

Package ‘epimdr’

January 25, 2020

Title Functions and Data for “Epidemics: Models and Data in R”

Version 0.6-5

Date 2020-01-23

Author Ottar N. Bjornstad [aut, cre]

Maintainer Ottar N. Bjornstad <onb1@psu.edu>

Description Functions, data sets and shiny apps for “Epidemics: Models and Data in R” by Ottar N. Bjornstad (ISBN 978-3-319-97487-3) <<https://www.springer.com/gp/book/9783319974866>>. The package contains functions to study the S(E)IR model, spatial and age-structured SIR models; time-series SIR and chain-binomial stochastic models; catalytic disease models; coupled map lattice models of spatial transmission and network models for social spread of infection. The package is also an advanced quantitative companion to the coursera Epidemics Massive Online Open Course <<https://www.coursera.org/learn/epidemics>>.

Depends R (>= 3.3.2), shiny, deSolve, polyspline

Suggests ade4, bbmle, fields, forecast, imputeTS, lme4, ncf, nleqslv, nlme, nlts, plotrix, pomp, rootSolve, Rwave, statnet,

License GPL-3

URL <https://github.com/objornstad/epimdr>,
<https://www.springer.com/gp/book/9783319974866>,
<http://ento.psu.edu/directory/onb1>

BugReports <https://github.com/objornstad/epimdr/issues>

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

NeedsCompilation no

Repository CRAN

Date/Publication 2020-01-25 05:30:02 UTC

R topics documented:

BarabasiAlbert	3
black	4
burnett	4
ccs	5
chainSIR	6
cholera	6
coyne	7
dalziel	7
ebola	8
ferrari	9
filipendula	9
fiv	10
flowField	11
flu	13
gillespie	14
gm	14
gonnet	16
gra	16
Icelandflu	17
integrandpc	17
litter	18
llik.cb	19
llik.pc	19
magono	20
May.app	20
meas	21
mossong	22
NB	22
NetworkSIR	23
niamey	24
niamey_daily	25
orv.app	25
pagiard	26
paili	26
palymes	27
pameasle	27
pertcop	28
peru	28
plot.cm	29
plot.netSIR	30
rOfun	30
rabbit	31
rabies	31
retrospec	32
ringlattice	33
SEIR.app	33

seirmod	34
seirmod2	35
SEIRS.app	35
SH9	36
silene2	37
sim.cb	37
SimTsir	38
SimTsir2	39
SIR.app	39
siragemod	40
sirmod	41
sirwmod	41
sivmod	42
summary.cm	43
summary.netSIR	43
tau	44
TSIR.app	45
TSIRIlyap	45
TSIRlyap	46
tydiphtheria	46
tymeasles	47
tyscarlet	48
tywhooping	48
usflu	49
WattsStrogatz	49

Index **51**

BarabasiAlbert *Function to generate a Barabasi-Albert network*

Description

Function to generate a Barabasi-Albert network

Usage

BarabasiAlbert(N, K)

Arguments

N the number of nodes
 K the number of neighbors to which each node is connected so degree = 2*K

Value

An object of class CM (contact matrix)

Examples

```
cm3=BarabasiAlbert(200, 4)
```

black	<i>Black's measles seroprevalence data.</i>
-------	---

Description

Seroprevalence-by-age-bracket for measles in prevaccination New Haven as studied by Black (1959).

Usage

```
black
```

Format

A data frame with 42 rows and 3 variables:

age age-bracket (in years)

mid mid-point of age-bracket (in years)

n number of tests

pos number seropositive

neg number seronegative

f seroprevalence

Source

Black (1959) Measles antibodies in the population of New Haven, Connecticut. *Journal of Immunology* 83:74-83

burnett	<i>Burnett's Parasitoid-Host data.</i>
---------	--

Description

Data is of 22 generations of greenhouse white flies (*Trialeurodes vaporariorum*) and its parasitoid, *Encarsia formosa*. Column names are self explanatory.

Usage

```
burnett
```

Format

A data frame with 22 rows and 7 variables:

Generation

NumberOfHostsExposed

NumberOfHostsParasitized

NumberOfHostsUnparasitized

NumberOfParasiteEggsLaid

NumberOfParasitesSearching

PercentageofHostsParasitized

Source

Burnett, T. A. (1958) Model of host-parasite interaction Proceedings of the 10th International Congress, Entomology, 1958, 2, 679-686

ccs

UK measles CCS data.

Description

The fraction of weeks measles was absent from each of the 954 cities and towns of England and Wales between 1944 and 1965.

Usage

ccs

Format

A data frame with 954 rows and 14 variables:

fade3 Average duration of fadeout (of at least 3 weeks of length)

ext Fraction of time when measles was absent

size Median population size

fade Average duration of fadeouts (of a week or longer)

se3 Standard error fade3

se Standard error of fade

n3 The number of fadeouts (of at least 3 weeks of length)

n The number of fadeout of a week or longer

names City/town name

Source

Bjornstad and Grenfell (2008) Hazards, spatial transmission and timing of outbreaks in epidemic metapopulations. *Environmental and Ecological Statistics* 15: 265-277. doi:10.1007/s10651-007-0059-3.

chainSIR	<i>Gradient-function for the chain-SIR model</i>
----------	--

Description

Gradient-function for the chain-SIR model

Usage

```
chainSIR(t, logx, params)
```

Arguments

t	Implicit argument for time
logx	A vector with values for the log-states
params	A vector with parameter values for the chain-SIR system

Value

A list of gradients

Examples

```
require(deSolve)
times = seq(0, 10, by=1/52)
paras2 = c(mu = 1/75, N = 1, beta = 625, gamma = 365/14, u=5)
xstart2 = log(c(S=.06, I=c(0.001, rep(0.0001, paras2["u"]-1)), R = 0.0001))
out = as.data.frame(ode(xstart2, times, chainSIR, paras2))
```

cholera	<i>Dacca cholera death data.</i>
---------	----------------------------------

Description

Monthly deaths from cholera in Dacca, East Bengal between 1891 and 1940.

