

Package ‘primer’

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Type Package

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Author M H H Stevens

Maintainer Hank Stevens <hank.stevens@miamioh.edu>

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Description Functions are primarily functions for systems of ordinary differential equations, difference equations, and eigenanalysis and projection of demographic matrices; data are for examples.

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 primer-package

Functions and data for "A Primer of Ecology with R"

Description

Functions are primarily functions for systems of ordinary differential equations, difference equations, and eigenanalysis and projection of demographic matrices; data are for examples.

Details

Package: primer
Type: Package
Version: 1.0
Date: 2012-05-16
License: GPL version 2 or later
LazyLoad: yes

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R* Springer, 2nd printing.

See Also

[lvcomp](#), [ode](#)

alogistic

Logistic growth with the Allee effect

Description

A function for continuous logistic growth with the Allee effect, for use with `ode` in the `deSolve` package.

Usage

```
alogistic(t, y, p)
```

Arguments

`t` Time points for which `N` will be returned.
`y` `N`, population size
`p` a vector of logistic growth (`r`, `alpha`) and Allee effect parameters (`a`, `tau`); `a` is the threshold population size.

Details

The user does not put these directly into this function, but rather uses code in the deSolve package. The function is based on the logistic growth equation

$$\frac{dN}{dt} = rN(1 - \alpha N) \left(1 - \frac{a + \tau}{N + \tau}\right)$$

with a being the threshold population size.

Author(s)

Hank Stevens

References

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[clogistic](#), [dlogistic](#), [thetalogistic](#), [levins](#)

Examples

```
library(deSolve)
p <- c(r=1,alpha=.01, a=10, tau=.1)
time <- 0:10
initialN <- 11
out <- ode(y=initialN, times=time,
           func=alogistic, parms=p)
plot(time, out[,-1], type='l')
```

bip_stability

Bipartite network properties

Description

A function to calculate the several properties of randomly constructed bipartite networks. This function installation of packages bipartite, igraph, and rARPACK.

Usage

```
bip_stability(
  Spp.a = 10:50,
  Spp.p = 5:25,
  C = c(0.05, 0.3),
  IS = NULL,
  quant = FALSE,
  ndd = 1,
  reps = 10
)
```

Arguments

| | |
|-------|---|
| Spp.a | numeric vector from which to draw a random number of animal species |
| Spp.p | numeric vector from which to draw a random number of animal species |
| C | numeric two element vector for minimum and maximum possible connectances. |
| IS | mean interaction strength. If NULL, it is calculated as the inverse of the matrix dimension, so that the expected sum of interaction strengths equals one. |
| quant | Logical indicating whether the estimate of modularity should be based on the binary adjacency matrix (FALSE, default), or a quantitative matrix (TRUE). |
| ndd | scalar (1 or 2) determining whether the intraspecific negative density dependence is the same in both networks (1), or is scaled to the interaction sizes in each matrix (2). |
| reps | number of random matrices. |

Details

The interaction strengths are exponentially distributed, with mean of IS (rate = 1/IS). Nestedness is WNODF (Almeida-Neto et al. 2011). It can calculate modularity in two ways, using either the binary adjacency matrix (ones and zeroes, Clauset, Newman and Moore 2004) or a quantitative matrix (Beckett 2016); the latter takes much more time to calculate, so it uses the binary matrix by default. It also tallies diversity as the total number of species and the connectance as the total number of links divided by the number of possible links.

To calculate resilience, the P by A bipartite matrix is expanded to a (P+A) x (P+A) symmetric matrix so the upper triangular portion are the effects of the animals on the plants, and the lower triangular portion is the effects of the plants on the animals.

The diagonal represents intraspecific density dependence; it is filled with the negative of the largest summed row of interaction strengths in the symmetric matrix. The symmetric matrix is interpreted as a Jacobian matrix. Therefore, resilience is the negative value of the real part of the dominant eigen value of the expanded symmetric matrix.

Value

Returns of list of a matrix with columns for species richness, connectance, nestedness, modularity, and resilience.

Author(s)

Hank Stevens <HankStevens@miamioh.edu>

References

- M. Almeida-Neto and W. Ulrich. A straightforward computational approach for measuring nestedness using quantitative matrices. *Environmental Modelling and Software*, 26(2):173–178, 2011.
- S. J. Beckett. Improved community detection in weighted bipartite networks. *Royal Society Open Science*, 3:140536, 2016.
- A. Clauset, M. E. J. Newman, and M. Christopher. Finding community structure in very large networks. *Physical Review E*, 70:066111, 2004.

