Package 'spm'

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Type Package

Title Stochastic Process Model (SPM)

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Description Stochastic Process Modeling

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Imports Rcpp (>= 0.11.1), RcppArmadillo (>= 0.4.200.0)

LinkingTo Rcpp, RcppArmadillo

Depends deSolve,mice,sas7bdat,RcppArmadillo

Suggests knitr

VignetteBuilder knitr

RoxygenNote 5.0.1

R topics documented:

prepare_data *Data pre-processing for analysis with stochastic process model methodology.*

Description

Data pre-processing for analysis with stochastic process model methodology.

Usage

```
prepare_data(x, y, col.id = NULL, col.status = NULL, col.age = NULL,
  col.age.event = NULL, covariates = NULL, interval = 1,
  verbose = FALSE)
```

Arguments

x	A path to the table with follow-up oservations (longitudinal study). Formats: csv, sas7bdat
y	A path to the table with vital statistics (mortality). File formats: csv, sas7bdat
col.id	A name of column containing subject ID. This ID should be the same in both longdat and vitstat tables. If not provided, the first column in the x and y will be used by default.
col.status	A name of the column containing status variable (0/1 which indicate alive/dead). If not provided - then the column #2 from the vital statistics dataset will be used.
col.age	A name of age column (also called 't1'). If not provided then the 3rd column from the longitudinal dataset (x) will be used.
col.age.event	A name of 'event' column. The event column indicates a time when the even occured (e.g. system failure). If not provided then the 3rd column from the vital statistics dataset will be used.
covariates	A list of covariates. If covariates not provided, then all columns from longitudinal table having index > 3 will be used as covariates.
interval	A number of breaks between observations for discrete model. Default = 1 unit of time.
verbose	A verbosing output indicator. Default=FALSE.

Value

A list of two elements: first element contains a preprocessed data for continuous model, with arbitrary intervals between observations and second element contains a prepocessed data table for a discrete model (with constant intervals between observations).

Examples

```
library(spm)
data <- prepare_data(x=system.file("data","longdat.csv",package="spm"), y=system.file("data","vitstat.csv",
head(data[[1]])
head(data[[2]])
```

simdata_cont *Multi-dimensional simulation function for continuous trait.*

Description

Multi-dimensional simulation function for continuous trait.

Usage

```
simdata_cont(N = 100, a = -0.05, f1 = 80, Q = 2e-07, f = 80, b = 5,
  mu0 = 2e-05, theta = 0.08, step = 0.05, tstart = 30, tend = 105,
  ystart = 80, sd0 = 4, k = 1)
```

Arguments

N	Number of individuals.
a	A k by k matrix, which characterize the rate of the adaptive response.
f1	A particular state, which if a deviation from the normal (or optimal). This is a vector with length of k.
Q	A matrix k by k, which is a non-negative-definite symmetric matrix.
f	A vector-function (with length k) of the normal (or optimal) state.
b	A diffusion coefficient, k by k matrix.
mu0	mortality at start period of time.
theta	A displacement coefficient of the Gompertz function.
tstart	A number that defines starting time (30 by default).
tend	A number, defines final time (105 by default).
ystart	A vector with length equal to number of dimensions used, defines starting values of covariates.
k	number of dimensions (k = 1 by default).

Value

A table with simulated data.

Examples

```
library(spm)
dat <- simdata_cont(N=500)
dat
```

simdata_cont_1D *One-dimensional simulation function for continuous time (arbitrary intervals between observations).*

Description

One-dimensional simulation function for continuous time (arbitrary intervals between observations).

Usage

```
simdata_cont_1D(N = 10, aH = -0.05, f1H = 80, QH = 2e-07, fH = 80,
  bH = 5, mu0H = 2e-05, thetaH = 0.08, step = 0.05, tstart = 30,
  tend = 105, ystart = 80, sd0 = 4)
```

Arguments

N	Number of individuals.
tstart	A number that defines starting time (30 by default).
tend	A number, defines final time (105 by default).
ystart	A vector with length equal to number of dimensions used, defines starting values of covariates.
a	A k by k matrix, which characterize the rate of the adaptive response.
f1	A particular state, which if a deviation from the normal (or optimal). This is a vector with length of k.
Q	A matrix k by k, which is a non-negative-definite symmetric matrix.
f	A vector-function (with length k) of the normal (or optimal) state.
b	A diffusion coefficient, k by k matrix.
mu0	mortality at start period of time.
theta	A displacement coefficient of the Gompertz function.

Value

A table with simulated data.