Usage

```
cholera
```

Format

A data frame with 600 rows and 4 variables:

Year Year

Month Month of the year

Dacca Monthly cholera deaths

Population Population size of district

Source

King, A.A., Ionides, E.L., Pascual, M. and Bouma, M. J. (2008) Inapparent infections and cholera dynamics. *Nature*, 454:877-880. doi.org/10.1038/nature07084.

 coyne

Gradient-function for Coyne et al's rabies model

Description

Gradient-function for Coyne et al's rabies model

Usage

coyne(t, logx, parms)

Arguments

t	Implicit argument for time
logx	A vector with values for the log-states
parms	A vector with parameter values for the dynamical system

Value

A list of gradients for the log system

Examples

```
require(deSolve)
times = seq(0, 50, by=1/520)
paras = c(gamma = 0.0397, b = 0.836, a = 1.34, sigma = 7.5,
alpha = 66.36, beta = 33.25, c = 0, rho = 0.8)
start = log(c(X=12.69/2, H1=0.1, H2=0.1, Y = 0.1, I = 0.1))
out = as.data.frame(ode(start, times, coyne, paras))
```

 dalziel

Measles incidence across 40 US cities

Description

A dataset of Measles incidence across 40 US cities with relevant demographic data

Usage

dalziel

Format

A data frame with 44,720 rows and 10 variables:

biweek biweek of the year

cases incidence

year year

loc city name

pop population size

rec susceptible recruits

country country

lon city longitude

lat city latitude

decimalYear time counter

Source

Dalziel et al. 2016. Persistent chaos of measles epidemics in the prevaccination United States caused by a small change in seasonal transmission patterns. PLoS Computational Biology 2016: e1004655. doi.org/10.1371/journal.pcbi.1004655.

ebola

Sierra-Leone Ebola 2015 data.

Description

The daily number of cases of ebola in Sierra Leone during the 2015 epidemic.

Usage

ebola

Format

A data frame with 103 rows and 4 variables:

date date

day day

cum_cases cumulative incidence

cases incidence calculated by differencing the cumcases and setting negatives to zero.

Source

<http://www.cdc.gov/vhf/ebola/outbreaks/2014-west-africa/cumulative-cases-graphs.html>

ferrari *Ferrari et al. 2005 outbreak data.*

Description

The incidence aggregated by serial interval of a number of outbreaks studied by Ferrari et al. 2005.

Usage

ferrari

Format

A data frame with 15 rows and 7 variables:

Eboladeaths00 Number of deaths from ebola during the 2000 Uganda outbreak

Ebolacases00 Number of cases of ebola during the 2000 Uganda outbreak

Ebolacases95 Number of cases of ebola during the 1995 DRC outbreak

FMDfarms Number of farms infected with FMD during the 2000-01 UK outbreak

HogCholera Number of cases of swine fever in pigs in the 1997-98 outbreak in the Netherlands

SarsHk Number of cases of SARS in Hong Kong during the 2003 outbreak

SarsSing Number of cases of SARS in Singapore during the 2003 outbreak

Source

Ferrari et al. (2005) Estimation and inference of R-0 of an infectious pathogen by a removal method. *Mathematical Biosciences* 198: 14-26. doi.org/10.1016/j.mbs.2005.08.002.

filipendula *Filipendula rust data.*

Description

Rust infection status of 162 populations of *Filipendula ulmaria* in a Swedish Island archipelago

Usage

filipendula

Format

A data frame with 162 rows and 4 variables:

y94 infection status in 1994

y95 infection status in 1995

X X coordinate

Y Y coordinate

Source

Smith et al. 2003. Epidemiological patterns at multiple spatial scales: an 11-year study of a *Triphragmium ulmariae* – *Filipendula ulmaria* metapopulation. *Journal of Ecology*, 91(5), pp.890-903. doi.org/10.1046/j.1365-2745.2003.00811.x.

fiv

*FIV infection in cats.***Description**

Immunological measures on cats infected with different strains of FIV

Usage

fiv

Format

A data frame with 238 rows and 18 variables:

Id Individual identifier

CD4 CD4 cell count

CD8B CD8B cell count

CD25 CD25 cell count

FAS_L FAS ligand

FAS FAS

IFNg Interferon gamma

IL_10 Interleukin 10

IL_12 Interleukin 12

IL_4 Interleukin 4

lymphocyte lymphocyte count

neutrophils neutrophil count

TNF_a Tumor necrosis factor

provirus provirus count

viremia viremia

Day day

No unique identifier

Treatment Experimental treatment

Source

Roy et al. 2009. Multivariate statistical analyses demonstrate unique host immune responses to single and dual lentiviral infection. *PloS one* 4, e7359. doi.org/10.1371/journal.pone.0007359.

flowField

Flowfield

Description

Plots the flow or velocity field for a one- or two-dimensional autonomous ODE system.

Usage

```
flowField(deriv, xlim, ylim, parameters = NULL, system = "two.dim",
  points = 21, col = "gray", arrow.type = "equal",
  arrow.head = 0.05, frac = 1, add = TRUE, xlab = if (system ==
  "two.dim") state.names[1] else "t", ylab = if (system == "two.dim")
  state.names[2] else state.names[1], ...)
```

Arguments

deriv	A function computing the derivative at a point for the ODE system to be analysed. Discussion of the required format of these functions can be found in the package vignette, or in the help file for the function <code>ode</code> .
xlim	In the case of a two-dimensional system, this sets the limits of the first dependent variable in which gradient reflecting line segments should be plotted. In the case of a one-dimensional system, this sets the limits of the independent variable in which these line segments should be plotted. Should be a numeric vector of length two.
ylim	In the case of a two-dimensional system this sets the limits of the second dependent variable in which gradient reflecting line segments should be plotted. In the case of a one-dimensional system, this sets the limits of the dependent variable in which these line segments should be plotted. Should be a numeric vector of length two.
parameters	Parameters of the ODE system, to be passed to <code>deriv</code> . Supplied as a numeric vector ; the order of the parameters can be found from the <code>deriv</code> file. Defaults to <code>NULL</code> .
system	Set to either <code>"one.dim"</code> or <code>"two.dim"</code> to indicate the type of system being analysed. Defaults to <code>"two.dim"</code> .
points	Sets the density of the line segments to be plotted; <code>points</code> segments will be plotted in the x and y directions. Fine tuning here, by shifting <code>points</code> up and down, allows for the creation of more aesthetically pleasing plots. Defaults to 11.
col	Sets the colour of the plotted line segments. Should be a character vector of length one. Will be reset accordingly if it is of the wrong length . Defaults to <code>"gray"</code> .
arrow.type	Sets the type of line segments plotted. If set to <code>"proportional"</code> the length of the line segments reflects the magnitude of the derivative. If set to <code>"equal"</code> the line segments take equal lengths, simply reflecting the gradient of the derivative(s). Defaults to <code>"equal"</code> .