Examples

```
# b <- bip_stability(Spp.a = 16:60, Spp.p = 8:30, C=c(.05, 0.5), reps=10, quant=FALSE)
# pairs(b)
```

BSsucc

*Secondary succession data***Description**

Functional group abundances (herbaceous annual, herbaceous perennial, woody) from one of the fields in the Buell-Small long term succession study (<http://www.ecostudies.org/bss/>). Data are based on visual estimates of percent cover, using annual means of each species, which are then summed for each functional group.

Format

A data frame with 147 observations on the following 3 variables.

AGE a numeric vector; indicates the age of succession since abandonment from agriculture.

variable plant functional type; a factor with levels Annual, Perennial, Woody

value a numeric vector

Source

Data graciously provided by Scott Meiners (Eastern Illinois University, <http://www.ecostudies.org/bss/>).

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

Examples

```
data(BSsucc)
#lattice::xyplot(value~ AGE, groups=variable, data=BSsucc,
  #type='smooth', span=.3, ylab="Percent Cover",
  #xlab="Age Since Abandonment (y)",
  #auto.key=list(columns=3, space="top", lines=TRUE,
  #points=FALSE))
```

CandG

Data drawn approximately from Collins and Glenn (1991)

Description

Numbers of species which were observed in 1–19 sites.

Format

The format is: num [1:19] 32 16 10 9 8 7 8 6 4 5 ...

Source

Data are approximations of histogram values for a single year of data in:

Collins, S.L. and Glenn, S.M. (1991) Importance of spatial and temporal dynamics in species regional abundance and distribution. *Ecology*, **72**, 654–664.

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

Examples

```
data(CandG)
barplot(CandG, names=1:19)
```

cat_function

A Cat Function

Description

This function allows you to express your love of cats.

Usage

```
cat_function(love = TRUE)
```

Arguments

love Do you love cats? Defaults to TRUE.

Author(s)

Hilary Parker

Examples

```
cat_function()
```

```
chesson          Two-species model of the storage effect
```

Description

Simulates a fluctuating environment over time, and two species' responses to the environment, after Chesson (1994).

Usage

```
chesson(
  alpha = c(1.1 * 1e-05, 1e-05),
  d = 0.1,
  years = 10,
  N0 = c(1000, 1e+05),
  w = c(0.6, 1),
  env.var = 1,
  specialization = 1,
  spread = 0.67,
  type = 1
)
```

Arguments

| | |
|----------------|---|
| alpha | a vector of length 2; the negative effects of all individuals (of both species) on each population – typically different among species. |
| d | disturbance rate; the proportion of all individuals killed at each time step. |
| years | numbers of time steps |
| N0 | vector of length 2; initial abundances. |
| w | vector of length 2; average fitnesses for each species. |
| env.var | degree of environmental variability. |
| specialization | determines the narrowness of each species fitness response. |
| spread | determines how far apart the peak fitness responses are. |
| type | determines the form of C , the negative effect of competition. |

Details

The argument `type` controls the value of e^C , the effect of competition on reproduction, where the annual finite rate of increase is $R = e^{E-C}$. `type = 1` causes $e^C = \alpha_i N_{J,i}$, that is, a species-specific fixed fraction of juveniles that depends on each species response to competition. This is illustrated in a for-loop in Stevens (2009, *Ch. 9, Storage Effect, Simulating Dynamics*). Any other value for `type` results in the same negative effect on both species that depends on the number of juveniles and the disturbance rate.

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variables, `y`.

Author(s)

Hank Stevens (HankStevens@miamioh.edu)

References

Chesson, P.L. (1994) Multispecies competition in variable environments. *Theoretical Population Biology*, **45**, 227–276.

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[succniche](#)

Examples

```
out <- chession(years=50)
layout(matrix(1:4, nc=2))
matplot(out[["time"]], out[["Ns"]], type='l', lty=c(1:3),
        xlab="Time", ylab="N", log="y")
plot(out[["time"]][-1], out[["env"]], type='l',
     xlab="Time", ylab="Environment")
matplot(out[["env"]], out[["Es"]], xlab="Environment",
        ylab="Density-independent reproduction")
matplot(out[["env"]], out[["Rs"]], xlab="Environment",
        ylab="Annual growth rate")
```

clogistic

Continuous Logistic Growth

Description

A function for continuous logistic growth, for use with `ode` in the `deSolve` package.

Usage

```
clogistic(times, y, parms)
```

Arguments

| | |
|-------|--|
| times | times points that will return N |
| y | N |
| parms | a vector of logistic growth parameters; the first must be r, and the second must be alpha (1/K). |

Details

The user does not put these directly into this function, but rather uses ode in the deSolve package.

The function implements the logistic growth equation

$$\frac{dN}{dt} = rN(1 - \alpha N)$$

or equivalently

$$\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$$

Value

Returns of list of one component (required by ode).

