Package ‘joineR’

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Description Analysis of repeated measurements and time-to-event data via random effects joint models. Some plotting functions and the variogram are also included.
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Description

The SANAD (Standard and New Antiepileptic Drugs) study (Marson et al., 2007) is a randomised control trial of standard and new antiepileptic drugs, comparing effects on longer term clinical outcomes. The data consists of longitudinal measurements of calibrated dose for the groups randomised to a standard drug (CBZ) and a new drug (LTG). The objective of the analysis is to investigate the effect of drug titration on the relative effects of LTG and CBZ on treatment failure (withdrawal of the randomized drug). There are several baseline covariates available, and also data on the time to withdrawal from randomized drug.

Usage

data(epileptic)

Format

This is a data frame in the unbalanced format, that is, with one row per observation. The data consists of columns for patient identifier, time of measurement, calibrated dose, baseline covariates, and survival data. The column names are identified as follows:

- [,1] - id - patient identifier
- [,2] - dose - calibrated dose
- [,3] - time - timing of clinic visit at which dose recorded
- [,4] - with.time - time of drug withdrawal/maximum follow up time
- [,5] - with.status - censoring indicator (1 = withdrawal of randomised drug and 0 = not withdrawn from randomised drug/lost to follow up)
- [,6] - with.status.uae - 1 if withdrawal due to unacceptable adverse effects, 0 otherwise
- [,7] - with.status.isc - 1 if withdrawal due to inadequate seizure control, 0 otherwise
- [,8] - treat - randomized treatment (CBZ or LTG)
- [,9] - age - age of patient at randomization
- [,10] - gender - gender of patient
- [,11] - learn.dis - learning disability
Source

SANAD Trial - University of Liverpool

References


Description

This is longitudinal data on an observational study on detecting effects of different heart valves, differing on type of tissue. The data consists of longitudinal measurements on three different heart function outcomes, after surgery occurred. There are several baseline covariates available, and also survival data.

Usage

data(heart.valve)

Format

This is a data frame in the unbalanced format, that is, with one row per observation. The data consists in columns for patient identification, time of measurements, longitudinal multiple longitudinal measurements, baseline covariates, and survival data. The column names are identified as follows:

- num - number for patient identification
- sex - gender of patient (0=Male and 1=Female)
- age - age of patient at day of surgery
- time - observed time point, with surgery date as the time zero (/years)
- fuyrs - maximum follow up time, with surgery date as the time zero (/years)
- status - censoring indicator (1=died and 0=lost of follow up)
- grad - Gradient, heart function longitudinal outcome
- log.grad - logarithm transformation, with base e, of the Gradient longitudinal outcome
- lvmi - Left Ventricular Mass Index, standardised by mass index, heart function longitudinal outcome
- log.lvmi - logarithm transformation, with base e, of the lvmi longitudinal outcome
- ef - Ejection Fraction, heart function longitudinal outcome
- bsa - body surface area, baseline covariate
- lvh - Left Ventricular pre-surgery hypertrophy, baseline covariate (0=good and 1=bad)
• **prenyha** - pre-surgery New York Heart Association (NYHA) Classification, baseline covariate (1=I/II and 3=III/IV)

• **redo** - revision procedure, baseline covariates (0=no and 1=yes)

• **size** - size of the valve, baseline covariate

• **con.cabg** - concomitant coronary artery bypass, baseline covariate (0=no and 1=yes)

• **creat** - creatinine at baseline

• **dm** - diabetes at baseline (0=no and 1=yes)

• **acei** - ace inhibitor at baseline (0=no and 1=yes)

• **lv** - left ventricular pre-surgery function, baseline covariate (1=good and 2=moderate and 3=poor)

• **emergenc** - operative urgency, baseline covariate (0=elective and 1=urgent and 3=emergency)

• **hc** - high cholesterol, baseline covariate (0=absent and 1=present treated and 2=present untreated)

• **sten.reg.mix** - aortic type (1=stenosis and 2=regurgitation and 3=mixed)

• **hs** - valve type used in the surgery (1=Homograft=human tissue and 0=Stentless=pig tissue)

### Source

Eric Lim - Royal Brompton Hospital

### References


### Examples

```r
data(heart.valve)
```

### joint

**Fit joint model for survival and longitudinal data measured with error**

### Description

This generic function fits a joint model with random latent association, building on the formulation described in Wulfsohn and Tsiatis (1997) while allowing for the presence of longitudinal and survival covariates, and three choices for the latent process. The link between the longitudinal and survival processes can be proportional or separate.
Usage

\[ \text{joint(data, long.formula, surv.formula,} \]
\[ \text{model = c("intslope", "int", "quad"),} \]
\[ \text{sepassoc = FALSE, longsep = FALSE, survsep = FALSE,} \]
\[ \text{gpt, lgp, max.it, tol)} \]

