

Package ‘phylopomp’

October 17, 2024

Contents

as.data.frame	2
curtail	2
diagram	3
gendat	4
geneal	5
genealogy diagram internals	5
getInfo	7
lbdp	8
lineages	10
moran	11
newick	12
parse_newick	13
phylopomp	14
reexports	14
s2i2r2	15
seir	16
si2r	19
siir	21
simulate	23
sir	24
treeplot	26
twospecies	28
yaml	31

Index	32
--------------	-----------

<code>as.data.frame</code>	<i>Coerce to a Data Frame</i>
----------------------------	-------------------------------

Description

Functions to coerce an object to a data frame.

Usage

```
## S3 method for class 'gpln'
as.data.frame(x, ...)
```

Arguments

<code>x</code>	any R object.
<code>...</code>	additional arguments to be passed to or from methods.

Details

An object of class ‘gpln’ is coerced to a data frame by means of `as.data.frame`.

<code>curtail</code>	<i>Curtail a genealogy to the given time</i>
----------------------	--

Description

Discards all nodes beyond the given time.

Usage

```
curtail(object, time = NA, prune = TRUE, obscure = TRUE)
```

Arguments

<code>object</code>	gpsim object.
<code>time</code>	logical; return the current time?
<code>prune</code>	logical; prune the genealogy?
<code>obscure</code>	logical; obscure the demes?

Value

A curtailed genealogy object.

Examples

```

library(ggplot2)

simulate("SIIR",time=5) -> x

plot_grid(
  x |>
    plot(prune=FALSE,points=TRUE),
  x |>
    curtail(time=3) |>
    plot(prune=FALSE,points=TRUE)+
    expand_limits(x=5),
  ncol=1,align="h",axis="tblr"
)

plot_grid(
  x |>
    plot(prune=TRUE,points=TRUE)+
    geom_vline(xintercept=3),
  x |> curtail(time=3) |>
    plot(prune=TRUE,points=TRUE)+
    geom_vline(xintercept=3)+
    expand_limits(x=5),
  ncol=1,align="h",axis="tblr"
)

```

diagram

Genealogy process diagram

Description

Produces a diagram of the genealogy process state.

Usage

```

diagram(
  object,
  prune = TRUE,
  obscure = TRUE,
  m = NULL,
  n = NULL,
  ...,
  digits = 1,
  palette = scales::hue_pal(l = 80, c = 20, h = c(220, 580))
)

## S3 method for class 'gpdiag'
print(x, newpage = is.null(vp), vp = NULL, ...)

```

Arguments

object	gpsim object.
prune	logical; prune the genealogy?
obscure	logical; obscure the demes?
m	width of plotting window, in nodes. By default, the nodes will be adjusted in width to fit the window.
n	height of the pockets, in balls. By default, the balls will be adjusted in size to fit the space available.
...	other arguments, ignored.
digits	non-negative integer; number of decimal digits to print in the node time
palette	color palette for indicating demes. This can be furnished either as a function or a vector of colors. If this is a function, it should take a single integer argument, the number of colors required. If it is a vector, it should have at least as many elements as there are demes in the genealogy.
x	An R object.
newpage	draw new empty page first?
vp	viewport to draw plot in

Value

A **grid** graphics object (grob), invisibly.

Examples

```
runSIR(Beta=3,gamma=0.1,psi=0.2,S0=100,I0=5,R0=0,time=2,t0=0) -> x
plot(x,points=TRUE,prune=FALSE)
plot_grid(plotlist=list(plot(x,points=TRUE)[[1]],diagram(x)),
  ncol=1,rel_heights=c(4,1))
```

gendat

Genealogy as a data frame

Description

Converts a given genealogy to a data frame.

Usage

```
gendat(object)
```

Arguments

object	a 'gpgen' object.
--------	-------------------

Value

A list of objects containing the information pertinent for filtering.

geneal	<i>Bare genealogy</i>
--------	-----------------------

Description

Extracts the bare genealogy from a Markov genealogy process simulation

Usage

```
geneal(object)
```

Arguments

object a 'gp-gen' object.

Value

A bare genealogy object.

genealogy diagram internals	<i>Diagramming internals</i>
-----------------------------	------------------------------

Description

Facilities to produce diagrammatic representations of genealogy process states.

Usage

```
genealogyGrob(object, m = NULL, n = NULL, vp = NULL, palette, ...)
```

```
nodeGrob(object, digits = 1, palette, n = NULL, vp = NULL)
```

```
pocketGrob(object, n, vp = NULL)
```

```
ballGrob(object, vp = NULL)
```

```
resizingTextGrob(..., vp = NULL)
```

```
## S3 method for class 'resizingTextGrob'
drawDetails(x, recording = TRUE)
```

```
## S3 method for class 'resizingTextGrob'
preDrawDetails(x)
```

```
## S3 method for class 'resizingTextGrob'
postDrawDetails(x)

## S3 method for class 'ballGrob'
drawDetails(x, recording = TRUE)

## S3 method for class 'ballGrob'
preDrawDetails(x)

## S3 method for class 'ballGrob'
postDrawDetails(x)

## S3 method for class 'gpsim'
print(x, ...)

## S3 method for class 'gpngen'
print(x, ...)

## S3 method for class 'gpyaml'
print(x, ...)
```

Arguments

<code>object</code>	list; pocket structure
<code>m</code>	width of plotting window, in nodes. By default, the nodes will be adjusted in width to fit the window.
<code>n</code>	length of longest genealogy
<code>vp</code>	viewport to draw plot in
<code>palette</code>	color palette for indicating demes. This can be furnished either as a function or a vector of colors. If this is a function, it should take a single integer argument, the number of colors required. If it is a vector, it should have at least as many elements as there are demes in the genealogy.
<code>...</code>	arguments to be passed to <code>textGrob</code> .
<code>digits</code>	non-negative integer; number of decimal digits to print in the node time
<code>x</code>	An R object.
<code>recording</code>	A logical value indicating whether a grob is being added to the display list or redrawn from the display list.