Author(s)

Hank Stevens <HankStevens@miamioh.edu>

References

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[dlogistic](#), [thetalogistic](#), [levins](#), [lvcomp2](#), [lvcompg](#)

Examples

```
library(deSolve)
p <- c(r=1, alpha=.01)
time <- 1:10
initialN <- 10
out <- ode(y=initialN, times=time,
           func=clogistic, parms=p)
plot(time, out[,-1], type='l')
```

ClostExp

Closterium Population Data

Description

Data set from an experiment testing whether trophic heterogeneity influences long term population sizes.

Format

A data frame with 144 observations on the following 5 variables.

Nutrients a factor with levels high low

No.per.ml a numeric vector

Day a numeric vector

rep a factor with levels a b c d

ID an ordered factor with levels a.low < d.low < c.low < b.low < c.high < a.high < d.high < b.high

Source

Stevens, M. H. H. and Steiner, C. E. (2006) Effects of predation and nutrient enrichment on a food web with edible and inedible prey. *Freshwater Biology*, **51**, 666–671.

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

Examples

```
data(ClostExp)
#lattice::xyplot(log10(No.per.ml) ~ Day|Nutrients, data=ClostExp, groups=rep, type='l')
```

compcol

Two-species Competition-colonization Metapopulation Model

Description

This model implements a Levins-type metapopulation model for two species, after Hastings (1980). For use with ode in the deSolve package.

Usage

```
compcol(t, y, params)
```

Arguments

| | |
|--------|---------------------------------|
| t | Argument for time |
| y | A vector for population 1 and 2 |
| params | Vector or list of parameters |

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variables, `y`.

Author(s)

Hank Stevens <HankStevens@miamioh.edu>

References

Hastings, A. (1980) Disturbance, coexistence, history, and competition for space. *Theoretical Population Biology*, **18**, 363–373.

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[levins](#), [compcolM](#), [succniche](#)

Examples

```
library(deSolve)
pars <- c(c1 = .3, c2 = 1, m1 = .1, m2 = .1)
pops <- c(.1, .1)
out <- ode(y=pops, t=0:20, fun=compcol, parms = pars)
matplot(out[,1], out[,-1], type='l')
```

compcolM

Multi-species Competition-colonization Model, With Habitat Destruction

Description

Multi-species competition colonization model, with habitat destruction, after Nee and May (1992). For use with `ode` in the `deSolve` package.

Usage

```
compcolM(t, y, params)
```

Arguments

| | |
|--------|------------------------------|
| t | Argument for each time point |
| y | A vector for the populations |
| params | Vector or list of parameters |

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variables, `y`.

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Nee, S. and May, R.M. (1992) Dynamics of metapopulations: habitat destruction and competitive coexistence. *Journal of Animal Ecology*, **61**, 37–40.

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[levins](#), [compcol](#), [succniche](#)

Examples

```
library(deSolve)
S <- 10
ci <- 2^seq(-5, 5, length=S)
m <- rep(.1, S)
params <- list(ci=ci, m=m, S=S, D=0)
init.N <- rep(0.01, S); t=seq(1, 200, .1)
cc.out <- ode(init.N, t, compcolM, params)
matplot(t, cc.out[, -1], type="l", ylab="Proportion of Habitat", xlab="Years")
```

coneflower

Smooth coneflower data

Description

A data set containing size, survival, and flowering in smooth coneflower

Usage

```
data(coneflower)
```

Format

A data frame with 136 rows and 5 variables:

logA natural log of total leaf area in the first year

logAp natural log of total leaf area in the second year ($A_p = A$ prime)

surv indicator of survival from year one to year 2 (0,1)

flower_p indicator of flowering in year 2 (0,1)

Source

Data provided graciously by Rachel Collins (Roanoke College).

Examples

```
data(coneflower)
ggplot2::qplot(logA, logAp, data=coneflower)
```

coneflowerrecruits *Smooth coneflower new recruits*

Description

A data set containing recruit size and survival.

Usage

```
data(coneflowerrecruits)
```

Format

A data frame with 36 rows and 3 variables:

area17 total leaf area in the first year

surv18 indicator of survival from year one to year 2 (0,1)

area19 total leaf area in the third year

| | |
|-----------------|------------------------------------|
| coneflowerseeds | <i>Smooth coneflower seed data</i> |
|-----------------|------------------------------------|

Description

A data set containing size and seed set of individual coneflowers.

Usage

```
data(coneflowerseeds)
```

Format

A data frame with 136 rows and 5 variables:

logAs natural log of total leaf area in the first year

seeds number of seeds produced in the first year

Examples

```
data(coneflowerseeds)
ggplot2::qplot(logAs, seeds, data=coneflowerseeds)
```

| | |
|-----------|---------------------------------|
| dlogistic | <i>Discrete Logistic Growth</i> |
|-----------|---------------------------------|

Description

Single species discrete logistic growth – a difference equation. A function for continuous logistic growth, for use with ode in the deSolve package, using method = 'euler' and integer time steps.