Arguments

data an object of class jointdata containing the variables named in the formulae arguments.

long.formula a formula object with the response variable, and the covariates to include in the longitudinal sub-model.

surv.formula a formula object with the survival time, censoring indicator and the covariates to include in the survival sub-model. The response must be a survival object as returned by the \text{Surv} function.

model a character string specifying the type of latent association. This defaults to the intercept and slope version as seen in Wulfsohn and Tsiatis. For association via the random intercept only, choose \text{model = "int"}, whereas for a quadratic association, use \text{model = "quad"}. Computing times are commensurate with the type of association structure chosen.

sepassoc logical value: if TRUE then the joint model is fitted with separate association, see Details.

longsep logical value: if TRUE, parameter estimates and log-likelihood from a separate linear mixed model analysis of the longitudinal data (see the \text{lme} function in the \text{nlme} package for details) are returned.

survsep if TRUE, parameter estimates and log-likelihood from a separate analysis of the survival data using the Cox proportional hazards model are returned (see \text{coxph} in the \text{survival} package for details).

gpt the number of quadrature points across which the integration with respect to the random effects will be performed. Defaults to \text{gpt = 3} which produces stable estimates in most datasets.

lgp the number of quadrature points which the log-likelihood is evaluated following a model fit. This defaults to \text{lgp = 10}, though \text{lgp = 3} is often sufficient.

max.it the maximum number of iterations of the EM algorithm that the function will perform. Defaults to \text{max.it = 200}, though more iterations may be necessary for large, complex data.

tol the tolerance level before convergence of the algorithm is deemed to have occurred. Default value is \text{tol = 0.001}.

Details

The \text{joint} function fits a joint model to survival and longitudinal data. The formulation is similar to Wulfsohn and Tsiatis (1997). A linear mixed effects model is assumed for the longitudinal data

\[ Y_i = X_{i1}(t_i)\beta_1 + D_i(t_i)U_i + \epsilon_i, \]
where $U_i$ is a vector of random effects, $(U_{0i}, \ldots, U_{qi})$ whose length depends on the model chosen, ie. $q = 1$ for the random intercept model. $D_i$ is the random effects covariate matrix, which will be time-dependent for all but the random intercept model. $X_{i1}$ is the longitudinal design matrix for unit $i$, and $t_i$ is the vector of measurement times for subject $i$. Measurement error is represented by $\epsilon_i$.

The Cox proportional hazards model is adopted for the survival data,
\[
\lambda(t) = \lambda_0(t) \exp \{ X_{i2}(t)^T \beta_2 + D_i(t)(\gamma^T U_i) \}.
\]

The parameter $\gamma$ determines the level of association between the two processes. For the intercept and slope model with separate association we have
\[
D_i(t)(\gamma^T U_i) = \gamma_0 U_{0i} + \gamma_1 U_{1i} t,
\]
whereas under proportional association
\[
D_i(t)(\gamma^T U_i) = \gamma(U_{0i} + U_{1i} t).
\]

$X_{i2}$ is the vector of survival covariates for unit $i$. The baseline hazard is $\lambda_0$.

The function uses an EM algorithm to estimate parameters in the joint model. Starting values are provided by calls to standard R functions lme and coxph for the longitudinal and survival components respectively.

**Value**

A list containing the parameter estimates from the joint model and, if required, from either or both of the separate analyses. The combined log-likelihood from a separate analysis and the log-likelihood from the joint model are also produced as part of the fit.

**Note**

Both llongsep and survsep ignore any latent association (i.e. $\gamma = 0$) between the longitudinal and survival processes but their output can be used to compare with the results from the joint model. If interest is solely in the individual processes then the user should instead make use of the functions lme and coxph mentioned above. Furthermore, if interest is in the separate effect of each random effect (this is for intercept and slope or quadratic models only) upon the survival data, the user should set sepassoc = TRUE.

**Author(s)**

Pete Philipson <pete.philipson@northumbria.ac.uk>

**References**

The general approach and model formulation is described by Wulfsohn and Tsiatis (1997) with extensions found in Henderson et al (2000).


jointdata 7

See Also
lme, coxph, jointdata, jointplot.