arrow.head	Sets the length of the arrow heads. Passed to <code>arrows</code> . Defaults to <code>0.05</code> .
frac	Sets the fraction of the theoretical maximum length line segments can take without overlapping, that they can actually attain. In practice, <code>frac</code> can be set to greater than 1 without line segments overlapping. Fine tuning here assists the creation of aesthetically pleasing plots. Defaults to 1.
add	Logical. If TRUE, the flow field is added to an existing plot. If FALSE, a new plot is created. Defaults to TRUE.
xlab	Label for the x-axis of the resulting plot.
ylab	Label for the y-axis of the resulting plot.
...	Additional arguments to be passed to either <code>plot</code> or <code>arrows</code> .

Value

Returns a `list` with the following components (the exact make up is dependent on the value of `system`):

add	As per input.
arrow.head	As per input.
arrow.type	As per input.
col	As per input, but with possible editing if a <code>character vector</code> of the wrong <code>length</code> was supplied.
deriv	As per input.
dx	A <code>numeric matrix</code> . In the case of a two-dimensional system, the values of the derivative of the first dependent derivative at all evaluated points.
dy	A <code>numeric matrix</code> . In the case of a two-dimensional system, the values of the derivative of the second dependent variable at all evaluated points. In the case of a one-dimensional system, the values of the derivative of the dependent variable at all evaluated points.
frac	As per input.
parameters	As per input.
points	As per input.
system	As per input.
x	A <code>numeric vector</code> . In the case of a two-dimensional system, the values of the first dependent variable at which the derivatives were computed. In the case of a one-dimensional system, the values of the independent variable at which the derivatives were computed.
xlab	As per input.
xlim	As per input.
y	A <code>numeric vector</code> . In the case of a two-dimensional system, the values of the second dependent variable at which the derivatives were computed. In the case of a one-dimensional system, the values of the dependent variable at which the derivatives were computed.
ylab	As per input.
ylim	As per input.

Author(s)

Michael J Grayling

See Also

[arrows, plot](#)

Examples

```
#See archived phaseR package for examples
```

flu

Boarding school influenza data.

Description

The daily number of children confined to bed in a boarding school in North England during an outbreak in 1978 of the reemerging A/H1N1 strain. The school had 763 boys of which 512 boys were confined to bed sometime during the outbreak.

Usage

```
flu
```

Format

A data frame with 14 rows and 2 variables:

day day since beginning of outbreak

cases number of sick children

Source

Anonymous (1978) EPIDEMIOLOGY: Influenza in a boarding school. British Medical Journal, 4 March 1978 p.587.

 gillespie

Gillespie exact algorithm

Description

Function simulating a dynamical system using the Gillespie exact algorithm

Usage

```
gillespie(rateqs, eventmatrix, parameters, initialvals, numevents)
```

Arguments

rateqs	a list with rate equations
eventmatrix	a matrix of changes in state variables associated with each event
parameters	a vector of parameter values
initialvals	a vector of initial values for the states
numevents	number of events to be simulated

Value

A data frame with simulated time series

Examples

```
rlist=c(quote(mu * (S+I+R)), quote(mu * S), quote(beta * S * I / (S+I+R)),
  quote(mu * I), quote(gamma * I), quote(mu*R))
emat=matrix(c(1,0,0,-1,0,0,-1,1,0,0,-1,0,0,-1,1,0,0,-1),ncol=3, byrow=TRUE)
paras = c(mu = 1, beta = 1000, gamma = 365/20)
inits = c(S=100, I=2, R=0)
sim=gillespie(rlist, emat, paras, inits, 100)
```

 gm

Defoliated by gypsy moth each in northeast US 1975-2002.

Description

A dataset containing the fraction of forest defoliated by the gypsy moth in 20km x 20km pixels across northeast US in each year between 1975 and 2002.

Usage

```
gm
```

Format

A data frame with 1086 rows and 30 variables:

UTMX UTM x-coordinates

UTMY UTM y-coordinates

d1975 Defoliation in 1975

d1976 Defoliation in 1976

d1977 Defoliation in 1977

d1978 Defoliation in 1978

d1979 Defoliation in 1979

d1980 Defoliation in 1980

d1981 Defoliation in 1981

d1982 Defoliation in 1982

d1983 Defoliation in 1983

d1984 Defoliation in 1984

d1985 Defoliation in 1985

d1986 Defoliation in 1986

d1987 Defoliation in 1987

d1988 Defoliation in 1988

d1989 Defoliation in 1989

d1990 Defoliation in 1990

d1991 Defoliation in 1991

d1992 Defoliation in 1992

d1993 Defoliation in 1993

d1994 Defoliation in 1994

d1995 Defoliation in 1995

d1996 Defoliation in 1996

d1997 Defoliation in 1997

d1998 Defoliation in 1998

d1999 Defoliation in 1999

d2000 Defoliation in 2000

d2001 Defoliation in 2001

d2002 Defoliation in 2002

Source

Bjornstad, O. N., Robinet, C., & Liebhold, A. M. (2010). Geographic variation in North American gypsy moth cycles: subharmonics, generalist predators, and spatial coupling. *Ecology*, 91(1), 106-118. doi.org/10.1890/08-1246.1.

gonnet

De et al. 2004 gonorrhoea contact matrix

Description

The directed contact network from De et al. (2004) contact-tracing of the spread of gonorrhoea across asexual network in Alberta Canada

Usage

gonnet

Format

A matrix with 89 rows and 89 columns:

gonet a matrix of directional contacts of disease spread

Source

De et al (2004). Sexual network analysis of a gonorrhoea outbreak. Sexually transmitted infections 80: 280-285. doi.org/10.1136/sti.2003.007187.

gra

Euthamia graminifolia rust data.

Description

Data on a fungal pathogen of the aster *Euthamia graminifolia* collected by Jennifer Keslow.