Examples

```
library(spm)
dat <- simdata_cont_1D(N=2500)
dat
```

simdata_discr *Multi-dimension simulation function*

Description

Multi-dimension simulation function

Usage

```
simdata_discr(N = 100, a = -0.05, f1 = 80, Q = 2e-08, f = 80, b = 5,
  mu0 = 1e-05, theta = 0.08, ystart = 80, tstart = 30, tend = 105,
  dt = 1, k = 1)
```

Arguments

N	Number of individuals
a	A k by k matrix, which characterize the rate of the adaptive response.
f1	A particular state, which is a deviation from the normal (or optimal). This is a vector with length of k.
Q	A matrix k by k, which is a non-negative-definite symmetric matrix.
f	A vector-function (with length k) of the normal (or optimal) state.
b	A diffusion coefficient, k by k matrix.
mu0	mortality at start period of time.
theta	A displacement coefficient of the Gompertz function.
ystart	A vector with length equal to number of dimensions used, defines starting values of covariates.
tstart	A number that defines starting time (30 by default).
tend	A number, defines final time (105 by default).
dt	A time step (1 by default).
k	number of dimensions (k = 1 by default).

Value

A table with simulated data.

Examples

```
library(spm)
data <- simdata_discr(N=1000, ystart=80, k=1)
head(data)
```

simdata_time_dep *Simulation function for continuous trait with time-dependant coefficients.*

Description

Simulation function for continuous trait with time-dependant coefficients.

Usage

```
simdata_time_dep(N = 10, formulas = list(at = "-0.05", f1t = "80", Qt =
  "2e-7*exp(0.08*t)", ft = "80", bt = "5", mu0t = "2e-5*exp(0.08*t)"),
  step = 0.05, tstart = 30, tend = 105, ystart = 80, sd0 = 4, k = 1)
```

Arguments

N	Number of individuals.
formulas	: a list of formulas that define age (time) - dependency. Default: list(at="a", f1t="f1", Qt="Q*exp(theta*t)", ft="f", bt="b", mu0t="mu0*exp(theta*t)")
tstart	A number that defines starting time (30 by default).
tend	A number, defines final time (105 by default).
ystart	A starting value of covariates.

Value

A table with simulated data.

Examples

```
library(spm)
dat <- simdata_time_dep(N=2500)
dat
```

spm *A central function that estimates Stochastic Process Model (SPM) parameters a from given dataset.*

Description

A central function that estimates Stochastic Process Model (SPM) parameters a from given dataset.

Usage

```
spm(x, model = "discrete", formulas = list(at = "a", f1t = "f1", Qt =
  "Q*exp(theta*t)", ft = "f", bt = "b", mu0t = "mu0*exp(theta*t)"),
  verbose = FALSE, tol = NULL)
```

Arguments

x	A dataset: is the output from prepare_data(...) function and consists of two separate data tables: (1) a data table for continuous-time model and (2) a data table for discrete-time model.
model	A model type. Choices are: "discrete", "continuous" or "time-dependent".
formulas	A list of parameter formulas used in the "time-dependent" model.
verbose	A verbosing output indicator (FALSE by default).
tol	A tolerance threshold for matrix inversion (NULL by default).

Value

For "discrete" and "continuous" model types: (1) a list of model parameter estimates for the discrete model type described in "", Akushevich et al, 2005 and (2) a list of model parameter estimates for the continuous model type described in "", Yashin et al, 2007.

For the "time-dependent" model (model parameters depend on time): a set of model parameter estimates.

Examples

```
library(spm)
#Prepare data for optimization
data <- prepare_data(x=system.file("data","longdat.csv",package="spm"), y=system.file("data","vitstat.csv",
#Parameters estimation (default model: discrete-time):
p.discr.model <- spm(data)
p.discr.model
# Continuous-time model:
p.cont.model <- spm(data, model="continuous")
p.cont.model
# Model with time-dependent coefficients:
data <- prepare_data(x=system.file("data","longdat.csv",package="spm"), y=system.file("data","vitstat.csv",
p.td.model <- spm(data, model="time-dependent")
p.td.model
```

---

spm_continuous *Continuous multi-dimensional optimization*

Description

Continuous multi-dimensional optimization

Usage

```
spm_continuous(dat, a = 0.05, f1 = 80, Q = 2e-08, f = 81, b = 5,
  mu0 = 2e-05, theta = 0.08, k = 1, verbose = F)
```

Arguments

dat	A data table.
a	A starting value of the rate of adaptive response to any deviation of Y from f1(t).
f1	A starting value of the average age trajectories of the variables which process is forced to follow.
Q	Starting values of the quadratic hazard term.
f	A starting value of the "optimal" value of variable which corresponds to the minimum of hazard rate at a respective time.
b	A starting value of a diffusion coefficient representing a strength of the random disturbance from Wiener Process.
mu0	A starting value of the baseline hazard.
theta	A starting value of the parameter theta (axe displacement of Gompertz function).
k	A number of dimensions.
verbose	An indicator of verbosing output.
tol	A tolerance threshold for matrix inversion.

Details

spm_integral_MD runs much slower that discrete but more precise and can handle time intervals with different lengths.

Value

A set of estimated parameters a, f1, Q, f, b, mu0, theta.