Details

Code for the resizing text adapted from a blog post by Mark Heckmann (<https://ryouready.wordpress.com/2012/08/01/creating-a-text-grob-that-automatically-adjusts-to-viewport-size/>).

`getInfo`*getInfo*

Description

Retrieve information from genealogy process simulation

Usage

```
getInfo(  
  object,  
  prune = TRUE,  
  obscure = TRUE,  
  t0 = FALSE,  
  time = FALSE,  
  description = FALSE,  
  structure = FALSE,  
  yaml = FALSE,  
  ndeme = FALSE,  
  lineages = FALSE,  
  newick = FALSE,  
  nsample = FALSE,  
  genealogy = FALSE,  
  gendat = FALSE  
)
```

Arguments

<code>object</code>	gpsim object.
<code>prune</code>	logical; prune the genealogy?
<code>obscure</code>	logical; obscure the demes?
<code>t0</code>	logical; return the zero-time?
<code>time</code>	logical; return the current time?
<code>description</code>	logical; return the description?
<code>structure</code>	logical; return the structure in R list format?
<code>yaml</code>	logical; return the structure in YAML format?
<code>ndeme</code>	logical; return the number of demes?
<code>lineages</code>	logical; return the lineage-count function?
<code>newick</code>	logical; return a Newick-format description of the tree?
<code>nsample</code>	logical; return the number of samples?
<code>genealogy</code>	logical; return the lineage-traced genealogy?
<code>gendat</code>	logical; return the data-frame format?

Value

A list containing the requested elements, including any or all of:

t0 the initial time (a numeric scalar)
time the final time (a numeric scalar)
ndeme the number of demes (an integer)
nsample the number of samples (an integer)
newick the genealogical tree, in Newick format
description a human readable description of the state of the genealogy process
yaml the state of the genealogy process in YAML format
structure the state of the genealogy process in R list format
lineages a [tibble](#) containing the lineage count function through time
gendat a [tibble](#) containing the (obscured) genealogy in a data-frame format
genealogy the lineage-traced genealogy (as a raw vector)

Examples

```
simulate("SIIR",time=3,psi1=1,psi2=0) |>
  simulate(Beta1=2,gamma=2,time=10,psi1=10,psi2=1) |>
  plot()

runSIIR(Beta1=10,Beta2=8,
  S0=200,I1_0=10,I2_0=8,R0=0,time=0,t0=-1) |>
  simulate(psi1=10,time=2) |>
  plot(points=TRUE,obscure=FALSE)

simulate("SIIR",Beta1=2,Beta2=50,gamma=1,psi1=2,
  S0=300,I1_0=20,I2_0=2,time=5) |>
  lineages() |>
  plot()
```

lbdp

Linear birth-death-sampling model

Description

The genealogy process induced by a simple linear birth-death process with constant-rate sampling.

Usage

```
runLBDP(time, t0 = 0, lambda = 2, mu = 1, psi = 1, n0 = 5)

continueLBDP(object, time, lambda = NA, mu = NA, psi = NA)

lbdp_exact(x, lambda, mu, psi, n0 = 1)

lbdp_pomp(x, lambda, mu, psi, n0 = 1, t0 = 0)
```


Arguments

time	final time
t0	initial time
lambda	per capita birth rate
mu	per capita recovery rate.
psi	per capita sampling rate.
n0	initial population size
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
x	genealogy in phylopomp format (i.e., an object that inherits from ‘gpgen’).

Details

`lbdp_exact` gives the exact log likelihood of a linear birth-death process, conditioned on $n_0 = 0$ (Stadler, 2010, Thm 3.5). The derivation is also given in comments in the code.

`lbdp_pomp` constructs a **pomp** object containing a given set of data and a linear birth-death-sampling process.

Value

`runLBDP` and `continueLBDP` return objects of class ‘gpsim’ with ‘model’ attribute “LBDP”.

`lbdp_exact` returns the log likelihood of the genealogy. Note that the time since the most recent sample is informative.

References

- A. A. King, Q. Lin, and E. L. Ionides. Exact phylodynamic likelihood via structured Markov genealogy processes. *arXiv* 2405.17032, 2024. doi:10.48550/arxiv.2405.17032.
- A. A. King, Q. Lin, and E. L. Ionides. Markov genealogy processes. *Theoretical Population Biology* **143**, 77–91, 2022. doi:10.1016/j.tpb.2021.11.003.
- T. Stadler. Sampling-through-time in birth-death trees. *Journal of Theoretical Biology* **267**, 396–404, 2010. doi:10.1016/j.jtbi.2010.09.010.
- T. Stadler. Sampling-through-time in birth-death trees. *Journal of Theoretical Biology* **267**, 396–404, 2010. doi:10.1016/j.jtbi.2010.09.010.

