

# Package ‘epimdr’

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

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**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, phaseR, polyspline

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**License** GPL-3

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BarabasiAlbert	<i>Function to generate a Barabasi-Albert network</i>
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---

**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 = 2xK

**Value**

An object of class CM (contact matrix)

**Examples**

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

---

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

---

**Description**

Seroprevalence-by-agebracket 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 it's 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 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 Pre-vaccination United States Caused by a Small Change in Seasonal Transmission Patterns PLoS Comput Biol, Public Library of Science, 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. *Math Biosci* 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.

---

flu	<i>Boarding school influenza data.</i>
-----	--

---

**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	<i>Gillespie exact algorithm</i>
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---

**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,-1,0,0,-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 gonorhea 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:

**gonnet** 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	<i>Euthamia graminifolia rust data.</i>
-----	---

---

**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	<i>Bordetella bronchiseptica in rabbit kittens.</i>
--------	---

---

**Description**

Data 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

---

*Negative log-likelihood function for the chain-binomial model*


---

**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 piecewise-constant catalytic model</i>
---------	---

---

**Description**

This function uses binomial likelihoods to estimate the piecewise-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	<i>Massachusetts gonorrhoea data.</i>
--------	---------------------------------------

---

**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. *Ecol Monogr* 72: 169-184. doi.org/10.2307/3100023.

---

moosong

*POLYMOD contact-rate data by Age.*

---

### Description

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

### Usage

moosong

**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 Parasit-host model

**Usage**

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

**Arguments**

R	the host reproductive rate
a	the parasite 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 probabiliy
gamma	the recovery probabiliy

**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	<i>Weekly measles incidence from 2003-04 in Niamey, Niger.</i>
--------	--

---

**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](https://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

*Rubella in Peru data.*

---

### Description

Rubella incidence by age as studied by Metcale 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	<i>Function to calculate R0 from a contact matrix</i>
-------	---

---

**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 brochiseptica data.</i>
--------	--

---

**Description**

Rabbits infected by *B. brochiseptica* 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

*Raccoon rabies data.*

---

**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**

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, 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

*Antler smut on wild campion.*

---

**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 *Function to simulate the chain-binomial model*

---

**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 wheter 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	<i>Launch a shiny-app simulating the SIR model</i>
---------	--

---

**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 mixin</i>
-----------	---

---

**Description**

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

**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	<i>Gradient-function for the SIRWS model</i>
---------	--

---

**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	<i>Gradient-function for the SIR model with outbreak-response vaccination</i>
--------	---

---

**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 barplot 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	<i>Function to summarize a netSIR object</i>
----------------	--

---

**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),
  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

*Function to do Lyapunov exponent calculations from a TSIR simulation*


---

**Description**

Function to do Lyapunov exponent calculations from a TSIR simulation

**Usage**

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

**Arguments**

I                    a vector containg the time series of Is  
 S                    vector containg 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
```

---

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

---

**Description**

A dataset containing the weekly 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>

---

<code>tymeasles</code>	<i>Weekly incidence of measles in Philadelphia between 1914 and 1947.</i>
------------------------	---

---

**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 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 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

*Function to generate a Watts-Strogats network*

---

**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 =  $2 \times K$

Prw the rewiring probability

**Value**

An object of class CM (contact matrix)

**Examples**

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

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