Package ‘gems’

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Author Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer
Maintainer Luisa Salazar Vizcaya <luisapaola.salazarvizcaya@insel.ch>
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Description Simulate and analyze multistate models with general hazard functions. gems provides functionality for the preparation of hazard functions and parameters, simulation from a general multistate model and predicting future events. The multistate model is not required to be a Markov model and may take the history of previous events into account. In the basic version, it allows to simulate from transition-specific hazard function, whose parameters are multivariable normally distributed.
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ArtCohort

Class "ArtCohort"

Description

Is a S4 class for the artificial cohort generated by simulateCohort.

Usage

## S4 method for signature 'ArtCohort,ANY,ANY,ANY'
x[i, j, ..., drop = TRUE]

## S4 method for signature 'ArtCohort'
update(object, newsize, addbaseline = matrix(NA, nrow =
    newsize - object@size), newInitialStates = rep(1, newsize - object@size))

## S4 method for signature 'ArtCohort'
head(x, ...)

## S4 method for signature 'ArtCohort'
tail(x, ...)

## S4 method for signature 'ArtCohort'
summary(object)

Arguments

x, object an ArtCohort
i, j, drop same as for data.frame
... passed on to data.frame method
newsize size of the updated cohort
addbaseline baseline for new part of cohort
newInitialStates initial states for new part of cohort

Slots

states.number Object of class "numeric": number of states
size Object of class "numeric": cohort size
baseline Object of class "matrix": baseline matrix
cumulativeIncidence

follow.up Object of class "numeric": maximum follow-up time
parameters Object of class "transition.structure": input parameters
parametersCovariances Object of class "transition.structure": input covariance matrices
timeToTransition Object of class "matrix": input timeToTransition matrix. logical components
transitionFunctions Object of class "transition.structure": input hazard functions
time.to.state Object of class "data.frame": entry times for each patient into each of the states

Objects from the Class

Objects are created by calls to the function simulateCohort.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

See Also

simulateCohort, transition.structure, transitionProbabilities, cumulativeIncidence

Examples

showClass("ArtCohort")

cumulativeIncidence transition probabilities

description

Calculates the cumulative incidence and prediction intervals after first state

Usage

cumulativeIncidence(object, times, M = 100, stateNames = paste("State",
as.list(1:dim(cohorts)[1])))

Arguments

object either the output of simulateCohort or the matrix with the probabilities
slot of that output.
times a time vector.
M number of groups for calculating confidence intervals.
stateNames a list with the names of states.
Value

an object of class "PosteriorProbabilities", containing the statenames, timepoints and the cumulative incidence with pointwise prediction intervals over time.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

References


See Also

PosteriorProbabilities, ArtCohort, simulateCohort

gems

gems: Generalized Multistate Simulation Model

Description

Simulate and analyze multistate models with general hazard functions. gems provides functionality for the preparation of hazard functions and parameters, simulation from a general multistate model and predicting future events. The multistate model is not required to be a Markov model and may take the history of previous events into account. In the basic version, it allows to simulate from transition-specific hazard function, whose parameters are multivariable normally distributed.

References


generateHazardMatrix

generate template for transition functions

Description

This function simplifies generating the matrix of transition functions.

Usage

generateHazardMatrix(statesNumber)
generateParameterCovarianceMatrix

Arguments
- statesNumber: the number of states to be considered.

Value
- a transition.structure of dimension $N \times N$, where $N$ is the number of states and with value "impossible" for all potential transitions.

Author(s)
- Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

References

See Also
- transition.structure, simulateCohort

---

generateParameterCovarianceMatrix
generate a template for parameter covariances

Description
- This function simplifies generating the matrix of parameter covariances from a matrix of mean parameters.

Usage
- generateParameterCovarianceMatrix(mu)

Arguments
- mu: a transition.structure of dimension $N \times N$, whose components list the mean values for the parameters in the transitionFunction.

Value
- a transition.structure of dimension $N \times N$ of covariance matrices for the parameters.

Author(s)
- Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer
generateParameterMatrix

References


See Also

transition.structure, generateParameterMatrix, simulateCohort

generateParameterMatrix

*generate a template for mean parameters*

Description

This function simplifies generating the matrix of mean parameters from a matrix of transition functions.

