

Package ‘denim’

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Type Package

Title Generate and Simulate Deterministic Compartmental Models

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Description R package to build and simulate deterministic compartmental models that can be non-Markovian. 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>

Depends R (>= 4.1.0)

Imports Rcpp (>= 1.0.6), colorspace, rlang, glue

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

LinkingTo Rcpp, testthat

Encoding UTF-8

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denim-package	<i>denim</i>
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Description

Simulate deterministic model

Details

Imports

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See Also

Useful links:

- <https://drthinong.com/denim/>
- <https://github.com/thinhong/denim>
- Report bugs at <https://github.com/thinhong/denim/issues>

denim_dsl

Define transitions using denim's domain-specific language (DSL)

Description

This function parses model transitions defined in denim's DSL syntax

Usage

```
denim_dsl(x)
```

Arguments

- x
- an expression written in denim's DSL syntax. Each line should be a transition written in the format `from -> to = transition` where expression can be either a math expression or one of denim's built-in dwell time distribution function

Value

denim_transition object

Examples

```
transitions <- denim_dsl({  
  S -> I = beta * (I/N) * S  
  I -> R = d_gamma(rate = 1/4, shape = 3)  
})
```

d_exponential	<i>Discrete exponential distribution</i>
---------------	--

Description

Discrete exponential distribution

Usage

```
d_exponential(rate, dist_init = FALSE)
```

Arguments

rate	rate parameter of an exponential distribution
dist_init	whether to distribute initial value across subcompartments following this distribution. (default to FALSE, meaning init value is always in the first compartment)

Value

a Transition object for simulator

Examples

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

d_gamma	<i>Discrete gamma distribution</i>
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Description

Discrete gamma distribution

Usage

```
d_gamma(rate, shape, dist_init = FALSE)
```

Arguments

rate	rate parameter of a gamma distribution
shape	shape parameter of a gamma distribution
dist_init	whether to distribute initial value across subcompartments following this distribution.

Value

a Transition object for simulator

Examples

```
transitions <- list("S -> I" = d_gamma(rate = 1, shape = 5))
transitions_dsl <- denim_dsl({S -> I = d_gamma(rate = 1, shape = 5)})
# define model parameters as distributional parameters
transitions_dsl <- denim_dsl({S -> I = d_gamma(rate = i_rate, shape = i_shape)})
```

d_lognormal	<i>Discrete log-normal distribution</i>
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Description

Discrete log-normal distribution

Usage

```
d_lognormal(mu, sigma, dist_init = FALSE)
```

Arguments

mu	location parameter or the ln mean
sigma	scale parameter or ln standard deviation
dist_init	whether to distribute initial value across subcompartments following this distribution. (default to FALSE, meaning init value is always in the first compartment)

Value

a Transition object for simulator

Examples

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

d_weibull *Discrete Weibull distribution*

Description

Discrete Weibull distribution

Usage

```
d_weibull(scale, shape, dist_init = FALSE)
```

Arguments

scale	scale parameter of a Weibull distribution
shape	shape parameter of a Weibull distribution
dist_init	whether to distribute initial value across subcompartments following this distribution. (default to FALSE, meaning init value is always in the first compartment)

Value

a Transition object for simulator

Examples

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

nonparametric *Nonparametric distribution transition*

Description

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

Usage

```
nonparametric(x, dist_init = FALSE)
```

Arguments

x	a vector of values
dist_init	whether to distribute initial value across subcompartments following this distribution. (default to FALSE, meaning init value is always in the first compartment)

Value

a Transition object for simulator

Examples

```
transitions <- list("S->I"=nonparametric( c(0.1, 0.2, 0.5, 0.2) ))
transitions <- denim_dsl({S->I=nonparametric( c(0.1, 0.2, 0.5, 0.2) )})
# you can also define a model parameter for the distribution
transitions <- denim_dsl({S->I=nonparametric( dwelltime_dist )})
```

plot.denim

Overloaded plot function for denim object

Description

Overloaded plot function for denim object

Usage

```
## S3 method for class 'denim'
plot(x, ..., color_palette = NULL)
```

Arguments

x	• output of denim::sim function
...	• additional parameter for plot() function
color_palette	• a palette name from the colorspace package. You can view available palettes with colorspace::hcl_palettes("qualitative", plot = TRUE).

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	output of function <code>denim_dsl()</code> or a list of transitions follows this format "transition" = expression
initialValues	a vector contains the initial values of all compartments defined in the transitions , follows this format <code>compartment_name = initial_value</code>
parameters	a vector contains values of any parameters that are not compartments, usually parameters used in <code>mathexp()</code> functions
simulationDuration	duration of time to be simulate
timeStep	set the output time interval. For example, if <code>simulationDuration = 10</code> means 10 days and <code>timeStep = 0.1</code> , 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 <code>errorTolerance = 0.001</code> ($1 - 0.999 = 0.001$). Default is 0.001

Value

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

Examples

```
# model can be defined using denim DSL
transitions <- denim_dsl({
  S -> I = beta * S * I / N
  I -> R = d_gamma(1/3, 2)
})

# or as a list
transitions <- list(
  "S -> I" = "beta * S * I / N",
  "I -> R" = "d_gamma(1/3, 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)
```

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