See Also

More example genealogy processes: `moran`, `s2i2r2`, `seir`, `si2r`, `siir`, `simulate()`, `sir`, `twospecies`

Examples

```
simulate("LBDP",time=4) |> plot(points=TRUE)

simulate("LBDP",lambda=2,mu=1,psi=3,n0=1,time=1) |>
  simulate(time=10,lambda=1) |>
  plot()
```

```
simulate("LBDP",time=4) |>
  lineages() |>
  plot()
```

lineages	<i>Lineage-count function</i>
----------	-------------------------------

Description

Lineage-counts, saturations, and event-codes.

Usage

```
lineages(object, prune = TRUE, obscure = TRUE)

## S3 method for class 'gplin'
plot(x, ..., palette = scales::hue_pal(l = 30, h = c(220, 580)))
```

Arguments

object	gpsim object.
prune	logical; prune the genealogy?
obscure	logical; obscure the demes?
x	object of class 'gpger'
...	passed to theme .
palette	color palette for branches. This can be furnished either as a function or a vector of colors. If this is a function, it should take a single integer argument, the number of colors required. If it is a vector, it should have at least as many elements as there are demes in the genealogy.

Details

This function extracts from the specified genealogy several important time-varying quantities. These include:

lineages number of lineages through time
saturation the number of lineages emerging from the event
event_type an integer coding the type of event

If the genealogy has been obscured (the default), the number in the `lineages` returned is the total number of lineages present at the specified time and the saturation is the total saturation. If the genealogy has not been obscured (`obscure = FALSE`), the deme-specific data are returned. In this case, the `deme` column specifies the pertinent deme.

The event types are:

- 0** no event,
- 1** a root,
- 1** a sample event,
- 2** a non-sample event,
- 3** the end of the time interval, which may or may not coincide with the latest tip of the genealogy.

Value

A [tibble](#) containing information about the genealogy. See Details for specifics. The [tibble](#) returned by `lineages` has a [plot](#) method.

Examples

```
library(tidyverse)

pal <- c("#00274c", "#ffcb05")

simulate("SIIR", time=3) -> x
plot_grid(
  x |> plot(),
  x |> lineages() |> plot(),
  x |> plot(obscurse=FALSE, palette=pal),
  x |> lineages(obscurse=FALSE) |>
    plot(palette=pal, legend.position=c(0.8, 0.9)),
  align="v", axis="b",
  ncol=2, byrow=FALSE
)
```

moran

The classical Moran model

Description

The Markov genealogy process induced by the classical Moran process, in which birth/death events occur at a constant rate and the population size remains constant.

Usage

```
runMoran(time, t0 = 0, mu = 1, psi = 1, n = 100)

continueMoran(object, time, mu = NA, psi = NA)

moran_exact(x, n = 100, mu = 1, psi = 1)
```

Arguments

time	final time
t0	initial time
mu	per capita event rate
psi	per capita sampling rate
n	population size
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
x	genealogy in phylopomp format (i.e., an object that inherits from ‘gpgen’).

Details

`moran_exact` gives the exact log likelihood of a genealogy under the uniformly-sampled Moran process.

Value

`runMoran` and `continueMoran` return objects of class ‘gpsim’ with ‘model’ attribute “Moran”.
`moran_exact` returns the log likelihood of the genealogy.

References

P.A.P. Moran. Random processes in genetics. *Mathematical Proceedings of the Cambridge Philosophical Society* **54**, 60–71, 1958. doi:[10.1017/s0305004100033193](https://doi.org/10.1017/s0305004100033193).

See Also

More example genealogy processes: [lbdp](#), [s2i2r2](#), [seir](#), [si2r](#), [siir](#), [simulate\(\)](#), [sir](#), [twospecies](#)

newick

Newick output

Description

Extract a Newick-format description of a genealogy.

Usage

```
newick(object, prune = TRUE, obscure = TRUE)
```

Arguments

object	gpsim object.
prune	logical; prune the genealogy?
obscure	logical; obscure the demes?

Value

A string in Newick format.

Examples

```
simulate("SIIR",time=1) |> newick()
```

parse_newick	<i>parse a Newick string</i>
--------------	------------------------------

Description

Parses a Newick description and returns a binary version of the genealogy.

Usage

```
parse_newick(x, t0 = 0, tf = NA)
```

Arguments

x	character; the Newick description. See Details for specifics.
t0	numeric; the root time.
tf	numeric; the current or final time.

Details

parse_newick can only handle a subset of the full Newick specification. In particular, labels are assumed to be of the form <TYPE>_<DEME>_<LABEL>, i.e., each label has three parts, separated by underscores ('_'). The parts are as follows.

- TYPE must be a single character from among the following: 'b', 'g', 'm', 'o'.
 - 'b' signifies a sample.
 - 'g' signifies an internal node.
 - 'm' signifies a root.
 - 'o' indicates an extant lineage.
- DEME must be a non-negative integer, specifying the deme in which the branch resides. If deme information is not present, use 0.
- LABEL is ignored and may be left out.