Usage

```
dlogistic(t, y, p)
```

Arguments

| | |
|---|---|
| t | times points that will return N |
| y | N |
| p | a vector of labeled logistic growth parameters; the first must be labeled rd, and the second must be labeled alpha (the value of alpha is 1/K). |

Details

Of the form,

$$N_{t+1} - N_t = r_d N_t (1 - \alpha N_t)$$

Value

Returns a list of one component (required by ode).

Author(s)

Hank Stevens (HankStevens@miamioh.edu)

References

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[clogistic](#), [lvcompg](#)

Examples

```
library(deSolve)
# MUST use the 'euler' integration method with integer time steps
p <- c(rd=1, alpha=.01)
time <- 0:10
initialN <- 10
out <- ode(y=initialN, times=time,
           func=dlogistic, parms=p, method='euler')
plot(time, out[,-1], type='l')
```

 dlvcomp2

Discrete Logistic Competition

Description

A function to simulate discrete 2 species Lotka-Volterra competition.

Usage

```
dlvcomp2(N, alpha, rd = c(1, 1))
```

Arguments

| | |
|-------|--|
| N | a vector of length two, containing $N[t]$ for both species. |
| alpha | a 2 x 2 matrix of the magnitudes of the per capita (negative) effects (i.e., positive value results in a negative effect). |
| rd | a vector of length 2 containing the discrete growth increments for 2 species. |

Value

Returns a vector of length 2, containing $N[t+1]$ for both species.

Author(s)

Hank Stevens (HStevens@muohio.edu)

References

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[dlogistic](#), [lvcomp2](#), [lvcomp3](#), [lvcompg](#)

Examples

```
alphas <- matrix(c( .01, .005,
                  .008, .01), ncol=2, byrow=TRUE)
t <- 20
N <- matrix(NA, nrow=t+1, ncol=2)
N[1,] <- c(10,10)
for(i in 1:t) N[i+1,] <- dlvcomp2(N[i,], alphas)
matplot(0:t, N, type='l', col=1, ylim=c(0,110))
abline(h=1/alphas[1,1], lty=3)
text(0, 1/alphas[1,1], "K", adj=c(0,0))
legend("right", c(expression("Sp.1 "*alpha[21]==0.008)),
        expression("Sp.2 "*alpha[12]==0.005)), lty=1:2, bty='n')
```

gotelli

Propagule Rain Metapopulation Model

Description

A function for the propagule rain or mainland-island metapopulation dynamics, for use with ode in the deSolve package.

Usage

```
gotelli(t, y, parms)
```

Arguments

| | |
|-------|--------------------------------------|
| t | Argument for time |
| y | A scalar for the population variable |
| parms | Vector or list of parameters |

Value

Returns a list of length one, for use with ode in the deSolve package.

Component 1 vector of the state variable (a scalar for the proportion of sites occupied).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Gotelli, N.J. (1991) Metapopulation models: the rescue effect, the propagule rain, and the core-satellite hypothesis. *The American Naturalist*, **138**, 768–776.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[gotelli](#), [hanski](#), [lande](#), [MetaSim](#), [clogistic](#)

Examples

```
## The function is currently defined as
function (t, y, parms)
{
  p <- y[1]
  with(as.list(parms), {
    dp <- ce * (1 - p) - e * p
    return(list(dp))
  })
}

library(deSolve)
p <- c(ce=.1, e=.01)
time <- 1:10
initialN <- .3
out <- ode(y=initialN, times=time, func=gotelli, parms=p)
plot(time, out[,-1], type='l')
```

hanski

Core-satellite Metapopulation Model

Description

A function for the core-satellite metaapopulation dynamics, for use with ode in the deSolve package.

Usage

```
hanski(t, y, parms)
```

Arguments

| | |
|-------|--------------------------------------|
| t | Argument for time |
| y | A scalar for the population variable |
| parms | Vector or list of parameters |

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variable (a scalar for the proportion of sites occupied).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Hanski, I. (1982) Dynamics of regional distribution: the core and satellite species hypothesis. *Oikos*, **38**, 210–221.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[gotelli](#), [hanski](#), [lande](#), [MetaSim](#), [clogistic](#)

Examples

```
prms <- c(ci<- 0.15, e=0.05)
out <- ode(y=.2, times=1:100, func=hanski, parms=prms )
matplot(out[,1], out[,2], type='l', ylab="p", xlab="time")
```

igp

A Lotka-Volterra Model of Intraguild Predation

Description

A Lotka-Volterra model of intraguild predation, after Holt and Polis (1997). For use with `ode` in the `deSolve` package.