Usage

gra

Format

A data frame with 360 rows and 8 variables:

block the block

row row

plot plot within block

xloc x coordinates

yloc y coordinate

comp plot composition

water treatment: dry or wet

score the rust score

Icelandflu	<i>Monthly incidence of influenza-like illness in Iceland between 1980 and 2009.</i>
------------	--

Description

A dataset containing the monthly ILI incidence in Iceland between 1980 and 2009.

Usage

Icelandflu

Format

A data frame with 360 rows and 3 variables:

month the month

year the year

ili ILI incidence

Source

Bjornstad ON, Viboud C. Timing and periodicity of influenza epidemics. Proceedings of the National Academy of Sciences. 2016 Nov 15;113(46):12899-901. doi.org/10.1073/pnas.1616052113.

integrandpc	<i>Auxillary function used by llik.pc</i>
-------------	---

Description

Auxillary function used by llik.pc

Usage

```
integrandpc(a, up, foi)
```

Arguments

a a vector with the ages

up a vector with upper age-bracket cut-offs

foi a vector with FoI

Value

A vector with FoIs matched to data

See Also

llik.pc

litter*Bordetella bronchiseptica* in rabbit kittens.

DescriptionData on *Bordetella bronchiseptica* in rabbit kittens in a breeding facility.**Usage**

litter

Format

A data frame with 494 rows and 8 variables:

Facility breeding facility**sick** infection status**Date** date sampled**Animal.code** animal identifier**msick** dams infection status**Litter** litter identifier**CFU** bacterial count**Description** unique litter identifier**Source**Long et al (2010) Identifying the Age Cohort Responsible for Transmission in a Natural Outbreak of *Bordetella bronchiseptica*. PLoS Pathogens 6(12): e1001224. doi:10.1371/journal.ppat.1001224.

llik.cb	<i>Negative log-likelihood function for the chain-binomial model</i>
---------	--

Description

Negative log-likelihood function for the chain-binomial model

Usage

```
llik.cb(S0, beta, I)
```

Arguments

S0	a scalar with value for S0
beta	a scalar with value for beta
I	a vector incidence aggregated at serial interval

Value

the negative log-likelihood for the model

Examples

```
twoweek=rep(1:15, each=2)
niamey_cases1=sapply(split(niamey$cases_1[1:30], twoweek), sum)
llik.cb(S0=6500, beta=23, I=niamey_cases1)
```

llik.pc	<i>Function to estimate parameters for the picewise-constant catalytic model</i>
---------	--

Description

This function uses binomial likelihoods to estimate the picewise-constant FoI model from age-incidence data

Usage

```
llik.pc(par, age, num, denom, up)
```

Arguments

par	a vector with initial guesses
age	a vector with the ages
num	a vector with number infected by age
denom	a vector with number tested by age
up	a vector with upper age-bracket cut-offs

Value

The negative log-likelihood for a candidate piecewise constant catalytic model

Examples

```
x=c(1,4,8,12,18,24)
para=rep(.1,length(x))
## Not run: optim(par=log(para),fn=loglikpc, age=rabbit$a, num=rabbit$inf, denom=rabbit$n, up=x)
```

magono

Massachusetts gonorrhoea data.

Description

Weekly cases of gonorrhoea in Massachusetts between 2006 and 2015.

Usage

magono

Format

A data frame with 422 rows and 4 variables:

number Weekly case reports

year Year

week Week of the year

time Time in fractions of year

Source

<https://www.tycho.pitt.edu>

May.app

Launch a shiny-app simulating May's Parasitoid-host Model model

Description

Launch a shiny-app simulating May's Parasitoid-host Model model

Usage

May.app

Format

An object of class shiny . appobj of length 5.

Details

Launch app for details

Examples

```
## Not run: May.app
```

meas

Bi-weekly measles incidence in London from 1944-65.

Description

A dataset containing the biweekly incidence of measles in London from 1944 to 1965

Usage

```
meas
```

Format

A data frame with 546 rows and 5 variables:

year year

week week of the year

time time

London incidence

B Biweekly births

Details

Birth numbers are annual, so in the data set, this number is evenly distributed across the 26 bi-weeks of each year.

Source

Bjornstad et al. (2002) Endemic and epidemic dynamics of measles: Estimating transmission rates and their scaling using a time series SIR model. Ecological Monographs 72: 169-184. doi.org/10.2307/3100023.

 mossong

POLYMOD contact-rate data by Age.

Description

Age-specific contact rates from the diary study by Mossong et al. 2008.

Usage

mossong

Format

A data frame with 900 rows and 3 variables:

contactor end of age-bracket (in years) of contactor group

contactee end of age-bracket (in years) of contactee group

contact.rate average contact rate

Source

Mossong et al. 2008 Social contacts and mixing patterns relevant to the spread of infectious diseases
 PLoS Med, Public Library of Science 5:e74. doi.org/10.1371/journal.pmed.0050074.

 NB

The Nicholson-Bailey model

Description

Function to simulate the Nicholson-Bailey Parasitoid-host model

Usage

NB(R, a, T = 100, H0 = 10, P0 = 1)

Arguments

R	the host reproductive rate
a	the parasitoid search efficiency
T	the length of simulation (number of time-steps)
H0	initial host numbers
P0	initial parasitoid numbers

Value

A list of simulated Host and Parasitoid numbers

Examples

```
sim= NB(R=1.1,a=0.1)
```

NetworkSIR	<i>Function to simulate an epidemic on a network</i>
------------	--

Description

Function to simulate a stochastic (discrete time) Reed-Frost SIR model on a social network

Usage

```
NetworkSIR(CM, tau, gamma)
```

Arguments

CM	a contact matrix
tau	the transmission probability
gamma	the recovery probability

Value

An object of class netSIR with infectious status for each node through time

Examples

```
cm1=BarabasiAlbert(N=200,K=2)
sim1=NetworkSIR(cm1,.3,0.1)
summary(sim1)
## Not run: plot(sim1)
```

niamey

Weekly measles incidence from 2003-04 in Niamey, Niger.