Examples

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve,
    var.col = c("fuys","status"),
    id.col = "num")
heart.long <- heart.valve[, c("num", "time", "log.lvmi")]
heart.cov <- UniqueVariables(heart.valve,
    c("age", "hs", "sex"),
    id.col = "num")
heart.valve.jd <- jointdata(longitudinal = heart.long,
    baseline = heart.cov,
    survival = heart.surv,
    id.col = "num",
    time.col = "time")
fit <- joint(data = heart.valve.jd,
    long.formula = log.lvmi ~ 1 + time + hs,
    surv.formula = Surv(fuys,status) ~ hs,
    model = "intslope")
```

Description

This function creates an object of class jointdata. This is an object with information on at least one of, longitudinal data or survival data. Moreover, it can also have data on baseline covariates.

Usage

```r
jointdata(longitudinal = NA, survival = NA, baseline = NA,
    id.col = "ID", time.col = NA)
```

Arguments

- **longitudinal**: a data frame or matrix in the unbalanced format (one row per observation), with subject identification, time of measurements, and longitudinal measurements and/or time dependent covariates. This must be given if no survival argument is.
- **survival**: a data frame or matrix with survival data for all the subjects. This must be given if no longitudinal argument is.
- **baseline**: a data frame or matrix with baseline covariates, or non-time dependent covariates, for the same subjects as in survival and/or longitudinal. This has to be in the balanced format (one row per subject). By default an object of this class does not include baseline covariates.
id.col  
an element of class character with the name identification of subject. This is to identify the subject identification in the data frames.

time.col  
an element of class character with the time measurements identification. This is to identify the time column in the data frames.

Details
This function creates an object of class jointdata. This is a list with elements used in joint modelling, mainly longitudinal and/or survival data. The output has to have at least one of the data sets, longitudinal or survival. However, for joint modelling is necessary to have both data sets. Moreover, a third data frame is possible to be given as input, for the baseline (non-time dependent) covariates. The subject identification and time measurement column names are necessary.

Value
This function returns a list of length six. The first element is the vector of subjects identification. The second is, if exists a data frame of the longitudinal data. The third element of the list is, if exists a data frame of the survival data. The fourth element of the list is, if exists a data frame on the baseline covariates. The fifth is, if longitudinal data is given, the column name identification of longitudinal times. And the sixth and last element of the list is the column name identification of subjects.

Author(s)
Ines Sousa (isousa@math.uminho.pt)

Examples

data(heart.valve)
heart.surv <- UniqueVariables(heart.valve,
   var.col = c("fuyrs", "status"),
   id.col = "num")

heart.valve.jd <- jointdata(survival = heart.surv,
   id.col = "num",
   time.col = "time")

Description
This function views the longitudinal profile of each unit with the last longitudinal measurement prior to event-time (censored or not) taken as the end-point, referred to as time zero. In doing so, the shape of the profile prior to event-time can be inspected. This can be done over a user-specified number of time units.
Usage