Usage

```
igp(t, y, params)
```

Arguments

| | |
|--------|---|
| t | the time point for a realization of the integration. |
| y | the vector of populations, at each time t. |
| params | a vector or list containing the necessary parameters. |

Value

Returns a list of length one which is the vector of the rates of increase (required by ode).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Holt, R.D. and Polis, G.A. (1997) A theoretical framework for intraguild predation. *The American Naturalist*, **149**, 745–764.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[lvcomp](#), [scheffer](#)

Examples

```
library(deSolve)
params <- c(bpb= 0.032, abp=10^-8, bpn=10^-5, anp=10^-4, mp=1,
           bnb=0.04, abn=10^-8, mn=1,
           r=1, abb=10^-9.5)
t=seq(0, 60, by=.1)
N.init <- c(B = 10^9, N = 10^4, P = 10^3)
igp.out <- ode(N.init, t, igp, params)
matplot(t, log10(igp.out[,-1]+1), type="l",
        ylab="log(Abundance)")
legend('right', c("B", "N", "P"), lty=1:3, col=1:3, lwd=2,
      bty="n")
```

lande

A Metapopulation Model with Habitat Destruction

Description

A function for the metaapopulation dynamics, for use with ode in the deSolve package.

Usage

```
lande(t, y, parms)
```

Arguments

| | |
|-------|--------------------------------------|
| t | Argument for time |
| y | A scalar for the population variable |
| parms | Vector or list of parameters |

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variable (a scalar for the proportion of sites occupied).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

P. Kareiva and Wennergren, U. (1995) Connecting landscape patterns to ecosystem and population processes. *Nature*, **373**, 299–302.

Lande, R. (1987) Extinction thresholds in demographic models of territorial populations. *The American Naturalist*, **130**, 624–635.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[gotelli](#), [hanski](#), [levins](#), [MetaSim](#), [clogistic](#)

Examples

```
## The function is currently defined as
function (t, y, parms)
{
  p <- y[1]
  with(as.list(parms), {
    dp <- ci * p * (1 - D - p) - e * p
    return(list(dp))
  })
}
library(deSolve)
p <- c(ci=.1, e=.01, D=.5)
time <- 1:10
initialN <- .3
out <- ode(y=initialN, times=time, func=lande, parms=p)
plot(time, out[,-1], type='l')
```

levins

Classic Metapopulation Model

Description

A function for the classic metaapopulation dynamics, for use with `ode` in the `deSolve` package.

Usage

```
levins(t, y, parms)
```

Arguments

| | |
|--------------------|--------------------------------------|
| <code>t</code> | Argument for time |
| <code>y</code> | A scalar for the population variable |
| <code>parms</code> | Vector or list of parameters |

Value

Returns a list of length one, for use with `ode` in the `deSolve` package.

Component 1 vector of the state variable (a scalar for the proportion of sites occupied).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Levins, R. (1969) Some demographic and genetic consequences of environmental heterogeneity for biological control. *Bulletin of the Entomological Society of America*, **15**, 237–240.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[gotelli](#), [hanski](#), [lande](#), [MetaSim](#), [clogistic](#)

Examples

```
## The function is currently defined as
function (t, y, parms)
{
  p <- y[1]
  with(as.list(parms), {
    dp <- ci * p * (1 - p) - e * p
    return(list(dp))
  })
}
```

```
library(deSolve)
p <- c(ci=.1, e=.01)
time <- 1:10
initialN <- .3
out <- ode(y=initialN, times=time, func=levins, parms=p)
plot(time, out[,-1], type='l')
```

lvcomp2

Two Species Lotka-Volterra Competition

Description

System of ordinary differential equations for two species Lotka-Volterra competition. For use with `ode` in the `deSolve` package.

Usage

```
lvcomp2(t, n, parms)
```

Arguments

| | |
|--------------------|--|
| <code>t</code> | Times points that will return N. |
| <code>n</code> | a vector of length two for the population sizes at time = t. |
| <code>parms</code> | vector or list of model parameters (see details below). |

Details

The parameters include r_1 , r_2 , a_{11} , a_{12} , a_{21} , a_{22} with the usual meanings. Here the a 's are the per capita effects which determine K ($a_{11} = 1/K$).

Value

Returns a list of length one which is the rate of increase (required by `ode`).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Lotka, A.J. (1956) *Elements of Mathematical Biology*. Dover Publications, Inc.
Stevens. M.H.H. (2009) *A Primer of Theoretical Population Ecology with R*. Use R! Series. Springer.