Description

A dataset containing the weekly incidence of measles in Niamey, Niger during the 2003-04 outbreak

Usage

niamey

Format

A data frame with 31 rows and 13 variables:

absweek week since beginning of outbreak

week week of the year

tot_cases weekly incidence for the whole city

tot_mort weekly deaths for the whole city

lethality weekly case fatality rate

tot_attack weekly attack rates for the whole city

cases_1 weekly incidence for district 1

attack_1 weekly attack rates for district 1

cases_2 weekly incidence for district 2

attack_2 weekly attack rates for district 2

cases_3 weekly incidence for district 3

attack_3 weekly attack rates for district 3

cum_cases weekly cumulative incidence for the whole city

Source

Grais et al (2008) Time is of the essence: exploring a measles outbreak response vaccination in Niamey, Niger. *Journal of the Royal Society Interface* 5: 67-74. <https://doi.org/10.1098/rsif.2007.1038>.

niamey_daily	<i>Day of appearance of each measles case from 2003-04 outbreak in Niamey, Niger.</i>
--------------	---

Description

A dataset containing the day of appearance of each measles case in Niamey, Niger during the 2003-04 outbreak.

Usage

```
niamey_daily
```

Format

A data frame with 10,937 rows and 1 variables:

day the day of appearance of each case since day of outbreak

Source

Grais et al. (2008) Time is of the essence: exploring a measles outbreak response vaccination in Niamey, Niger. *Journal of the Royal Society Interface* 5: 67-74. doi.org/10.1098/rsif.2007.1038.

orv.app	<i>Launch a shiny-app to study outbreak-response vaccination campaigns</i>
---------	--

Description

Launch a shiny-app to study outbreak-response vaccination campaigns

Usage

```
orv.app
```

Format

An object of class shiny.appobj of length 5.

Details

Launch app for details

Examples

```
## Not run: orv.app
```

pagiard	<i>Weekly incidence of giardia in Pennsylvania between 2006 and 2014.</i>
---------	---

Description

A dataset containing the weekly incidence of giardia in Pennsylvania between 2006 and 2014.

Usage

pagiard

Format

A data frame with 448 rows and 3 variables:

PENNSYLVANIA weekly incidence

YEAR the year

WEEK the week

Source

<https://www.tycho.pitt.edu>

paili	<i>Weekly deaths from Influenza-like illness in Pennsylvania between 1972 and 1998.</i>
-------	---

Description

A dataset containing the weekly ILI related deaths in Pennsylvania between 1972 and 1998.

Usage

paili

Format

A data frame with 1404 rows and 3 variables:

PENNSYLVANIA weekly deaths

YEAR the year

WEEK the week

Source

<https://www.tycho.pitt.edu>

palymes	<i>Weekly incidence of Lymes disease in Pennsylvania between 2006 and 2014.</i>
---------	---

Description

A dataset containing the weekly incidence of Lymes disease in Pennsylvania between 2006 and 2014.

Usage

palymes

Format

A data frame with 448 rows and 3 variables:

PENNSYLVANIA weekly incidence

YEAR the year

WEEK the week

Source

<https://www.tycho.pitt.edu>

pameasle	<i>Weekly incidence of measles in Pennsylvania between 1928 and 1969.</i>
----------	---

Description

A dataset containing the weekly incidence of measles in Pennsylvania between 2006 and 2014.

Usage

pameasle

Format

A data frame with 448 rows and 3 variables:

PENNSYLVANIA weekly incidence

YEAR the year

WEEK the week

Source

<https://www.tycho.pitt.edu>

pertcop	<i>Weekly whooping cough incidence from 1900-1937 in Copenhagen, Denmark.</i>
---------	---

Description

A dataset containing the weekly incidence of whooping cough from Copenhagen, Denmark between January 1900 and December 1937

Usage

pertcop

Format

A data frame with 1982 rows and 9 variables:

date date

births births

day day of month

month month of year

year year

cases weekly incidence

deaths weekly deaths

popsize weekly population size interpolated from census data

Source

Lavine et al. 2013. Immune boosting explains regime- shifts in prevaccine-era pertussis dynamics. PLoS One, 8(8):e72086. doi:10.1371/journal.pone.0072086.

peru	<i>Rubella in Peru data.</i>
------	------------------------------

Description

Rubella incidence by age as studied by Metcalf et al (2011).

Usage

peru

Format

A data frame with 95 rows and 2 variables:

age end of age-bracket (in years)

cumulative cumulative number of rubella cases

incidence number of rubella cases

n total cases

Source

Metcalf et al (2011) Rubella metapopulation dynamics and importance of spatial coupling to the risk of congenital rubella syndrome in Peru. *Journal of the Royal Society Interface* 8: 369-376. doi:10.1371/journal.pone.0072086.

plot.cm

Function to plot an object of class CM

Description

Function to plot an object of class CM

Usage

```
## S3 method for class 'cm'  
plot(x, ...)
```

Arguments

x an object of class cm
... other arguments

Value

A plot of the contract matrix

Examples

```
cm=ringlattice(N=20,K=4)  
## Not run: plot(cm)
```

plot.netSIR *Function to plot a netSIR object*

Description

Function to plot a netSIR object

Usage

```
## S3 method for class 'netSIR'  
plot(x, ...)
```

Arguments

x an object of class netSIR
... other arguments

See Also

[netSIR](#)

r0fun *Function to calculate R0 from a contact matrix*

Description

Function to calculate R0 from a contact matrix

Usage

```
r0fun(CM, tau, gamma)
```

Arguments

CM an object of class CM
tau = probability of infection across an edge
gamma = probability of removal per time step

Value

the R0

Examples

```
cm1=BarabasiAlbert(N=200,K=2)  
r0fun(cm1, 0.3, 0.1)
```

rabbit	<i>Rabbit Bordetella bronchiseptica data.</i>
--------	---

Description

Rabbits infected by *B. bronchiseptica* by age as studied by Long et al (2010).

Usage

rabbit

Format

A data frame with 42 rows and 3 variables:

a end of age-bracket (in months)

n number of rabbits tested

inf number of rabbits infected with the bacterium

Source

Long et al (2010) Identifying the Age Cohort Responsible for Transmission in a Natural Outbreak of *Bordetella bronchiseptica*. PLoS Pathogens 6(12): e1001224. doi:10.1371/journal.ppat.1001224.

rabies	<i>Raccoon rabies data.</i>
--------	-----------------------------

Description

Data is the average monthly number of reported cases of rabid raccoons across all counties within each of 11 east coast US states the time line is from the first reported case in each state (starting in late 1970s for West Virginia).