```
jointplot(object, Y.col, Cens.col, lag, split = TRUE, col1, col2,
xlab, ylab, gp1lab, gp2lab, smooth,
mean.profile = FALSE, mcol1, mcol2)
```

Arguments

- **object**: Name of the jointdata object
- **Y.col**: An element of class character identifying the longitudinal response part of the jointdata object.
- **Cens.col**: An element of class character identifying the survival status or censoring indicator part of the jointdata object.
- **lag**: Argument which specifies how many units in time we look back through. Defaults to the maximum observation time across all units.
- **split**: TRUE/FALSE argument which allows the profiles of units which ‘fail’ and those which are ‘censored’ to be viewed in separate panels of the same graph. This is the default option. Using `split = FALSE` will plot all profiles overlaid on a single plot.
- **col1**: argument to choose the colour for the profiles of the ‘censored’ units.
- **col2**: argument to choose the colour for the profiles of the ‘failed’ units.
- **xlab**: An element of class character indicating the title for the x-axis.
- **ylab**: An element of class character indicating the title for the x-axis.
- **gp1lab**: An element of class character for the group corresponding to a censoring indicator of zero. Typically, the censored group.
- **gp2lab**: An element of class character for the group corresponding to a censoring indicator of one. Typically, the group experiencing the event of interest.
- **smooth**: the smoother span. This gives the proportion of points in the plot which influence the smooth at each value. Defaults to a value of 2/3. Larger values give more smoothness. See `lowess` for further details.
- **mean.profile**: draw mean profiles if TRUE. Only applies to the `split = TRUE` case.
- **mcol1**: argument to choose the colour for the mean profile of the units with a censoring indicator of zero.
- **mcol2**: argument to choose the colour for the mean profile of the units with a censoring indicator of one.

Details

The function tailors the `xyplot` function in **lattice** to produce a representation of joint data with longitudinal and survival components.

Author(s)

Pete Philipson <pete.philipson@northumbria.ac.uk>
References


See Also

`xyplot`, `joint`, `jointdata`

Examples

data(heart.valve)
heart.surv <- UniqueVariables(heart.valve,
   var.col = c("fuys", "status"),
   id.col = "num")
heart.long <- heart.valve[,c("num", "time", "log.lvmi")]
heart.cov <- UniqueVariables(heart.valve,
   c("age", "sex"),
   id.col = "num")
heart.valve.jd <- jointdata(longitudinal = heart.long,
   baseline = heart.cov,
   survival = heart.surv,
   id.col = "num",
   time.col = "time")
jointplot(heart.valve.jd, Y.col = "log.lvmi",
   Cens.col = "status", lag = 5)

---

jointSE  

*Standard errors via bootstrap for a joint model fit*

Description

This function takes a model fit from a joint model and calculates standard errors, with optional confidence intervals, for the main longitudinal and survival covariates.

Usage

`jointSE(fitted, n.boot, gpt, lgpt, max.it, tol,`
` print.detail = FALSE)`

Arguments

fitted  
A list containing as components the parameter estimates obtained by fitting a joint model along with the respective formulae for the longitudinal and survival sub-models and the model chosen, see `joint` for further details.

n.boot  
Argument specifying the number of bootstrap samples to use in order to obtain the standard error estimates and confidence intervals. Note that at least `n.boot=100` is required in order for the function to return non-zero confidence intervals.
gpt

the number of quadrature points across which the integration with respect to the random effects will be performed. Defaults to gpt=3 which produces stable estimates in most datasets.

lgpt

the number of quadrature points which the log-likelihood is evaluated over following a model fit. This defaults to lgpt = 10, though lgpt = 3 is often sufficient.

max.it

the maximum number of iterations of the EM algorithm that the function will perform. Defaults to max.it = 200, though more iterations may be necessary for large, complex data.

tol

the tolerance level before convergence of the algorithm is deemed to have occurred. Default value is tol = 0.001.

print.detail

This argument determines the level of printing that is done during the bootstrapping. If TRUE then the parameter estimates from each bootstrap sample are output.

Details

Standard errors and confidence intervals are obtained by repeated fitting of the requisite joint model to bootstrap samples of the original longitudinal and survival data. It is rare that more than 200 bootstrap samples are needed for estimating a standard error. The number of bootstrap samples needed for accurate confidence intervals can be as large as 1000.

Author(s)

Ruwanthi Kolamunnage-Dona (Ruwanthi.Kolamunnage-Dona@liverpool.ac.uk) and Pete Philipson (pete.philipson@northumbria.ac.uk)

References


See Also

lme, coxph, joint, jointdata.

Examples

data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, 
   var.col = c("fuys", "status"),
   id.col="num")
heart.long <- heart.valve[, c("num", "time", "log.lvmi")]
heart.cov <- UniqueVariables(heart.valve, 
   c("age", "hs", "sex"),
   id.col="num")
heart.valve.jd <- jointdata(longitudinal = heart.long, 
   baseline = heart.cov,
```

survival = heart.surv,
id.col = "num",
time.col = "time")
fit <- joint(heart.valve.jd,
  long.formula = log.lvmi ~ 1 + time + hs,
surv.formula = Surv(fuyrs,status) ~ hs,
  model = "int")
jointSE(fitted = fit, n.boot = 1)
```

---

### Description

Add lines to an existing plot of an object of Class `jointdata`, for a longitudinal variable. It is possible to plot all the subjects in the data set, or just a selected subset. See `subset.jointdata`

### Usage

```r
## S3 method for class 'jointdata'
lines(x, Y.col, ...)
```

### Arguments

- `x`  
  object of class `jointdata`

- `Y.col`  
  column number, or column name, of longitudinal variable to be plotted

- `...`  
  other graphical arguments

### Value

A graphical device with a plot for longitudinal data. Other functions are useful to be used with this as `plot` and `points`

### Author(s)

Ines Sousa (isousa@math.uminho.pt)

### Examples

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, var.col = c("fuyrs", "status"),
  id.col = "num")
heart.long <- heart.valve[, c(1, 4, 5, 7, 8, 9, 10, 11)]
heart.jd <- jointdata(longitudinal = heart.long,
  survival = heart.surv, id.col = "num", time.col = "time")
# Randomly select a pair of subjects to plot profiles of
take <- sample(1 : max(heart.jd$survival$num), 2)
heart.jd.1 <- subset(heart.jd, take[1])
heart.jd.2 <- subset(heart.jd, take[2])
```
Liver cirrhosis longitudinal data

Description

This dataset gives the longitudinal observations of prothrombin index, a measure of liver function, for patients from a controlled trial into prednisone treatment of liver cirrhosis. Time-to-event information in the form of the event time and associated censoring indicator are also recorded along with a solitary baseline covariate - the allocated treatment arm in this instance. The data are taken from Andersen et al (1993, p. 19) and were analysed in Henderson, Diggle and Dobson (2002). This is a subset of the full data where a number of variables were recorded both at entry and during the course of the trial.