See Also

[lvcomp3](#), [lvcompg](#), [clogistic](#)

Examples

```
## The function is currently defined as
function (t, n, parms)
{
  with(as.list(parms), {
    dn1dt <- r1 * n[1] * (1 - a11 * n[1] - a12 * n[2])
    dn2dt <- r2 * n[2] * (1 - a22 * n[2] - a21 * n[1])
    list(c(dn1dt, dn2dt))
  })
}
library(deSolve)
parms <- c(r1 = 1, r2 = 0.1, a11 = 0.2, a21 = 0.1, a22 = 0.02, a12 = 0.01)
initialN <- c(1, 1)
out <- ode(y = initialN, times = 1:100, func = lvcomp2, parms = parms)
matplot(out[, 1], out[, -1], type = "l")
```

lvcomp3

Three Species Lotka-Volterra Competition

Description

System of ordinary differential equations for three species Lotka-Volterra competition. For use with ode in the deSolve package.

Usage

```
lvcomp3(t, n, parms)
```

Arguments

| | |
|-------|--|
| t | the time for each integration. |
| n | a vector of length three for the population sizes at time = t. |
| parms | vector or list of model parameters (see details below). |

Details

The parameters include r , a with the usual meanings. Here the a 's are the per capita effects which determine K ($a_{11} = 1/K_1$).

Value

Returns a list of length one which is the rate of increase (required by ode).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Lotka, A.J. (1956) *Elements of Mathematical Biology*. Dover Publications, Inc.
 Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[lvcomp2](#), [lvcompg](#), [clogistic](#)

Examples

```
## The function is currently defined as
function (t, n, parms)
{
  with(as.list(parms), {
    dn1dt <- r1 * n[1] * (1 - a11 * n[1] - a12 * n[2] - a13 *
      n[3])
    dn2dt <- r2 * n[2] * (1 - a22 * n[2] - a21 * n[1] - a23 *
      n[3])
    dn3dt <- r3 * n[3] * (1 - a33 * n[3] - a31 * n[1] - a32 *
      n[2])
    list(c(dn1dt, dn2dt, dn3dt))
  })
}

library(deSolve)
parms <- c(r1 = 0.1, r2 = 0.2, r3 = 0.3,
  a11 = 0.1, a12 = 0.01, a13 = 0.01,
  a21 = 0.01, a22 = 0.15, a23 = 0.01,
  a31 = 0.01, a32 = 0.01, a33 = 0.2)
initialN <- c(1, 1, 1)
out <- ode(y = initialN, times = 1:100, func = lvcomp3, parms = parms)
matplot(out[, 1], out[, -1], type = "l")
```

lvcompg

A General Lotka-Volterra Competition Model

Description

A general Lotka-Volterra competition model, for any number of species. For use with `ode` in the `deSolve` package. This function uses a vector and matrix within the list of parameters.

Usage

```
lvcompg(t, n, parms)
```

Arguments

| | |
|-------|---|
| t | the time point for a realization of the integration. |
| n | the vector of populations, at each time t. |
| parms | a LIST containing a vector of growth rates (r), and a matrix of interaction coefficients (a). |

Value

Returns a list of length one which is the vector of the rates of increase (required by ode).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Lotka, A.J. (1956) *Elements of Mathematical Biology*. Dover Publications, Inc.
 Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[lvcomp3](#), [clogistic](#), [igp](#), [scheffer](#)

Examples

```
## Specify the number of species
S <- 10
alpha <- .01
r <- runif(S)*2
a <- matrix(rnorm(S^2, m=alpha, sd=alpha/10), nrow=S, ncol=S)
parms <- list(r,a)
t=seq(0,40, by=.1)
N0 <- runif(S)/(S*alpha)
library(deSolve)
lvout <- ode(N0, t, lvcomp, parms)
matplot(t, lvout[,-1], type="l", ylab="N", log='y')
```

 LVCompGames

Lotka-Volterra Competition Games

Description

A pedagogical tool for learning about isoclines and stable equilibria.

Usage

```
LVCompGames(Alpha = NULL, r1 = 0.1, r2 = 0.1, num = 20, time = 10, step = 1)
```

Arguments

| | |
|-------|---|
| Alpha | a 2 x 2 matrix of coefficients; if NULL, then a sensible random matrix will be generated - fun for games. |
| r1 | the intrinsic rate of increase for species 1 (isocline – a solid line). |
| r2 | the intrinsic rate of increase for species 2 (isocline – a dashed line). |
| num | the desired number of random starting points for trajectories. |
| time | the number of time steps for each trajectory. |
| step | the number of time steps for which the integration is estimated (has no effect on accuracy, merely the smoothness of the line). |

Value

First generates a plot of isoclines and initial points; the user is then prompted to "Hit <return>" in the console to see the trajectories. These will indicate the rate and path the trajectories, demonstrating, among other things, whether the equilibrium is stable.