Value

An object of class "gpgen".

phylopomp	<i>Phylodynamics for POMP models</i>
-----------	--------------------------------------

Description

Simulation and inference of Markov genealogy processes.

Author(s)

Aaron A. King, Qianying Lin

References

A. A. King, Q. Lin, and E. L. Ionides. Exact phylodynamic likelihood via structured Markov genealogy processes. *arXiv* 2405.17032, 2024. doi:[10.48550/arxiv.2405.17032](https://doi.org/10.48550/arxiv.2405.17032).

A. A. King, Q. Lin, and E. L. Ionides. Markov genealogy processes. *Theoretical Population Biology* **143**, 77–91, 2022. doi:[10.1016/j.tpb.2021.11.003](https://doi.org/10.1016/j.tpb.2021.11.003).

reexports	<i>Objects exported from other packages</i>
-----------	---

Description

These objects are imported from other packages. Follow the links below to see their documentation.

cowplot [plot_grid](#)

foreach [%dopar%](#), [foreach](#), [registerDoSEQ](#)

grid [viewport](#)

pomp [bake](#), [freeze](#), [stew](#)

yaml [as.yaml](#), [read_yaml](#)

s2i2r2

*Two-host infection model with waning, immigration, and demography.***Description**

The population is structured by infection progression and host species.

Usage

```
runS2I2R2(
  time,
  t0 = 0,
  Beta11 = 4,
  Beta12 = 0,
  Beta22 = 4,
  gamma1 = 1,
  gamma2 = 1,
  psi1 = 1,
  psi2 = 0,
  omega1 = 0,
  omega2 = 0,
  b1 = 0,
  b2 = 0,
  d1 = 0,
  d2 = 0,
  iota1 = 0,
  iota2 = 0,
  S1_0 = 100,
  S2_0 = 100,
  I1_0 = 0,
  I2_0 = 10,
  R1_0 = 0,
  R2_0 = 0
)

continueS2I2R2(
  object,
  time,
  Beta11 = NA,
  Beta12 = NA,
  Beta22 = NA,
  gamma1 = NA,
  gamma2 = NA,
  psi1 = NA,
  psi2 = NA,
  omega1 = NA,
  omega2 = NA,
```

```
b1 = NA,  
b2 = NA,  
d1 = NA,  
d2 = NA,  
iota1 = NA,  
iota2 = NA  
)
```

Arguments

time	final time
t0	initial time
Beta11, Beta22	transmission rates within species 1 and 2, respectively
Beta12	transmission from species 2 to species 1
gamma1, gamma2	recovery rates for species 1 and 2, respectively
psi1, psi2	per capita sampling rates
omega1, omega2	rates of waning of immunity
b1, b2	per capita birth rates
d1, d2	per capita death rates
iota1, iota2	infection importation rates
S1_0, S2_0	initial sizes of susceptible populations
I1_0, I2_0	initial sizes of infected populations
R1_0, R2_0	initial sizes of immune populations
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object

Value

runS2I2R2 and continueS2I2R2 return objects of class ‘gpsim’ with ‘model’ attribute “S2I2R2”.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [seir](#), [si2r](#), [siir](#), [simulate\(\)](#), [sir](#), [twospecies](#)

seir	<i>Classical susceptible-exposed-infected-recovered model</i>
------	---

Description

The population is structured by infection progression.

Usage

```
runSEIR(  
  time,  
  t0 = 0,  
  Beta = 4,  
  sigma = 1,  
  gamma = 1,  
  psi = 1,  
  omega = 0,  
  S0 = 100,  
  E0 = 5,  
  I0 = 5,  
  R0 = 0  
)  
  
runSEIRS(  
  time,  
  t0 = 0,  
  Beta = 4,  
  sigma = 1,  
  gamma = 1,  
  psi = 1,  
  omega = 0,  
  S0 = 100,  
  E0 = 5,  
  I0 = 5,  
  R0 = 0  
)  
  
continueSEIR(  
  object,  
  time,  
  Beta = NA,  
  sigma = NA,  
  gamma = NA,  
  psi = NA,  
  omega = NA  
)  
  
continueSEIRS(  
  object,  
  time,  
  Beta = NA,  
  sigma = NA,  
  gamma = NA,  
  psi = NA,  
  omega = NA  
)
```

```
seirs_pomp(x, Beta, sigma, gamma, psi, omega = 0, S0, E0, I0, R0)
```

Arguments

time	final time
t0	initial time
Beta	transmission rate
sigma	progression rate
gamma	recovery rate
psi	per capita sampling rate
omega	rate of waning of immunity
S0, E0, I0, R0	initial sizes of S, E, I, R compartments, respectively.
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
x	genealogy in phylopomp format.

Details

seirs_pomp constructs a ‘pomp’ object containing a given set of data and an SEIRS model.

Value

runSEIR and continueSEIR return objects of class ‘gpsim’ with ‘model’ attribute “SEIR”.

seirs_pomp returns a ‘pomp’ object.