Usage

data(liver)

Format

A data frame in the unbalanced format with longitudinal observations from 488 subjects. The column form of the data is subject identifier, prothrombin index measurement, time of prothrombin index measurement, treatment indicator and then the survival data. The column names are detailed below:

• id  - number for patient identification
• prothrombin - prothrombin index measurement (?units)
• time  - time of prothrombin index measurement
• treatment - patient treatment indicator (0 = placebo, 1 = prednisone)
• survival - patient survival time (in years)
• cens  - censoring indicator (1 = died and 0 = censored)

Source


References


Examples
data(liver)

mental Mental Health Trial Data

Description

The data is obtained from a trial in which chronically ill mental health patients were randomised across two treatments: placebo and an active drug. A questionnaire instrument was used to assess each patient’s mental state at weeks 0, 1, 2, 4, 6 and 8 post-randomisation, a high recorded score implying a severe condition. Some of the 100 patients dropped out of the study for reasons that were thought to be related to their mental state, and therefore potentially informative; others dropped out for reasons unrelated to their mental state.

Usage
data(mental)

Format

A balanced data set with respect to the times at which observations recorded. The data consists of the following variables on each patient:

- [,1] - id - patient identifier (1,2,...,100)
- [,2] - Y.t0 - mental state assessment in week 0 (coded NA if missing)
- [,3] - Y.t1 - mental state assessment in week 1
- [,4] - Y.t2 - mental state assessment in week 2
- [,5] - Y.t4 - mental state assessment in week 4
- [,6] - Y.t6 - mental state assessment in week 6
- [,7] - Y.t8 - mental state assessment in week 8
- [,8] - treat - treatment allocation (0=placebo; 1=active drug)
- [,9] - n.obs - number of non-missing mental state assessments
- [,10] - event.time - imputed dropout time in weeks (coded 8.002 for completers)
- [,11] - status - censoring indicator (0=completer or non-informative dropout, 1=potentially informative dropout)
plot.jointdata

Plot longitudinal data

Description
Plot longitudinal data of an object of class jointdata, for a longitudinal variable. It is possible to plot all the subjects in the data set, or just a selected subset. See subset.jointdata.

Usage

## S3 method for class 'jointdata'
plot(x, Y.col, type, xlab, xlim, ylim, main, pty, ...)

Arguments

- **x**: object of class jointdata
- **Y.col**: column number, or column name, of longitudinal variable to be plotted. Defaults to Y.col = NA, plotting all longitudinal variables
- **type**: the type of line to be plotted, see plot for further details.
- **xlab**: a title for the x-axis, see title.
- **xlim, ylim**: numeric vectors of length 2, giving the x and y coordinates ranges, see plot.window for further details.
- **main**: an overall title for the plot: see title.
- **pty**: A character specifying the type of plot region to be used, see par for details.
- **...**: other graphical arguments (see plot)

Value
A graphical device with a plot for longitudinal data. Other functions are useful to be used with this as lines and points

Author(s)
Ines Sousa (isousa@math.uminho.pt)

Examples

data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, var.col = c("fuyrs", "status"),
id.col = "num")
heart.long <- heart.valve[, c(1, 4, 5, 7, 8, 9, 10, 11)]
heart.jd <- jointdata(longitudinal = heart.long,
survival = heart.surv, id.col = "num", time.col = "time")
plot(heart.jd, Y.col = "grad", col = "grey")
Describes the empirical variogram for longitudinal data

**Usage**

```r
## S3 method for class 'vargm'
plot(x, smooth = FALSE, bdw = NULL, follow.time = NULL, points = TRUE, ...)
```

**Arguments**

- **x**: object of class `vargm` obtained by using function `variogram`
- **smooth**: Logical value to use a non-parametric estimator to calculate the variogram of all $v_{ijk}$. The default is FALSE, as it uses time averages.
- **bdw**: bandwidth to use in the time averages. The default is NULL, because this is calculated automatically.
- **follow.time**: the interval of time we want to construct the variogram for. When NULL this is the maximum of the data.
- **points**: Logical value if the points $v_{ijk}$ should be plotted
- ... other graphical options as in `par`