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Lotka, A.J. (1956) *Elements of Mathematical Biology*. Dover Publications, Inc.
 Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[lvcomp2](#), [lvcompg](#), [clogistic](#),

Examples

```
## LVCompGames() # Hit return in the console to see the trajectories.
```

 MetaSim

Simulation of Stochastic Metapopulation Models

Description

Originally focused on creating a community of core-satellite species, this function allows simulation of several metapopulation models, where colonization and extinction rates are stochastic draws from uniform distributions, with specified means and ranges.

Usage

```
MetaSim(
  Time = 50,
  NSims = 1,
  method = "hanski",
  ci = 0.25,
  e = 0.25,
  phi = 0.75,
  p0 = 0.5,
  D = 0.5
)
```

Arguments

| | |
|--------|--|
| Time | A scalar for the number of time steps over which to simulate each population. |
| NSims | A scalar for the number of simulations, which is analogous to the number of species in the community. |
| method | A character string, in quotes, specifying which metapopulation model to use: "hanski", "gotelli", "lande", "levins". See "See Also" below. |
| ci | Scalar for mean colonization rate. |
| e | Scalar for mean extinction rate. |
| phi | A scalar for the relative variability in rates. See Details. |
| p0 | Initial proportion of sites occupied for each species. |
| D | Parameter for habitat destruction; applies to only the "lande" model. |

Details

phi is one half of the relative range of each rate (colonization and extinction). For each time step, each rate is drawn from a uniform distribution, $Unif(\text{rate}-\text{phi}, \text{rate}+\text{phi})$. Thus, the range is $2*\text{phi}$, and center on the specified mean (ci or e).

Value

Function returns a list with these components.

| | |
|------------|--|
| method | The method used (default is "hanski"). |
| time | The integer sequence of times, from 0 to the value of the argument Time. |
| Ns | Time by NSims matrix of observed population sizes. |
| Parameters | A named vector of the parameters used for the simulations. |

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[gotelli](#), [hanski](#), [levins](#)

Examples

```
out <- MetaSim(NSims=2)
pops <- out$Ns
matplot(out$t, pops, type='l')
title(sub=paste(out$method, "model"))
```

moths

Moth Species Richness

Description

Data set of moth species richness from Ohio and Indiana, USA.

Format

A data frame with 21 observations on the following 6 variables.

region a factor with levels NCT WAP for the two collection regions.

site a factor with levels associated with county names.

area a numeric vector for the area of each forest fragment

spp a numeric vector, the number of moth species.

lat a numeric vector; latitude

long a numeric vector; longitude

Source

Data provided graciously by Keith Summerville and Thomas Crist; see "A Primer of Ecology with R" for specific references.

References

K. S. Summerville and T. O. Crist. 2003. Determinants of lepidopteran community composition and species diversity in eastern deciduous forests: roles of season, ecoregion and patch size. *Oikos*, 100:134-148.

K. S. Summerville and T. O. Crist. 2004. Contrasting effects of habitat quantity and quality on moth communities in fragmented landscapes. *Ecography*, 27:3-12.

Examples

```
data(moths)
plot(spp ~ area, data=moths)
```

one_over_f *Function to generate 1/f noise.*

Description

Generates 1/f noise with a specified power or amplitude.

Usage

```
one_over_f(gamma = 1, N = 200)
```

Arguments

| | |
|-------|---|
| gamma | spectral power, numeric, where 0 generates a white noise time series, 2 generates reddened noise. Defaults to 1 (pink). |
| N | length of the time series. |

Author(s)

Hank Stevens

References

J. M. Halley. Ecology, evolution and 1/f-noise. *Trends in Ecology & Evolution*, 11:33-37, 1996.
O. L. Petchey, A. Gonzalez, and H. B. Wilson. Effects on population persistence: the interaction between environmental noise colour, intra-specific competition and space. *Proceedings of the Royal Society of London Series B*, 264:1841-1847, 1997. J. E. Cohen, C. M. Newman, A. E. Cohen, O. L. Petchey, and A. Gonzalez. Spectral mimicry: a method of synthesizing matching time series with different Fourier spectra. *Circuits, Systems and Signal Processing*, 18:431-442, 1999.

See Also

[spec_mimic()] to rearrange one vector, X, to mimic the spectrum of another vector, Y; [plot_f()] to plot the time series and the spectrogram of the series.

Examples

```
set.seed(1)
time.series <- one_over_f(gamma=2, N=50)
plot(1:50, time.series, type='l', main="Reddened noise")
time.series <- one_over_f(gamma=0, N=50)
plot(1:50, time.series, type='l', main="White noise")
one_over_f()
```

Description

Used primarily to repeat simulations and analyses of Pimm and Lawton (1977), given a Jacobian matrix. Analyses include eigenanalysis, but also measuring average interaction strength (May 1972), average intraspecific negative density dependence, and the strength of the omnivory interaction, if present.