References

A. A. King, Q. Lin, and E. L. Ionides. Exact phylodynamic likelihood via structured Markov genealogy processes. *arXiv* 2405.17032, 2024. doi:10.48550/arxiv.2405.17032.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [si2r](#), [siir](#), [simulate\(\)](#), [sir](#), [twospecies](#)

Examples

```
simulate("SEIR",Beta=2,sigma=2,gamma=1,psi=2,S0=1000,I0=5,time=5) |>
  simulate(Beta=5,gamma=2,time=10,psi=3) |>
  plot()

runSEIR(Beta=3,gamma=1,psi=2,S0=20,I0=5,R0=0,time=5,t0=-1) |>
  plot(points=TRUE,obscure=FALSE)

runSEIR(Beta=3,gamma=0.1,psi=0.2,S0=100,I0=5,R0=0,time=2,t0=0) -> x
plot_grid(plotlist=list(plot(x,points=TRUE),diagram(x)),
  ncol=1,rel_heights=c(4,1))
```

```
simulate("SEIR",sigma=1,omega=1,time=20,I0=4) |> plot(obscure=FALSE)

simulate("SEIR",sigma=1,omega=1,time=20,I0=4) |>
  lineages(obscure=FALSE) |>
  plot()
```

si2r

Two-deme model of superspreading

Description

Deme 2 consists of "superspreaders" who engender clusters of infection in "superspreading events".

Usage

```
runSI2R(
  time,
  t0 = 0,
  Beta = 5,
  mu = 5,
  gamma = 1,
  omega = 0,
  psi1 = 1,
  psi2 = 0,
  sigma12 = 1,
  sigma21 = 3,
  S0 = 500,
  I0 = 10,
  R0 = 0
)

continueSI2R(
  object,
  time,
  Beta = NA,
  mu = NA,
  gamma = NA,
  omega = NA,
  psi1 = NA,
  psi2 = NA,
  sigma12 = NA,
  sigma21 = NA
)
```

Arguments

time final time

t0	initial time
Beta	transmission rate
mu	mean superspreading-event cluster size
gamma	recovery rate
omega	rate of waning of immunity
psi1, psi2	sampling rates for demes 1 and 2, respectively
sigma12, sigma21	movement rates from deme 1 to 2 and 2 to 1, respectively
S0	initial size of susceptible population
I0	initial size of I1 population (I2 = 0 at t = 0)
R0	initial size of recovered population
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object

Details

Superspreaders (deme 2) behave differently than ordinary infections: transmission events occur at the same rate (Beta), but at each event, a superspreader infects N individuals, where

$$N \sim 1 + \text{Geometric}(1/\mu).$$

Thus, assuming susceptibles are not limiting, the mean number of infections resulting from a superspreading event is μ and the variance in this number is $\mu^2 - \mu$. If susceptibles are limiting, i.e., if the number of susceptibles is not greater than N , then all remaining susceptibles are infected.

Value

runSI2R and continueSI2R return objects of class ‘gpsim’ with ‘model’ attribute “SI2R”.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [seir](#), [siir](#), [simulate\(\)](#), [sir](#), [twospecies](#)

Examples

```
simulate("SI2R",time=1) |>
  plot(obscure=FALSE)

runSI2R(Beta=10,S0=2000,time=1,psi1=0) |>
  simulate(time=2,psi1=1) |>
  plot(points=TRUE,obscure=FALSE)

simulate("SI2R",time=5) |>
  lineages() |>
  plot()

simulate("SI2R",time=2) |>
  diagram(m=30)
```

```

simulate("SI2R",time=20,omega=0.2,mu=20) -> x
plot_grid(
  x |> plot(obscure=FALSE),
  x |> lineages(obscure=FALSE) |> plot(),
  ncol=1,
  align="v",axis="b"
)

```

siir

Two-strain SIR model.

Description

Two distinct pathogen strains compete for susceptibles.

Usage

```

runSIIR(
  time,
  t0 = 0,
  Beta1 = 5,
  Beta2 = 5,
  gamma = 1,
  psi1 = 1,
  psi2 = 0,
  sigma12 = 0,
  sigma21 = 0,
  omega = 0,
  S0 = 500,
  I1_0 = 10,
  I2_0 = 10,
  R0 = 0
)

continueSIIR(
  object,
  time,
  Beta1 = NA,
  Beta2 = NA,
  gamma = NA,
  psi1 = NA,
  psi2 = NA,
  sigma12 = NA,
  sigma21 = NA,
  omega = NA
)

```

Arguments

time	final time
t0	initial time
Beta1, Beta2	transmission rates from each of the infectious classes.
gamma	recovery rate.
psi1, psi2	sampling rates.
sigma12, sigma21	movement rates from deme 1 to 2 and 2 to 1, respectively
omega	rate of loss of immunity
S0	initial size of susceptible population.
I1_0	initial size of I2 population.
I2_0	initial size of I2 population.
R0	initial size of recovered population.
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object

Value

runSIIR and continueSIIR return objects of class ‘gpsim’ with ‘model’ attribute “SIIR”.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [seir](#), [si2r](#), [simulate\(\)](#), [sir](#), [twospecies](#)