Usage

generateParameterMatrix(hf)

Arguments

hf

a transition.structure of dimension $N \times N$, where $N$ is the number of states.

Value

a transition.structure of dimension $N \times N$, whose components are lists of the right length for the parameters in the corresponding hazard function hf.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

References


See Also

transition.structure, simulateCohort
PosteriorProbabilities

Class "PosteriorProbabilities"

Description

This S4 class summarizes the posterior probabilities over time for objects of class "ArtCohort".

Usage

```r
## S4 method for signature 'PosteriorProbabilities,ANY,ANY,ANY'
x[i, j, ..., drop = TRUE]

## S4 method for signature 'PosteriorProbabilities'
plot(x, ci = FALSE, main = paste(x@type,
   "after starting in State", x@states[1], "at time 0"),
   states = 1:dim(x@probabilities)[2], lwd = c(2, 2), col = c("blue",
   "green3"), lty = c(1, 2), xlab = "Time", ylab = "Probability", ...)

## S4 method for signature 'PosteriorProbabilities'
head(x, ...)

## S4 method for signature 'PosteriorProbabilities'
tail(x, ...)
```

Arguments

- `x`: the PosteriorProbabilities object
- `i`, `j`, `drop`: same as for a "data.frame"
- `...`: arguments passed on to main method
- `ci`: should confidence intervals be displayed
- `main`, `xlab`, `ylab`: same as any plot
- `states`: which states to display
- `lwd`, `col`, `lty`: vectors of length 2, with first component for the point estimate and second component for the confidence interval

Slots

- `states`: Object of class "character": names of states
- `times`: Object of class "numeric": time points at which probabilities are evaluated
- `probabilities`: Object of class "matrix": posterior Probabilities to be in each state at each time
- `lower`: Object of class "matrix": lower prediction bound to be in each state at each time
- `upper`: Object of class "matrix": upper prediction bound to be in each state at each time
- `type`: Object of class "character": describes type of probability
Objects from the Class

Objects are created by calls to the function simulateCohort.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

See Also

transitionProbabilities, cumulativeIncidence, ArtCohort

Examples

showClass("PosteriorProbabilities")

---

Simulate a cohort of patients from a set of functions associated to each possible transition in a multistate model. The multistate model is not required to be a Markov model and may take the history of previous events into account. In the basic version, it allows to simulate from transition-specific hazard function, whose parameters are multivariable normally distributed. For each state, all transition-specific hazard functions and their parameters need to be specified. For simulating one transition, all possible event times are simulated and the minimum is chosen. Then simulation continues from the corresponding state until an absorbing state of time to is reached.

Usage

```r
simulateCohort(transitionFunctions, parameters, cohortSize = 1000,
parameterCovariances = FALSE, timeToTransition = array(FALSE, dim =
  dim(transitionFunctions@list.matrix)), baseline = matrix(NA, nrow =
  cohortSize), initialState = rep(1, cohortSize),
absorbing = transitionFunctions@states.number, to = 100,
report.every = 100, sampler.steps = 1000)
```

Arguments

- **transitionFunctions**
  a transition.structure of dimension \( N \times N \) that contains the hazard functions
- **parameters**
  a transition.structure of dimension \( N \times N \) that contains the parameters
- **cohortSize**
  a numeric indicating the number of patients to be simulated.
The transition functions contain hazard functions or time to event function associated to each possible transition. The elements of this list can be either expressed as an explicit R function or as a character ("impossible", "Weibull", "multWeibull", "exponential") in order to express impossible transitions or parametric forms for the distributions of time to event. If the functions should depend on time, baseline characteristics or be history-dependent, the function arguments \( t \), \( bl \) or \( history \) can be used. Time \( t \) refers to the time since entry into the current state. For the time since the initial state, use \( t+\text{sum(history)} \).

The components of the parameters argument list the mean values for the parameters in the transition function. If the corresponding transition function is a function, the parameters should appear in the same order as in the function, leaving out \( t \), \( bl \) and \( history \). If the corresponding transition function is the character "Weibull", the first argument is the shape and the second one the scale. If the corresponding transition function is the character "multWeibull", specify weights, shapes, scales in this order.

Note that when using the parameter covariances argument it is the users responsibility to ensure that the functions are parametrized such that parameters for each transition are multivariate normally distributed and mutually independent.