**Value**

The function returns a graphical device with the plot of empirical variogram

**Author(s)**

Ines Sousa (isousa@math.uminho.pt)

**Examples**

```r
data(mental)
mental.unbalanced <- to.unbalanced(mental, id.col = 1,
  times = c(0,1,2,4,6,8),
  Y.col = 2:7,
  other.col = c(8,10,11))

names(mental.unbalanced)[3] <- "y"

v <- variogram(indv = tail(mental.unbalanced[, 1], 30),
  time = tail(mental.unbalanced[, 2], 30),
  Y = tail(mental.unbalanced[, 3], 30))

plot(v)
```
points.jointdata

Add points to an existing jointdata plot

Description

Add points to an existing plot of an object of class jointdata, for a longitudinal variable. It is possible plot all the subjects in the data set, or just a selected subset. See subset.jointdata

Usage

```r
## S3 method for class 'jointdata'
points(x, y.col, ...)  
```

Arguments

- `x`  
  object of class jointdata
- `y.col`  
  column number, or column name, of longitudinal variable to be plotted
- `...`  
  other graphical arguments

Value

A graphical device with a plot for longitudinal data. Other functions are useful to be used with this as `plot` and `lines`

Author(s)

- Ines Sousa (isousa@math.uminho.pt)

Examples

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, var.col = c("fuyrs", "status"),
id.col = "num")
heart.long <- heart.valve[, c(1, 4, 5, 7, 8, 9, 10, 11)]
heart.jd <- jointdata(longitudinal = heart.long,
survival = heart.surv, id.col = "num", time.col = "time")
# Randomly select a pair of subjects to plot profiles of
take <- sample(1 : max(heart.jd$survival$num), 2)
heart.jd.1 <- subset(heart.jd, take[1])
heart.jd.2 <- subset(heart.jd, take[2])
plot(heart.jd.1, Y.col = "grad", type = "p")
points(heart.jd.2, Y.col = "grad", col = "blue", pch = 20)
```
Sample from a jointdata object

Description

Generic function used to sampling a subset of data from an object of class jointdata, with a specific size of number of subjects.

Usage

```r
sample.jointdata(object, size, replace = FALSE)
```

Arguments

- **object**: an object of class jointdata
- **size**: number of subjects to include in the sampled subset
- **replace**: should sampling be with replacement?

Value

The function returns an object of class jointdata, with data only on the subjects sampled.

Author(s)

Ines Sousa (isousa@math.uminho.pt)

See Also

sample.jointdata, UniqueVariables.

Examples

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve,
  var.col=c("fuyrs", "status"),
  id.col = "num")
heart.valve.jd <- jointdata(survival = heart.surv,
  id.col = "num",
  time.col = "time")
sample.jointdata(heart.valve.jd, size = 10)
```
Description

Returns an object of class jointdata which is a subset of an original object of class jointdata.

Usage

```r
## S3 method for class 'jointdata'
subset(x, subj.subset, ...)
```

Arguments

- `x` an object of class jointdata
- `subj.subset` vector of subject identifiers, to include in the data subset. This must be a unique vector of patient identifiers.
- `...` further arguments to be passed to or from other methods.

Value

The function returns an object of class jointdata, with data only on a subset of subjects.

Author(s)

Ines Sousa (isousa@math.uminho.pt)

Examples

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, var.col = c("fuyrs", "status"),
id.col = "num")
heart.long <- heart.valve[, c(1, 4, 5, 7, 8, 9, 10, 11)]
heart.jd <- jointdata(longitudinal = heart.long,
survival = heart.surv, id.col = "num", time.col = "time")
take <- heart.jd$survival$num[heart.jd$survival$status == 0]
heart.jd.cens <- subset(heart.jd, take)
```
Summary: A random effects joint model fit

Description

Generic function used to produce summary information from a fitted random effects joint model as represented by object of class `joint`.

Usage

```r
## S3 method for class 'joint'
summary(object, variance, ...)
```

Arguments

- `object` an object inheriting from class `joint` representing a fitted random effects joint model.
- `variance` should the variance components be output as variances or standard deviations? Defaults to `variance = TRUE`.
- `...` further arguments for the summary

Value

An object inheriting from class `summary.joint` with all components included in `object` (see `joint` for a full description of the components) plus the following components:

- `nobs` the total number of (typically longitudinal) observations (i.e. rows in an unbalanced data set).
- `ngrps` the number of groups in the analysed dataset, often individual subjects.

Author(s)

Pete Philipson (pete.philipson@northumbria.ac.uk)

Examples

data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, 
  var.col=c("fuys","status"),
  id.col="num")
heart.long <- heart.valve[, c("num", "time", "log.lvmi")]
heart.cov <- UniqueVariables(heart.valve,
  c("age", "hs", "sex"),
  id.col = "num")
heart.valve.jd <- jointdata(longitudinal = heart.long, 
  baseline = heart.cov, 
  survival = heart.surv, 
  id.col = "num",
  ...)
summary.jointdata