Examples

```
simulate("SIIR", time=3, psi1=1, psi2=0) |>
  simulate(Beta1=2, gamma=2, time=10, psi1=10, psi2=1) |>
  plot()

runSIIR(Beta1=10, Beta2=8,
  S0=200, I1_0=10, I2_0=8, R0=0, time=0, t0=-1) |>
  simulate(psi1=10, time=2) |>
  plot(points=TRUE, obscure=FALSE)

simulate("SIIR", Beta1=2, Beta2=50, gamma=1, psi1=2,
  S0=300, I1_0=20, I2_0=2, time=5) |>
  lineages() |>
  plot()
```

simulate	<i>simulate</i>
----------	-----------------

Description

Simulate Markov genealogy processes

Usage

```
simulate(object, ...)

## Default S3 method:
simulate(object, ...)

## S3 method for class 'character'
simulate(object, time, ...)

## S3 method for class 'gpsim'
simulate(object, time, ...)
```

Arguments

object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
...	additional arguments to the model-specific simulation functions
time	end timepoint of simulation

Details

When object is of class ‘gpsim’, i.e., the result of a genealogy-process simulation, `simulate` acts to continue the simulation to a later timepoint. Note that, one cannot change initial conditions or `t0` when continuing a simulation.

Value

An object of ‘gpsim’ class.

References

A. A. King, Q. Lin, and E. L. Ionides. Exact phylodynamic likelihood via structured Markov genealogy processes. *arXiv* 2405.17032, 2024. doi:[10.48550/arxiv.2405.17032](https://doi.org/10.48550/arxiv.2405.17032).

A. A. King, Q. Lin, and E. L. Ionides. Markov genealogy processes. *Theoretical Population Biology* **143**, 77–91, 2022. doi:[10.1016/j.tpb.2021.11.003](https://doi.org/10.1016/j.tpb.2021.11.003).

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [seir](#), [si2r](#), [siir](#), [sir](#), [twospecies](#)

sir*Classical susceptible-infected-recovered model*

Description

A single, unstructured population of hosts.

Usage

```
runSIR(  
  time,  
  t0 = 0,  
  Beta = 2,  
  gamma = 1,  
  psi = 1,  
  omega = 0,  
  S0 = 100,  
  I0 = 2,  
  R0 = 0  
)
```

```
runSIRS(  
  time,  
  t0 = 0,  
  Beta = 2,  
  gamma = 1,  
  psi = 1,  
  omega = 0,  
  S0 = 100,  
  I0 = 2,  
  R0 = 0  
)
```

```
continueSIR(object, time, Beta = NA, gamma = NA, psi = NA, omega = NA)
```

```
sir_pomp(x, Beta, gamma, psi, omega = 0, S0, I0, R0, t0 = 0)
```

```
runSIRS(  
  time,  
  t0 = 0,  
  Beta = 2,  
  gamma = 1,  
  psi = 1,  
  omega = 0,  
  S0 = 100,  
  I0 = 2,  
  R0 = 0
```



```
)

continueSIRS(object, time, Beta = NA, gamma = NA, psi = NA, omega = NA)

sirs_pomp(x, Beta, gamma, psi, omega = 0, S0, I0, R0, t0 = 0)
```

Arguments

time	final time
t0	initial time
Beta	transmission rate.
gamma	recovery rate.
psi	sampling rate.
omega	immunity waning rate
S0, I0, R0	initial sizes of susceptible, infected, and recovered populations, respectively.
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
x	genealogy in phylopomp format (i.e., an object that inherits from ‘gpgen’).

Details

sir_pomp constructs a ‘pomp’ object containing a given set of data and a SIR model.

Value

runSIR and continueSIR return objects of class ‘gpsim’ with ‘model’ attribute “SIR”.

sir_pomp and sirs_pomp return ‘pomp’ objects.

References

A. A. King, Q. Lin, and E. L. Ionides. Exact phylodynamic likelihood via structured Markov genealogy processes. *arXiv* 2405.17032, 2024. doi:10.48550/arxiv.2405.17032.

A. A. King, Q. Lin, and E. L. Ionides. Markov genealogy processes. *Theoretical Population Biology* 143, 77–91, 2022. doi:10.1016/j.tpb.2021.11.003.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [seir](#), [si2r](#), [siir](#), [simulate\(\)](#), [twospecies](#)

Examples

```
simulate("SIR",Beta=2,gamma=1,psi=2,S0=1000,I0=5,time=5) |>
  simulate(Beta=5,gamma=2,time=10,psi=3) |>
  plot()

runSIR(Beta=3,gamma=1,psi=2,S0=20,I0=5,R0=0,time=5,t0=-1) |>
  plot(points=TRUE)
```

```
runSIR(Beta=3,gamma=0.1,psi=0.2,S0=100,I0=5,R0=0,time=2,t0=0) -> x
plot_grid(plotlist=list(plot(x,points=TRUE),diagram(x)),
  ncol=1,rel_heights=c(4,1))

simulate("SIRS",omega=1,time=20,I0=4) |> plot()
simulate("SIRS",omega=1,time=20,I0=4) |> lineages() |> plot()
```

treeplot

*Fancy tree plotter***Description**

Plots a genealogical tree.

