code>nimp</code>	Number of multiple imputation. Default is 10.
<code>epsilon</code>	When the last time is an event, a censoring time equal to <code>max(time) + epsilon</code> is added. By default, <code>epsilon</code> is set to 1.

<code>bootstrap</code>	Logical. Whether to estimate the censoring distribution using bootstrap samples. Default is FALSE.
<code>nboot</code>	If <code>bootstrap</code> is set to TRUE, <code>nboot</code> determines the number of bootstrap samples.

Details

It was shown that if censoring times are observed for all individuals, methods for standard right-censored survival data can be used to analyse cumulative incidence functions from competing risks (Fine and Gray 1999). Therefore the idea proposed by Ruan and Gray (2008) is to impute potential censoring times for individuals who have failed from the competing events. The censoring times are imputed from the conditional Kaplan-Meier estimator of the censoring distribution.

Estimation of the censoring distribution may be improved through bootstrapping.

The competing risks model formulation in `formula` mimics the one in `survfit`.

Value

An object of class `kmi` with the following components:

<code>imputed.data</code>	A list of matrices giving the imputed times in the first column and imputed event type in the second column. The event status for imputed times take value 0 (censored).
<code>original.data</code>	The original data set
<code>info</code>	Gives the names of the time and event indicator column in the original data set.
<code>call</code>	The matched call.

Note

This multiple imputation technique does not work for left-truncated data.

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References

- Ruan, P.K. and Gray, R.J. (2008). Analyses of cumulative incidence functions via non-parametric multiple imputation. *Statistics in Medicine*, 27(27):5709–5724.
- Fine, J.P. and Gray, R.J. (1999). A Proportional Hazards Model for the Subdistribution of a Competing Risk. *Journal of the American Statistical Association*. 94(446):496–509.

See Also

[icu.pneu](#), [cox.kmi](#), [Surv](#), [survfit](#)

Examples

```
data(icu.pneu)

dat <- kmi(Surv(entry, exit, status) ~ 1, data = icu.pneu,
          etype = event, id= id, failcode = 3, nimp = 5)

## another way to specify the formula if there is no status
## variable
icu.pneu$ev <- icu.pneu$event
icu.pneu$ev[icu.pneu$status == 0] <- 0

dat <- kmi(Surv(entry, exit, ev != 0) ~ 1, data = icu.pneu,
          etype = ev, id= id, failcode = 3, nimp = 5)
```

print.cox.kmi *Print method for cox.kmi objects*

Description

Print method for `cox.kmi` objects.

Usage

```
## S3 method for class 'cox.kmi':
print(x, print.ind = FALSE, ...)
```

Arguments

<code>x</code>	An object of class <code>cox.kmi</code> .
<code>print.ind</code>	A logical specifying whether to print the results of the analyses performed on each imputed data set. By default, only the pooled estimates are printed.
<code>...</code>	Further arguments

Value

No value returned

Author(s)

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See Also

[cox.kmi](#), [summary.cox.kmi](#)

```
print.summary.cox.kmi
```

Print method for summary.cox.kmi objects

Description

Print method for `summary.cox.kmi` objects.

Usage

```
## S3 method for class 'summary.cox.kmi':  
print(x,  
      digits = max(getOption("digits") - 3, 3),  
      signif.stars = getOption("show.signif.stars"),  
      print.ind = FALSE, ...)
```

Arguments

<code>x</code>	An object of class <code>summary.cox.kmi</code> .
<code>digits</code>	Significant digits to print.
<code>signif.stars</code>	Logical. If TRUE, 'significance stars' are printed for each coefficient.
<code>print.ind</code>	Logical specifying whether to print a summary of the models fitted on each imputed data set. Default is FALSE
<code>...</code>	Further arguments

Value

No value returned

Author(s)

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See Also

[summary.cox.kmi](#)

summary.cox.kmi *Summary method for cox.kmi objects*

Description

Provides a summary of the fitted model.

Usage

```
## S3 method for class 'cox.kmi':
summary(object, conf.int = 0.95, scale = 1, ...)
```

Arguments

object	An object of class <code>cox.kmi</code> .
conf.int	Level of the confidence intervals. Default is 0.95
scale	Vector of scale factors for the coefficients, default to 1. The confidence limits are for the risk change associated with one scale unit.
...	Further arguments

Value

An object of class `summary.cox.kmi` with the following components:

call	The matched call
coefficients	A matrix with 5 columns including the regression coefficients, subdistribution hazard ratios, standard-errors, t-statistics and corresponding two-sided p-values.
conf.int	A matrix with 4 columns that consists of the subdistribution hazard ratios, $\exp(-\text{coef})$ and the lower and upper bounds of the confidence interval.
individual.fit	A list of <code>summary.coxph</code> objects for each imputed data set

Author(s)

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See Also

[cox.kmi](#), [print.summary.cox.kmi](#), [summary.coxph](#)

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