```r
time.col = "time"
fit <- joint(data = heart.valve.jd, 
            long.formula = log.lvmi ~ 1 + time + hs, 
            surv.formula = Surv(fuhrs, status) ~ hs, 
            model = "intslope")
summary(fit)
```

**summary.jointdata**  \hspace{1cm} Summarise a jointdata object

**Description**

Generic function used to produce summaries of objects of class jointdata

**Usage**

```r
## S3 method for class 'jointdata'
summary(object, ...)
```

**Arguments**

- `object` an object of class jointdata
- `...` further arguments for the summary

**Value**

The function returns a list with five elements. Each summarises each element of the jointdata object.

- `subjects` Gives the number of subjects in the data set.
- `longitudinal` If longitudinal data is available, it gives the names and class of the longitudinal variables.
- `survival` If survival data is available, it gives the number of subjects with failure and censored survival times.
- `baseline` If baseline covariates is available, it gives the names and class of the baseline covariates.
- `times` If longitudinal data is available, it gives the unique longitudinal time measurements, if it is a balanced study. In case of unbalanced study, it will only state it is an unbalanced study.

**Author(s)**

Ines Sousa (isousa@math.uminho.pt)

**See Also**

jointdata, UniqueVariables.
summarybal

**Examples**

```r
data(heart.valve)
heart.surv <- UniqueVariables(heart.valve, 
    var.col = c("fuys", "status"),
    id.col = "num")
heart.valve.jd <- jointdata(survival = heart.surv,
    id.col = "num",
    time.col = "time")
summary(heart.valve.jd)
```

**Description**

For a balanced longitudinal data set a vector of the mean response and variances at defined time points is returned along with the correlation matrix of the responses across the time points.

**Usage**

```r
summarybal(object, Y.col, times, use = "all.obs", na.rm, ...)
```

**Arguments**

- **object** a longitudinal data set in the balanced format.
- **Y.col** the column numbers of the longitudinal measurements at each design time point in the object. This does not have to be all of the longitudinal measurements taken and may be a subset instead.
- **times** a vector of unique time points of the longitudinal measurements. This does not have to be all of the study time points and may be a subset instead, but should match the columns defined in Y.col
- **use** an optional character string giving a method for computing covariances in the presence of missing values. This must be (an abbreviation of) one of the strings "all.obs", "complete.obs" or "pairwise.complete.obs". Defaults to use = "all.obs"
- **na.rm** logical. Should missing values be removed? By default, na.rm = FALSE.
- **...** further arguments for the summary

**Value**

The function returns a list with three elements: **mean.vect** - a matrix with the time points in the first column and the mean response vector as the second column; **variance** - the vector of variances for the response at the time points and **cor.mtx** containing the correlation matrix of the responses between each pair of time points.

**Author(s)**

Ines Sousa (isousa@math.uminho.pt)
to.balanced

See Also
to.balanced.

Examples
data(mental)
summarybal(mental, Y.col = 2:7, times = c(0, 1, 2, 4, 6, 8), na.rm = TRUE)

Description
Transforms a longitudinal data set in the unbalanced format to the balanced format

Usage
to.balanced(data, id.col, time.col, Y.col, other.col = NA)

Arguments
data a data frame with longitudinal data in the unbalanced format. That is, in the format of 'one row per observation'.
id.col a column number, or column name, in the data frame data, where the patient identifier is located.
time.col a column number, or column name, in the data frame data, where the time measurements are.
Y.col a vector of column numbers, or column names, of longitudinal variables, and/or time dependent covariates in the data frame data.
other.col a vector of column numbers, or column names, of baseline covariates, and/or other subject level data, as for example, survival data. Default does not include other.col.

Value
The function returns a data frame with longitudinal data in the balanced format. The balanced format is considered in this context as the format where each row has data on each subject. Notice that in this format we will have multiple columns for the same longitudinal variable, each corresponding to the variable observed at each time point.

Author(s)
Ines Sousa (isousa@math.uminho.pt)

See Also
to.unbalanced.
Examples