Usage

```
## S3 method for class 'gpgen'
plot(x, ..., time, t0, prune = TRUE, obscure = TRUE)

treeplot(
  tree,
  time = NULL,
  t0 = 0,
  ladderize = TRUE,
  points = FALSE,
  ...,
  palette = scales::hue_pal(l = 30, h = c(220, 580))
)
```

Arguments

x	object of class ‘gpgen’
...	plot passes extra arguments to treeplot . treeplot passes extra arguments to theme .
time	numeric; time of the genealogy.
t0	numeric; time of the root.
prune	logical; prune the genealogy?
obscure	logical; obscure the demes?
tree	character; tree representation in Newick format.
ladderize	Ladderize?
points	Show nodes and tips?
palette	color palette for branches. This can be furnished either as a function or a vector of colors. If this is a function, it should take a single integer argument, the number of colors required. If it is a vector, it should have at least as many elements as there are demes in the genealogy.

Value

A printable ggplot object.

Examples

Not run:

```
library(ggplot2)
library(phylopomp)
times <- seq(from=0,to=8,by=0.1)[-1]

png_files <- sprintf(
  file.path(tempdir(),"frame%05d.png"),
  seq_len(2*length(times))
)

pb <- utils::txtProgressBar(0,2*length(times),0,style=3)
x <- simulate("SIIR",time=0,Beta1=5,Beta2=10,gamma=1,omega=0.5,
  psi1=0.2,psi2=0.1,sigma12=1,sigma21=1,S0=200,I1_0=3,I2_0=2)

img <- 1
for (k in seq.int(from=1,to=length(times),by=1)) {
  x <- simulate(x,time=times[k])
  ggsave(
    filename=png_files[img],
    plot=plot(
      x, t0=0, time=max(times),
      points=FALSE, prune=FALSE, obscure=FALSE,
      palette=c("#ffcb05", "#dddddd"),
      axis.line=element_line(color="white"),
      axis.ticks=element_line(color="white"),
      axis.text=element_blank(),
      plot.background=element_rect(fill=NA,color=NA),
      panel.background=element_rect(fill=NA,color=NA)
    ),
    device="png",dpi=300,
    height=2,width=3,units="in"
  )
  setTxtProgressBar(pb,img)
  img <- img+1
}

for (k in seq.int(from=length(times),to=1,by=-1)) {
  x <- curtail(x,time=times[k])
  ggsave(
    filename=png_files[img],
    plot=plot(
      x, t0=0, time=max(times),
      points=FALSE, prune=FALSE, obscure=FALSE,
      palette=c("#ffcb05", "#dddddd"),
      axis.line=element_line(color="white"),
      axis.ticks=element_line(color="white"),
```

```

        axis.text=element_blank(),
        plot.background=element_rect(fill=NA,color=NA),
        panel.background=element_rect(fill=NA,color=NA)
    ),
    device="png",dpi=300,
    height=2,width=3,units="in"
)
setTxtProgressBar(pb,img)
img <- img+1
}

library(gifski)
gif_file <- "movie1.gif"
gifski(png_files,gif_file,delay=0.08,loop=TRUE)
unlink(png_files)

## End(Not run)

```

twospecies

Two-host infection model with waning, immigration, demography, and spillover.

Description

The population is structured by infection progression and host species.

Usage

```

runTwoSpecies(
  time,
  t0 = 0,
  Beta11 = 0.5,
  Beta12 = 0.5,
  Beta21 = 0.06,
  Beta22 = 1.5,
  gamma1 = 0.5,
  gamma2 = 0.5,
  psi1 = 2,
  psi2 = 0,
  omega1 = 0,
  omega2 = 0,
  b1 = 0.2,
  b2 = 0.5,
  d1 = 0.2,
  d2 = 0.5,
  iota1 = 0,
  iota2 = 0.001,

```

```
S1_0 = 1000,  
S2_0 = 300,  
I1_0 = 0,  
I2_0 = 0,  
R1_0 = 0,  
R2_0 = 700  
)
```

```
continueTwoSpecies(  
  object,  
  time,  
  Beta11 = NA,  
  Beta12 = NA,  
  Beta21 = NA,  
  Beta22 = NA,  
  gamma1 = NA,  
  gamma2 = NA,  
  psi1 = NA,  
  psi2 = NA,  
  omega1 = NA,  
  omega2 = NA,  
  b1 = NA,  
  b2 = NA,  
  d1 = NA,  
  d2 = NA,  
  iota1 = NA,  
  iota2 = NA  
)
```

```
twospecies_pomp(  
  x,  
  Beta11,  
  Beta12,  
  Beta21,  
  Beta22,  
  gamma1,  
  gamma2,  
  psi1,  
  psi2,  
  omega1,  
  omega2,  
  b1,  
  b2,  
  d1,  
  d2,  
  iota1,  
  iota2,  
  S1_0,
```

```

    S2_0,
    I1_0,
    I2_0,
    R1_0,
    R2_0
  )

```

Arguments

time	final time
t0	initial time
Beta11, Beta22	transmission rates within species 1 and species 2, respectively
Beta12	transmission from species 2 to species 1
Beta21	transmission from species 1 to species 2
gamma1, gamma2	recovery rates
psi1, psi2	per capita sampling rates
omega1, omega2	rates of waning of immunity
b1, b2	per capita birth rates
d1, d2	per capita death rates
iota1, iota2	imported infection rates
S1_0, S2_0	initial sizes of the susceptible populations in each species
I1_0, I2_0	initial sizes of infected populations
R1_0, R2_0	initial sizes of immune populations
object	either the name of the model to simulate <i>or</i> a previously computed ‘gpsim’ object
x	genealogy in phylopomp format.

