Package 'denim'

June 5, 2024

Type Package

Title Generate and Simulate Deterministic Discrete-Time Compartmental Models

Version 1.0.0

Date 2024-05-28

Description R package to build and simulate deterministic discrete-time compartmental models that can be non-Markov. Length of stay in each compartment can be defined to follow a parametric distribution (d_exponential(), d_gamma(), d_weibull(), d_lognormal()) or a non-parametric distribution (nonparametric()). Other supported types of transition from one compartment to another includes fixed transition (constant()), multinomial (multinomial()), fixed transition probability (transprob()).

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URL https://drthinhong.com/denim/, https://github.com/thinhong/denim

BugReports https://github.com/thinhong/denim/issues

Imports Rcpp (>= 1.0.6), viridisLite

Suggests covr, knitr, rmarkdown, testthat (>= 3.0.0), xml2, deSolve, DiagrammeR

LinkingTo Rcpp, testthat

Encoding UTF-8

RoxygenNote 7.3.1

VignetteBuilder knitr

Config/testthat/edition 3

NeedsCompilation yes

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Date/Publication 2024-06-05 19:50:10 UTC

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See Also

Useful links:

- https://drthinhong.com/denim/
- https://github.com/thinhong/denim
- Report bugs at https://github.com/thinhong/denim/issues

`constant` *Fixed transition*

Description

Define a fixed number of individuals of the left compartment transit to the right compartment at every time step

Usage

```
constant(x)
```

Arguments

`x`	number of individuals who move from one compartment to another

Value

a Distribution object for simulator

Examples

```
transitions <- list("S->I" = constant(10))
```

`d_exponential` *Discrete exponential distribution*

Description

Discrete exponential distribution

Usage

```
d_exponential(rate)
```

Arguments

`rate`	rate parameter of an exponential distribution

Value

a Distribution object for simulator

Examples

```
transitions <- list("I -> D" = d_exponential(0.3))
```

`d_gamma` *Discrete gamma distribution*

Description

Discrete gamma distribution

Usage

```
d_gamma(scale, shape)
```

Arguments

`scale`	scale parameter of a gamma distribution
`shape`	shape parameter of a gamma distribution

Value

a Distribution object for simulator

Examples

```
transitions <- list("S -> I" = d_gamma(1, 5))
```

`d_lognormal` *Discrete log-normal distribution*

Description

Discrete log-normal distribution

Usage

```
d_lognormal(mu, sigma)
```

Arguments

mu	location parameter or the ln mean
sigma	scale parameter or ln standard deviation

Value

a Distribution object for simulator

Examples

```
transitions <- list("I -> D" = d_lognormal(3, 0.6))
```

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d_weibull *Discrete Weibull distribution*

Description

Discrete Weibull distribution

Usage

```
d_weibull(scale, shape)
```

Arguments

scale	scale parameter of a Weibull distribution
shape	shape parameter of a Weibull distribution

Value

a Distribution object for simulator

Examples

```
transitions <- list("I -> D" = d_weibull(0.6, 2))
```

mathexpr *Mathematical expression*

Description

Mathematical expression

Usage

```
mathexpr(expr)
```

Arguments

expr	User defined mathematial expression. he expression will be processed by muparser library which offers a wide variety of operators. Visit muparser website (https://beltoforion.de/en/muparser/features.php) to see full list of available operators.

Value

a Distribution object for simulator

Examples

```
transitions <- list("S->I"=mathexpr("beta*S/N"))
# definition for parameters in the expression required
params <- c(N = 1000, beta = 0.3)
```

multinomial *Multinomial*

Description

Define a set of probabilities of transition from one compartment to multiple compartments

```
"I -> R, D" = multinomial(0.9, 0.1),
"I -> R" = d_gamma(3, 2),
"I -> D" = d_lognormal(2, 0.5)
```

is equal to

```
"0.9 * I -> R" = d_gamma(3, 2),
"0.1 * I -> D" = d_lognormal(2, 0.5)
```

Usage

```
multinomial(...)
```

Arguments

...	a vector of probabilities, must add up to 1

Value

a Distribution object for simulator

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nonparametric *Nonparametric distribution*

Description

Convert a vector of frequencies, percentages... into a distribution

Usage

```
nonparametric(...)
```

Arguments

...	a vector of values

Value

a Distribution object for simulator

Examples

```
transitions <- list("S->I"=nonparametric(0.1, 0.2, 0.5, 0.2))
```

---

sim *Simulator for deterministic discrete time model with memory*

Description

Simulation function that call the C++ simulator

Usage

```
sim(
  transitions,
  initialValues,
  parameters = NULL,
  simulationDuration,
  timeStep = 1,
  errorTolerance = 0.001
)
```

Arguments

`transitions`	a list of transitions follows this format `"transition" = distribution()`
`initialValues`	a vector contains the initial values of all compartments defined in the **transitions**, follows this format `compartment_name = initial_value`
`parameters`	a vector contains values of any parameters that are not compartments, usually parameters used in `mathexp()` functions
`simulationDuration`	duration of time to be simulate
`timeStep`	set the output time interval. For example, if `simulationDuration = 10` means 10 days and `timeStep = 0.1`, the output will display results for each 0.1 daily interval
`errorTolerance`	set the threshold so that a cumulative distribution function can be rounded to 1. For example, if we want a cumulative probability of 0.999 to be rounded as 1, we set `errorTolerance = 0.001` (1 - 0.999 = 0.001). Default is 0.001

Value

a data.frame with class `denim` that can be plotted with a `plot()` method

Examples

```
transitions <- list(
   "S -> I" = "beta * S * I / N",
   "I -> R" = d_gamma(3, 2)
)

initialValues <- c(
   S = 999,
   I = 1,
   R = 0
)

parameters <- c(
   beta = 0.012,
   N = 1000
)

simulationDuration <- 30
timeStep <- 0.01

mod <- sim(transitions = transitions,
           initialValues = initialValues,
           parameters = parameters,
           simulationDuration = simulationDuration,
           timeStep = timeStep)
```

`transprob` *Transition probability*

Description

A fixed percentage of the left compartment transit to the right compartment at every time step

Usage

```
transprob(x)
```

Arguments

`x`	a float number between 0 to 1

Value

a Distribution object for simulator

Examples

```
transitions <- list("S->I"=transprob(0.8))
```

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