```r
to.unbalanced <- data.frame(num = 1:10, Y1.1 = rnorm(10), Y1.2 = rnorm(10), Y2.1 = rnorm(10), Y2.2 = rnorm(10), age = rnorm(10))
simul <- to.unbalanced(simul, id.col = 1, times = c(1,2),
                      Y.col = 2:5, other.col = 6)
simul <- to.balanced(simul, id.col = "num", time.col = "time",
                    Y.col = c("Y1.1","Y2.1"), other.col = "age")
```

### to.unbalanced

*Transform data to the longitudinal unbalanced format*

**Description**

Transforms a longitudinal data set in the balanced format to the unbalanced format.

**Usage**

```r
to.unbalanced(data, id.col, times, Y.col, other.col = NA)
```

**Arguments**

- `data`: a data frame with longitudinal data in the balanced format. That is, in the format of 'one row per subject'.
- `id.col`: a column number, or column name, in the data frame `data`, where the patient identifications is.
- `times`: a vector with the unique time points where the patients are observed. This is the study design time points in a balanced data set.
- `Y.col`: a vector of column numbers, or column names, of longitudinal variables, and/or time dependent covariates in the data frame `data`.
- `other.col`: a vector of column numbers, or column names, of baseline covariates, and/or other subject level data, as for example, survival data. Default does not include `other.col`.

**Value**

The function returns a data frame with longitudinal data in the unbalanced format. The unbalanced format is considered in this context as the format where each row has data on each subject observation.

**Author(s)**

Ines Sousa (isousa@uminho.pt)

**See Also**

`to.balanced`.
Examples

```r
simul <- data.frame(num = 1:10,Y1.1 = rnorm(10),Y1.2 = rnorm(10),
                    Y2.1 = rnorm(10),Y2.2 = rnorm(10), age = rnorm(10))
to.unbalanced(simul, id.col = 1, times = c(1,2), Y.col = 2:5,
               other.col = 6)
```

UniqueVariables  

Extracts the unique non-time dependent variables per patient, from an unbalanced data set

Description

This function extracts a set of unique variables within a patient, returning a data frame with columns, patient identification and variables selected. Each row corresponds to the data for each individual.

Usage

```r
UniqueVariables(data, var.col, id.col="ID")
```

Arguments

- `data`: data frame, or matrix, with at least a column of patient identification and a covariate column
- `var.col`: vector of column names or column numbers, of the variables (non-time dependent). Cannot have mix of numbers and column names.
- `id.col`: column name or column number of the patient identification

Details

This function can be used, when longitudinal data is in the unbalanced format, and it is necessary, for example, to extract the set of unique baseline covariates, or any non-time dependent variables, that in the unbalanced format, are repeated for each observation row. Also, if the original data frame has survival data, this can also be used to extract the survival information from the original data set.

Value

The function returns a data frame with patient identification and covariates selected. Each row corresponds to the data for each individual. Note that, this can be only used for non-time dependent covariates. If extracting unique time dependent covariates, the function gives an error, because it can’t select what is the unique covariate.

Author(s)

Ines Sousa (isousa@math.pt)
Examples

```r
data(heart.valve)
heart.cov <- UniqueVariables(heart.valve,
c(2, 3, 5, 6, 12:25),
id.col = "num")
```

### Description

Calculates the variogram for observed measurements, with two components, the total variability in the data, and the variogram for all time lags in all individuals.

### Usage

```r
variogram(indv, time, Y)
```

### Arguments

- **indv**: vector of individual identification, as in the longitudinal data, repeated for each time point
- **time**: vector of observation time, as in the longitudinal data
- **Y**: vector of observed measurements. This can be a vector of longitudinal data, or residuals after fitting a model for the mean response

### Details

The empirical variogram in this function is calculated from observed half-squared-differences between pairs of measurements, \(v_{ijk} = 0.5 \cdot (r_{ij}-r_{ik})^2\) and the corresponding time differences \(u_{ijk}=t_{ij}-t_{ik}\). The variogram is plotted for averages of each time lag for the \(v_{ijk}\) for all \(i\).

### Value

The function returns a list with two elements. The first `sv` is a matrix with columns for all values \$(u_{ijk}, v_{ijk})\$, and the second `sigma2` is the total variability in the data. This is an object of class `vargm`.

### Note

There is a function `plot.vargm` which should be used to plot the empirical variogram.

### Author(s)

Ines Sousa (isousa@math.uminho.pt)
Examples

data(mental)
mental.unbalanced <- to.unbalanced(mental, id.col = 1,
times = c(0, 1, 2, 4, 6, 8),
y.col = 2:7,
other.col = c(8, 10, 11))

names(mental.unbalanced)[3] <- "Y"
vgm <- variogram(indv = tail(mental.unbalanced[, 1], 30),
time = tail(mental.unbalanced[, 2], 30),
Y = tail(mental.unbalanced[, 3], 30))
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