Usage

rabies

Format

A data frame with 208 rows and 12 variables:

Month Month since rabies appearance in the state

CT Connecticut

DE Delaware

MD Maryland

MA Massachusetts
NJ New Jersey
NY New York
NC North Carolina
PA Pennsylvania
RI Rhode Island
VA Virginia
WV West Virginia

Source

Childs et al. 2000. Predicting the local dynamics of epizootic rabies among raccoons in the United States Proceedings of the National Academy of Sciences 97:13666-13671. doi.org/10.1073/pnas.240326697.

retrospec	<i>Function to predict efficacy of outbreak-response vaccination campaign</i>
-----------	---

Description

Function to predict efficacy of outbreak-response vaccination campaign

Usage

```
retrospec(R, day, vaccine_efficacy, target_vaccination,
          intervention_length, mtime, LP = 7, IP = 7, N = 10000)
```

Arguments

R	reproductive ratio
day	first day of ORV campaign
vaccine_efficacy	Vaccine efficacy
target_vaccination	fraction of population vaccinated during ORV campaign
intervention_length	duration of ORV campaign
mtime	length of simulation
LP	length of latent period
IP	length of infectious period
N	initial susceptible population size

Value

A list of gradients

Examples

```
red1=retrospec(R=1.8, 161, vaccine_efficacy=0.85, target_vaccination=0.5,
  intervention_length=10, mtime=250, LP=8, IP=5, N=16000)
1-red1$redn
```

ringlattice	<i>Function to generate a ring lattice</i>
-------------	--

Description

Function to generate a ring lattice

Usage

```
ringlattice(N, K)
```

Arguments

N	the number of nodes
K	the number of neighbors to which each node is connected so degree = 2xK

Value

An object of class CM (contact matrix)

Examples

```
cm=ringlattice(N=20,K=4)
```

SEIR.app	<i>Launch a shiny-app simulating the seasonal SEIR model</i>
----------	--

Description

Launch a shiny-app simulating the seasonal SEIR model

Usage

```
SEIR.app
```

Format

An object of class shiny.appobj of length 5.

Details

Launch app for details

Examples

```
## Not run: SEIR.app
```

seirmod

Gradient-function for the SEIR model

Description

Gradient-function for the SEIR model

Usage

```
seirmod(t, y, parms)
```

Arguments

t	Implicit argument for time
y	A vector with values for the states
parms	A vector with parameter values for the SEIR system

Value

A list of gradients

Examples

```
require(deSolve)
times = seq(0, 10, by=1/120)
paras = c(mu = 1/50, N = 1, beta = 1000, sigma = 365/8, gamma = 365/5)
start = c(S=0.06, E=0, I=0.001, R = 0.939)
out=ode(y=start, times=times, func=seirmod, parms=paras)
```

`seirmod2`*Gradient-function for the forced SEIR model*

Description

Gradient-function for the forced SEIR model

Usage

```
seirmod2(t, y, parms)
```

Arguments

<code>t</code>	Implicit argument for time
<code>y</code>	A vector with values for the states
<code>parms</code>	A vector with parameter values for the SIR system

Value

A list of gradients

Examples

```
require(deSolve)
times = seq(0, 10, by=1/120)
paras = c(mu = 1/50, N = 1, beta0 = 1000, beta1 = 0.2, sigma = 365/8, gamma = 365/5)
start = c(S=0.06, E=0, I=0.001, R = 0.939)
out=ode(y=start, times=times, func=seirmod2, parms=paras)
```

`SEIRS.app`*Launch a shiny-app simulating the SEIRS model*

Description

Launch a shiny-app simulating the SEIRS model

Usage

```
SEIRS.app
```

Format

An object of class `shiny.appobj` of length 5.

Details

Launch app for details

Examples

```
## Not run: SEIRS.app
```

SH9

Daily measures of malaria infected mice.

Description

Daily data on laboratory mice infected with various strains of *Plasmodium chaudi*

Usage

SH9

Format

A data frame with 1300 rows and 11 variables:

Line line number

Day day of infection

Box Cage number

Mouse Mouse identifier

Treatment Plasmodium strain

Ind2 Unique mouse identifier

Weight Mouse weight

Glucose Blood glucose level

RBC Red blood cell count

Sample Sample number

Para Parasite count

Source

Sylvie Huijben

silene2	<i>Antler smut on wild campion.</i>
---------	-------------------------------------

Description

Data on a fungal pathogen of the wild campion collected by Janis Antonovics

Usage

silene2

Format

A data frame with 876 rows and 5 variables:

X road segment number

lat latitude

long longitude

hmean number of healthy plants

dmean number of diseased plants

Source

Antonovics, J. 2004. Long-term study of a plant-pathogen metapopulation. In: Hanski, Ilkka, and Oscar E. Gaggiotti. Ecology, genetics, and evolution of metapopulations. Academic Press. doi.org/10.1371/journal.pone.0007359.

sim.cb	<i>Function to simulate the chain-binomial model</i>
--------	--

Description

Function to simulate the chain-binomial model

Usage

sim.cb(S0, beta)

Arguments

S0 a scalar with value for S0

beta a scalar with value for beta

Value

A data-frame with time series of susceptibles and infecteds

Examples

```
sim=sim.cb(S0=6500, beta=23)
```

SimTsir*Function to simulate the stochastic TSIR*

Description

Function to simulate the stochastic TSIR assuming stochasticity in transmission and a Poisson birth-death process

Usage

```
SimTsir(alpha = 0.97, B = 2300, beta = 25, sdbeta = 0, S0 = 0.06,  
I0 = 180, IT = 520, N = 3300000)
```

Arguments

alpha	the exponent on I
B	the birth rate
beta	the transmission rate
sdbeta	the standard deviation on beta
S0	the initial susceptible fraction
I0	the initial number of infecteds
IT	the length of simulation
N	the population size

Value

A list with time series of simulated infected and susceptible hosts

Examples

```
out = SimTsir()
```

SimTsir2 *Function to simulate the seasonally-forced TSIR*

Description

Function to simulate the stochastic TSIR assuming stochasticity in transmission and a Poisson birth-death process

Usage

```
SimTsir2(beta, alpha, B, N, inits = list(Snull = 0, Inull = 0),
         type = "det")
```

Arguments

beta	the seasonal transmission coefficients
alpha	the exponent on I
B	a vector of Births (the length of which determines the length of the simulation)
N	the population size
inits	a list containing initial S and I
type	an argument "det" or "stoc" that determines whether a deterministic or stochastic simulation is done

Value

A list with time series of simulated infected and susceptible hosts

Examples

```
## Not run: see chapter 8 in book
```

SIR.app *Launch a shiny-app simulating the SIR model*

Description

Launch a shiny-app simulating the SIR model

Usage

```
SIR.app
```

Format

An object of class shiny.appobj of length 5.