Details

twospecies_pomp constructs a ‘pomp’ object containing a given set of data and a TwoSpecies model.

Value

runTwoSpecies and continueTwoSpecies return objects of class ‘gpsim’ with ‘model’ attribute “TwoSpecies”.

twospecies_pomp returns a ‘pomp’ object.

See Also

More example genealogy processes: [lbdp](#), [moran](#), [s2i2r2](#), [seir](#), [si2r](#), [siir](#), [simulate\(\)](#), [sir](#)

`yaml`

YAML output

Description

Human- and machine-readable description.

Usage

```
yaml(object)
```

Arguments

`object` `gpsim` object.

Value

A string in YAML format, with class “`gpyaml`”.

Examples

```
simulate("SIIR",time=1) |> yaml()
```

Index

* Genealogy processes

lbdp, 8
moran, 11
s2i2r2, 15
seir, 16
si2r, 19
siir, 21
simulate, 23
sir, 24
twospecies, 28

* internals

genealogy diagram internals, 5

* internal

as.data.frame, 2
genealogy diagram internals, 5
getInfo, 7
reexports, 14

%dopar% (reexports), 14

%dopar%, 14

as.data.frame, 2

as.yaml, 14

as.yaml (reexports), 14

bake, 14

bake (reexports), 14

ballGrob (genealogy diagram internals),
5

continueLBDP (lbdp), 8

continueMoran (moran), 11

continueS2I2R2 (s2i2r2), 15

continueSEIR (seir), 16

continueSEIRS (seir), 16

continueSI2R (si2r), 19

continueSIIR (siir), 21

continueSIR (sir), 24

continueSIRS (sir), 24

continueTwoSpecies (twospecies), 28

curtail, 2

diagram, 3

drawDetails.ballGrob (genealogy
diagram internals), 5

drawDetails.resizingTextGrob
(genealogy diagram internals),
5

foreach, 14

foreach (reexports), 14

freeze, 14

freeze (reexports), 14

gendat, 4

geneal, 5

genealogy diagram internals, 5

genealogyGrob (genealogy diagram
internals), 5

getInfo, 7

LBDP (lbdp), 8

lbdp, 8, 12, 16, 18, 20, 22, 23, 25, 30

lbdp_exact (lbdp), 8

lbdp_pomp (lbdp), 8

lineages, 10

Moran (moran), 11

moran, 9, 11, 16, 18, 20, 22, 23, 25, 30

moran_exact (moran), 11

newick, 12

nodeGrob (genealogy diagram internals),
5

parse_newick, 13

phylopomp, 14

phylopomp, package (phylopomp), 14

phylopomp-package (phylopomp), 14

plot, 11

plot.gp (treeplot), 26

plot.gp (lineages), 10

plot_grid, 14

plot_grid (reexports), 14
 pocketGrob (genealogy diagram
 internals), 5
 postDrawDetails.ballGrob (genealogy
 diagram internals), 5
 postDrawDetails.resizingTextGrob
 (genealogy diagram internals),
 5
 preDrawDetails.ballGrob (genealogy
 diagram internals), 5
 preDrawDetails.resizingTextGrob
 (genealogy diagram internals),
 5
 print.gpdia (diagram), 3
 print.gpgen (genealogy diagram
 internals), 5
 print.gpsim (genealogy diagram
 internals), 5
 print.gpyaml (genealogy diagram
 internals), 5

 read_yaml, 14
 read_yaml (reexports), 14
 reexports, 14
 registerDoSEQ, 14
 registerDoSEQ (reexports), 14
 resizingTextGrob (genealogy diagram
 internals), 5
 runLBDP (lbdp), 8
 runMoran (moran), 11
 runS2I2R2 (s2i2r2), 15
 runSEIR (seir), 16
 runSEIRS (seir), 16
 runSI2R (si2r), 19
 runSIIR (siir), 21
 runSIR (sir), 24
 runSIRS (sir), 24
 runTwoSpecies (twospecies), 28

 S2I2R2 (s2i2r2), 15
 s2i2r2, 9, 12, 15, 18, 20, 22, 23, 25, 30
 SEIR (seir), 16
 seir, 9, 12, 16, 16, 20, 22, 23, 25, 30
 seirs_pomp (seir), 16
 SI2R (si2r), 19
 si2r, 9, 12, 16, 18, 19, 22, 23, 25, 30
 SIIR (siir), 21
 siir, 9, 12, 16, 18, 20, 21, 23, 25, 30
 simulate, 9, 12, 16, 18, 20, 22, 23, 25, 30

 SIR (sir), 24
 sir, 9, 12, 16, 18, 20, 22, 23, 24, 30
 sir_pomp (sir), 24
 SIRS (sir), 24
 sirs_pomp (sir), 24
 stew, 14
 stew (reexports), 14

 textGrob, 6
 theme, 10, 26
 tibble, 8, 11
 treeplot, 26, 26
 TwoSpecies (twospecies), 28
 twospecies, 9, 12, 16, 18, 20, 22, 23, 25, 28
 twospecies_pomp (twospecies), 28

 viewport, 14
 viewport (reexports), 14

 yaml, 31