Value

an object of class "ArtCohort" with time.to.state slot of dimension \( \text{cohortSize} \times N \) with entry times for each patient into each of the states.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

References

See Also

generateHazardMatrix, generateParameterMatrix, generateParameterCovarianceMatrix,
ArtCohort, transitionProbabilities, cumulativeIncidence

Examples

# Here is an example model with 3 states and 2 possible transitions.

# number of states in the model
statesNumber <- 3

# cohort size
cohortSize <- 100

# specification of hazard functions
hazardf <- generateHazardMatrix(statesNumber)
hazardf[[1,2]] <- function(t, r1, r2)
{
  ifelse(t<=2, r1 , r2)
}
hazardf[[2,3]] <- "weibull"

# list of parameters for the hazard functions
mu <- generateParameterMatrix(hazardf)
mu[[1,2]] <- list(0.33, 0.03) # r1, r2
mu[[2,3]] <- list(1,0.84) # shape, scale

# time
maxTime <- 10

# simulate the cohort
cohort <- simulateCohort(
  transitionFunctions = hazardf,
  parameters = mu,
  cohortSize = cohortSize,
  to=maxTime)

# output
head(cohort)

# transition probability
tr <- transitionProbabilities(cohort, times=seq(0,4,.1))
plot(tr, ci=FALSE)

# cumulative incidence
inc <- cumulativeIncidence(cohort, times=seq(0,4,.1))
plot(inc, ci=FALSE, states=c(2,3))
Description

The simulated data set for each patient contains data for kidney injuries, bleeding complications and the combined endpoint of stroke or death. The data was simulated from the original data following the steps described in the package vignette.

Format

A data frame with 194 observations on the following 7 variables.

- **id**: a character vector that contains the patient id’s
- **kidney**: a numeric vector; indicator variable that show if an event has occurred
- **kidney.dur**: a numeric vector; times at which the events occurred or the patients were censored
- **bleeding**: a numeric vector; indicator variable that show if an event has occurred
- **bleeding.dur**: a numeric vector; times at which the events occurred or the patients were censored
- **death**: a numeric vector; indicator variable that show if an event has occurred
- **death.dur**: a numeric vector; times at which the events occurred or the patients were censored

References


Examples

```r
head(data(tavi))
```

transition.structure  
Class "transition.structure"

Description

This S4 class provides a structure to specify different characteristics of transitions, such as transition functions, parameters or parameter covariances.
Usage

```r
## S4 method for signature 'transition.structure'
x[[i, j, ..., exact = TRUE]]

## S4 replacement method for signature 'transition.structure'
x[[i, j]] <- value

possibleTransitions(object)

## S4 method for signature 'transition.structure'
possibleTransitions(object)

## S4 method for signature 'transition.structure'
print(x)
```

Arguments

- `x`, object: the `transition.structure`
- `i, j`: same as for `matrix`
- `exact, value, ...`: passed on to `list` method

Slots

- `states.number`: Object of class "numeric": number of states
- `list.matrix`: Object of class "matrix": a list with two dimensions, where list element `[i,j]` correspond to transitions from `i` to `j`

Objects from the Class

Objects are created by calls to the functions `generateHazardMatrix`, `generateParameterMatrix`, `generateParameterCovarianceMatrix`.

Author(s)

Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

See Also

- `generateHazardMatrix`, `generateParameterMatrix`, `generateParameterCovarianceMatrix`

Examples

```r
showClass("transition.structure")
```
transitionProbabilities

transition probabilities

Description
Calculates the probabilities and prediction intervals after first state

Usage
transitionProbabilities(object, times, M = 100, stateNames = paste("State", as.list(1:dim(cohorts)[1])))

Arguments
- object: either the output of simulateCohort or the matrix with the probabilities slot of that output.
- times: a time vector.
- M: number of groups for calculating confidence intervals.
- stateNames: a list with the names of states.

Value
an object of class "PosteriorProbabilities", containing the statenames, timepoints and the transition probabilities with pointwise prediction intervals over time.

Author(s)
Luisa Salazar Vizcaya, Nello Blaser, Thomas Gsponer

References

See Also
PosteriorProbabilities, ArtCohort, simulateCohort
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