Details

Launch app for details

Examples

```
## Not run: SIR.app
```

siragemod	<i>Gradient-function for the age-structured SIR model with possibly heterogeneous mixing</i>
-----------	--

Description

Gradient-function for the age-structured SIR model with possibly heterogeneous mixing

Usage

```
siragemod(t, logx, parms)
```

Arguments

t	Implicit argument for time
logx	A vector with log-values for the log-states
parms	A vector with parameter values for the age-structured SIR system

Value

A list of gradients

Examples

```
a=rep(1,4)
n=length(a)
betaM=matrix(1, ncol=4, nrow=4)
pars =list(N=1, gamma=365/14, mu=0.02, sigma=0.2, beta=500, betaM=betaM,p=rep(0,4), a=a)
xstart<-log(c(S=rep(0.099/n,n), I=rep(0.001/n,n), R=rep(0.9/n,n)))
times=seq(0,10,by=14/365)
out=as.data.frame(ode(xstart, times=times, func=siragemod, parms=pars))
```

sirmod *Gradient-function for the SIR model*

Description

Gradient-function for the SIR model

Usage

```
sirmod(t, y, parms)
```

Arguments

t	Implicit argument for time
y	A vector with values for the states
parms	A vector with parameter values for the SIR system

Value

A list of gradients

Examples

```
require(deSolve)
times = seq(0, 26, by=1/10)
paras = c(mu = 0, N = 1, beta = 2, gamma = 1/2)
start = c(S=0.999, I=0.001, R = 0)
out=ode(y=start, times=times, func=sirmod, parms=paras)
```

sirwmod *Gradient-function for the SIRWS model*

Description

Gradient-function for the SIRWS model

Usage

```
sirwmod(t, logy, parms)
```

Arguments

t	Implicit argument for time
logy	A vector with values for the log(states)
parms	A vector with parameter values for the SIRWS system

Value

A list of gradients (in log-coordinates)

Examples

```
require(deSolve)
times = seq(0, 26, by=1/10)
paras = c(mu = 1/70, p=0.2, N = 1, beta = 200, omega = 1/10, gamma = 17, kappa=30)
start = log(c(S=0.06, I=0.01, R=0.92, W = 0.01))
out = as.data.frame(ode(start, times, sirwmod, paras))
```

sivmod

Gradient-function for the SIR model with outbreak-response vaccination

Description

Gradient-function for the SIR model with outbreak-response vaccination

Usage

```
sivmod(t, x, parms)
```

Arguments

t	Implicit argument for time
x	A vector with values for the states
parms	A vector with parameter values for the SIR system

Value

A list of gradients

See Also

[retrospec](#)

summary.cm

Function to calculate the degree distribution for an object of class CM

Description

Function to calculate the degree distribution for an object of class CM

Usage

```
## S3 method for class 'cm'
summary(object, plot = FALSE, ...)
```

Arguments

object	an object of class cm
plot	if TRUE a bar plot of the degree distribution is produced
...	other arguments

Value

A plot of the contract matrix

Examples

```
cm=WattsStrogatz(N=20, K=4, Prw=.3)
summary(cm)
```

summary.netSIR

Function to summarize a netSIR object

Description

Function to summarize a netSIR object

Usage

```
## S3 method for class 'netSIR'
summary(object, ...)
```

Arguments

object	an object of class netSIR
...	other arguments

Value

A data-frame with the time series of susceptible, infected and recovered individuals

See Also

[netSIR](#)

tau	<i>Gillespie tau-leap algorithm</i>
-----	-------------------------------------

Description

Function simulating a dynamical system using the Gillespie tau-leap approximation

Usage

```
tau(rateqs, eventmatrix, parameters, initialvals, deltaT, endT)
```

Arguments

rateqs	a list with rate equations
eventmatrix	a matrix of changes in state variables associated with each event
parameters	a vector of parameter values
initialvals	a vector of initial values for the states
deltaT	the tau-leap time interval
endT	the time length of simulation

Value

A data frame with simulated time series

Examples

```
rlist2=c(quote(mu * (S+E+I+R)), quote(mu * S), quote(beta * S * I/(S+E+I+R)),
  quote(mu*E), quote(sigma * E), quote(mu * I), quote(gamma * I), quote(mu*R))
emat2=matrix(c(1,0,0,0,-1,0,0,0,-1,1,0,0,0,-1,0,0,0,-1,1,0,0,0,-1,0,0,0,-1,1,0,0,0,-1,0,0,0,-1,1,0,0,0,-1),
  ncol=4, byrow=TRUE)
paras = c(mu = 1, beta = 1000, sigma = 365/8, gamma = 365/5)
inits = c(S=999, E=0, I=1, R = 0)
sim2=tau(rlist2, emat2, paras, inits, 1/365, 1)
```

`TSIR.app`*Launch a shiny-app simulating TSIR model*

Description

Launch a shiny-app simulating TSIR model

Usage

```
TSIR.app
```

Format

An object of class `shiny.appobj` of length 5.

Details

Launch app for details

Examples

```
## Not run: TSIR.app
```

`TSIRllyap`*Function to calculate the local Lyapunov exponents for the TSIR*

Description

Function to calculate the local Lyapunov exponents from an object of class `lyap`.

Usage

```
TSIRllyap(x, m = 1)
```

Arguments

`x` an object of class `lyap` (normally from a call to `TSIRlyap`)
`m` number of forward iterations on the attractor

Value

An object of class `llyap` with the local Lyapunov exponent and S-I data

Examples

```
## Not run: see chapter 10 in book
```

TSIRlyap	<i>Function to do Lyapunov exponent calculations from a TSIR simulation</i>
----------	---

Description

Function to do Lyapunov exponent calculations from a TSIR simulation

Usage

```
TSIRlyap(I, S, alpha, bt, N)
```

Arguments

I	a vector containing the time series of Is
S	vector containing the time series of Ss
alpha	the exponent on I
bt	the seasonal transmission coefficients
N	the population size

Value

An object of class lyap with the lyapunov exponent, values for the Jacobians, parameters and data

Examples

```
## Not run: see chapter 10 in book
```

tydiphtheria	<i>Weekly incidence of diphtheria in Philadelphia between 1914 and 1947.</i>
--------------	--

Description

A dataset containing the weekly incidence incidence of diphtheria in Philadelphia between 1914 and 1947.