Examples

```
library(spm)
# Reading the data:
longdat <- read.csv(system.file("data","longdat.csv",package="spm"))
vitstat <- read.csv(system.file("data","vitstat.csv",package="spm"))
dd <- prepare_data(longdat=longdat, vitstat=vitstat,interval=1, col.status="IsDead", col.id="ID", col.age="A
data <- dd[[1]][,2:6]
#Parameters estimation:
pars <- spm_continuous(dat=data,a=-0.05, f1=80, Q=2e-8, f=80, b=5, mu0=2e-5, theta=0.08, k = 1)
pars
```

---

spm_continuous_1D *Continuous one-dimensional optimization*

Description

Continuous one-dimensional optimization

Usage

```
spm_continuous_1D(dat, a = -0.05, f1 = 80, Q = 2e-08, f = 80, b = 5,
  mu0 = 2e-05, theta = 0.08)
```

Arguments

dat	A data table.
a	A starting value of the rate of adaptive response to any deviation of Y from f1(t).
f1	A starting value of the average age trajectories of the variables which process is forced to follow.
Q	Starting values of the quadratic hazard term.
f	A starting value of the "optimal" value of variable which corresponds to the minimum of hazard rate at a respective time.
b	A starting value of a diffusion coefficient representing a strength of the random disturbance from Wiener Process.
mu0	A starting value of the baseline hazard.
theta	A starting value of the parameter theta (axe displacement of Gompertz function).
k	A number of dimensions.
verbose	An indicator of verbosing output.
tol	A tolerance threshold for matrix inversion.

Details

spm_integral_1D runs much slower that discrete but more precise and can handle time intervals with different lengths.

Value

A set of estimated parameters a, f1, Q, f, b, mu0, theta.

Examples

```
library(spm)
# Reading the data:
longdat <- read.csv(system.file("data","longdat.csv",package="spm"))
vitstat <- read.csv(system.file("data","vitstat.csv",package="spm"))
dd <- prepare_data(longdat=longdat, vitstat=vitstat,interval=1, col.status="IsDead", col.id="ID", col.age="A
data <- dd[[1]][,2:6]
#Parameters estimation:
pars <- spm_continuous_1D(dat=data,a=-0.05, f1=80, Q=2e-8, f=80, b=5, mu0=2e-5, theta=0.08)
pars
```

---

spm_discrete *Discrete multi-dimensional optimization*

Description

Discrete multi-dimensional optimization

Usage

```
spm_discrete(dat, k = 1, theta_range = seq(0.001, 0.09, by = 0.001),
  tol = NULL)
```

Arguments

dat	A data table.
k	A number of dimensions.
theta_range	A range of theta parameter (axe displacement of Gompertz function), default: from 0.001 to 0.09 with step of 0.001.
tol	A tolerance threshold for matrix inversion (NULL by default).

Details

This function is way much faster that continuous spm_continuous_MD(...) (but less precise) and used mainly in estimation a starting point for the spm_continuous_MD(...).

Value

A list of two elements: (1) estimated parameters u, R, b, epsilon, Q, mu0, theta and (2) estimated parameters a, f1, Q, f, b, mu0, theta. Note: b and mu0 from first list are different from b and mu0 from the second list.

Examples

```
library(spm)
# Reading longitudinal data
longdat <- read.csv(system.file("data","longdat.csv",package="spm"))
# Prepare data for optimization
vitstat <- read.csv(system.file("data","vitstat.csv",package="spm"))
data <- prepare_data(longdat=longdat, vitstat=vitstat,interval=1, col.status="IsDead", col.id="ID", col.age=
# Parameters estimation
pars <- spm_discrete(data[[2]], k=1, theta_range=seq(0.001,0.09,by=0.001), tol=NULL)
pars
```

---

spm_time_dep *spm_time_dep : a function that can handle time-dependant coefficients:*

Description

spm_time_dep : a function that can handle time-dependant coefficients:

Usage

```
spm_time_dep(x, start = list(a1 = -0.5, a2 = 0.2, f1 = 80, Q = 2e-08, f = 80,
  b = 5, mu0 = 1e-05), formulas = list(at = "a1*t+a2", f1t = "f1", Qt =
  "Q*exp(theta*t)", ft = "f", bt = "b", mu0t = "mu0*exp(theta*t)"),
  verbose = TRUE, lower_bound = NULL, upper_bound = NULL, factr = 1e-16,
  lmult = 0.5, umult = 2)
```

Arguments

x	: input data table.
start	: a list of starting parameters, default: llist(a=-0.5, f1=80, Q=2e-8, f=80, b=5, mu0=1e-5, theta=0.08),
formulas	: a list of formulas that define age (time) - dependency. Default: list(at="a1*t+a2", f1t="f1", Qt="Q*exp(theta*t)", ft="f", bt="b", mu0t="mu0*exp(theta*t)")

Value

optimal coefficients

Examples

```
library(spm)
#Data preparation:
N <- 1000
data <- simdata_time_dep(N=2500)
opt.par <- spm_time_dep(data[,2:6], formulas=list(at="a", f1t="f1", Qt="Q*exp(theta*t)", ft="f", bt="b", mu0
opt.par
```

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