Usage

```
tydiphtheria
```

Format

A data frame with 1774 rows and 4 variables:

YEAR the year

WEEK the week

PHILADELPHIA weekly diphtheria incidence

TIME the time counter

Source

<https://www.tycho.pitt.edu>

tymeasles

Weekly incidence of measles in Philadelphia between 1914 and 1947.

Description

A dataset containing the weekly incidence of measles in Philadelphia between 1914 and 1947.

Usage

tymeasles

Format

A data frame with 1774 rows and 4 variables:

YEAR the year

WEEK the week

PHILADELPHIA weekly measles incidence

TIME the time counter

Source

<https://www.tycho.pitt.edu>

tyscarlet	<i>Weekly incidence of scarlet fever in Philadelphia between 1914 and 1947.</i>
-----------	---

Description

A dataset containing the weekly incidence of scarlet fever in Philadelphia between 1914 and 1947.

Usage

tyscarlet

Format

A data frame with 1774 rows and 4 variables:

YEAR the year

WEEK the week

PHILADELPHIA weekly scarlet fever incidence

TIME the time counter

Source

<https://www.tycho.pitt.edu>

tywhooping	<i>Weekly incidence of whooping cough in Philadelphia between 1925 and 1947.</i>
------------	--

Description

A dataset containing the weekly incidence of whooping cough in Philadelphia between 1925 and 1947.

Usage

tywhooping

Format

A data frame with 1200 rows and 5 variables:

YEAR the year

WEEK the week

PHILADELPHIA weekly whooping cough incidence

TIME the time counter

TM observation counter

Source

<https://www.tycho.pitt.edu>

usflu	<i>US 1975/76 ILI data.</i>
-------	-----------------------------

Description

Influenza-like illness data for the lower 48 states and the District of Columbia during the 1975/76 season dominated by A/H3N2/Victoria strain

Usage

usflu

Format

A data frame with 49 rows and 7 variables:

State State number

Acronym State code

Pop Population size

Latitude Latitude

Longitude Longitude

Start Week of start of epidemic

Peak Week of peak of epidemic

Source

Viboud C, Bjornstad ON, Smith DL, Simonsen L, Miller MA, Grenfell BT (2006) Synchrony, waves, and spatial hierarchies in the spread of influenza. *Science* 312: 447-451. doi.org/10.1126/science.1125237.

WattsStrogatz	<i>Function to generate a Watts-Strogats network</i>
---------------	--

Description

Function to generate a Watts-Strogats network

Usage

WattsStrogatz(N, K, Prw)

Arguments

N	the number of nodes
K	the number of neighbors to which each node is connected so degree = $2*K$
Prw	the rewiring probability

Value

An object of class CM (contact matrix)

Examples

```
cm2=WattsStrogatz(N=20, K=4, Prw=.3)
```

Index

*Topic **datasets**

black, 4
burnett, 4
ccs, 5
cholera, 6
dalziel, 7
ebola, 8
ferrari, 9
filipendula, 9
fiv, 10
flu, 13
gm, 14
gonnet, 16
gra, 16
Icelandflu, 17
litter, 18
magono, 20
May.app, 20
meas, 21
mossong, 22
niamey, 24
niamey_daily, 25
orv.app, 25
pagiard, 26
paili, 26
palymes, 27
pameasle, 27
pertcop, 28
peru, 28
rabbit, 31
rabies, 31
SEIR.app, 33
SEIRS.app, 35
SH9, 36
silene2, 37
SIR.app, 39
TSIR.app, 45
tydiphtheria, 46
tymeasles, 47
tyscarlet, 48
tywhooping, 48
usflu, 49

arrows, 12, 13

BarabasiAlbert, 3
black, 4
burnett, 4

ccs, 5
chainSIR, 6
character, 11, 12
cholera, 6
coyne, 7

dalziel, 7

ebola, 8

ferrari, 9
filipendula, 9
fiv, 10
flowField, 11
flu, 13

gillespie, 14
gm, 14
gonnet, 16
gra, 16

Icelandflu, 17
integrandpc, 17

length, 11, 12
list, 12
litter, 18
llik.cb, 19
llik.pc, 19

magono, 20

matrix, [12](#)
May.app, [20](#)
meas, [21](#)
mossong, [22](#)

NB, [22](#)
netSIR, [30](#), [44](#)
netSIR (NetworkSIR), [23](#)
NetworkSIR, [23](#)
niamey, [24](#)
niamey_daily, [25](#)
numeric, [11](#), [12](#)

ode, [11](#)
orv.app, [25](#)

pagiard, [26](#)
paili, [26](#)
palymes, [27](#)
pameasle, [27](#)
pertcop, [28](#)
peru, [28](#)
plot, [12](#), [13](#)
plot.cm, [29](#)
plot.netSIR, [30](#)

r0fun, [30](#)
rabbit, [31](#)
rabies, [31](#)
retrospec, [32](#), [42](#)
ringlattice, [33](#)

SEIR.app, [33](#)
seirmod, [34](#)
seirmod2, [35](#)
SEIRS.app, [35](#)
SH9, [36](#)
silene2, [37](#)
sim.cb, [37](#)
SimTsir, [38](#)
SimTsir2, [39](#)
SIR.app, [39](#)
siragemod, [40](#)
sirmod, [41](#)
sirwmod, [41](#)
sivmod, [42](#)
summary.cm, [43](#)
summary.netSIR, [43](#)

tau, [44](#)

TSIR.app, [45](#)
TSIRllyap, [45](#)
TSIRlyap, [46](#)
tydiphtheria, [46](#)
tymeasles, [47](#)
tyscarlet, [48](#)
tywhooping, [48](#)

usflu, [49](#)

vector, [11](#), [12](#)

WattsStrogatz, [49](#)