Usage

```
pimmlawton(mat, N = 1, omni.i = NA, omni.j = NA, omega = NULL)
```

Arguments

| | |
|--------|---|
| mat | a numerical matrix; the "maximum" Jacobian matrix. See details below. |
| N | a scalar for the number of randomizations |
| omni.i | if omnivory is present, the row/col index for the prey. |
| omni.j | if omnivory is present, the row/col index for the predator. |
| omega | if not NULL, a scalar $0 < x < 1$ indicating the relative weight of omnivory (after McCann et al. (1998)) |

Details

This function simulates a constrained randomization of a Jacobian food web matrix. The matrix it uses mat is of a special form, which assumes that all non-zero values are drawn from a uniform distribution between zero and a value of some specified magnitude, either positive or negative.

Value

Returns a data frame, where each row corresponds to a single random Jacobian matrix, with the following columns.

| | |
|---------|---|
| DomEig | the real part of the dominant eigenvalue |
| Im | the imaginary part of the dominant eigenvalue |
| IntraDD | average magnitude, over all species, of the intraspecific negative density dependence; the square root of the sum of the squared diagonal elements of the random Jacobian matrix |
| I | average interaction strength (after May 1972); the square root of, sum of the squared off diagonal elements divided by the number of off diagonal elements. |
| I.omni | average interaction strength for the omnivory interaction; the square root of, sum of the squared omnivory elements effect of predator on prey and prey on predator divided by two. |

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

May, R.M. (1973) *Stability and Complexity in Model Ecosystems*, volume 6 of *Monographs in Population Biology*. Princeton University Press.

McCann, K., Hastings, A. and Huxel, G.R. (1998) Weak trophic interactions and the balance of nature. *Nature*, **395**, 794–798.

Pimm, S.L and Lawton, J.H. (1997) Number of trophic levels in ecological communities. *Nature*, **268**, 329–331.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer. 2009.

Examples

```
### A relevant style of matrix for the first food chain in Pimm and Lawton (1977).
### Note each non-zero element is the appropriate sign, and the maximum magnitude
### specified by Pimm and Lawton (1977).
```

```
Aq = matrix(c(
  -1, -10,  0,  0,
  0.1,  0, -10,  0,
  0, 0.1,  0, -10,
  0,  0, 0.1,  0),
  nrow=4, byrow=TRUE)
```

```
pimmlawton(Aq, N=1)
```

```
out <- pimmlawton(Aq, N=2000)
out <- subset(out, -1/DomEig <150)
hist(-1/out$DomEig, main="Frequencies of Return Time")
```

plot_f

plot_f

Description

Function to plot a time series and its periodogram, and calculate the confidence interval of 2 times the spectral power.

Usage

```
plot_f(z)
```

Arguments

z numeric vector.

Author(s)

Hank Stevens

References

J. M. Halley. Ecology, evolution and 1/f-noise. *Trends in Ecology & Evolution*, 11:33-37, 1996.
 O. L. Petchey, A. Gonzalez, and H. B. Wilson. Effects on population persistence: the interaction between environmental noise colour, intra-specific competition and space. *Proceedings of the Royal Society of London Series B*, 264:1841-1847, 1997. J. E. Cohen, C. M. Newman, A. E. Cohen, O. L. Petchey, and A. Gonzalez. Spectral mimicry: a method of synthesizing matching time series with different Fourier spectra. *Circuits, Systems and Signal Processing*, 18:431-442, 1999.

See Also

[one_over_f()] to generate 1/f noise; [spec_mimic()] to rearrange one vector, X, to mimic the spectrum of another vector; [spectrum()] for the hard work.

Examples

```
## white noise
plot_f(z=runif(50))

plot_f
```

 PopSim

Population Simulator

Description

Resampling stochastic simulator for a single density-independent population.

Usage

```
PopSim(Rs, N0, years = 50, sims = 10)
```

Arguments

| | |
|-------|---|
| Rs | vector of observed annual growth rates ($N[t+1]/N[t]$). |
| N0 | initial population size. |
| years | number of years to simulate. |
| sims | number of simulated populations. |

Details

Designed to simulate trajectories based on resampled observed $N[t+1]/N[t]$.

Value

Returns a matrix of population sizes for time = t (rows) for each replicated population (columns).

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[sparrows](#)

Examples

```
lambdas <- runif(10, .5, 1.5)
out <- PopSim(Rs=lambdas, years=50, N0=50)
matplot(0:50, out, type='l')
summary(out[51,])
```

predpreyLV

The Lotka-Volterra Predator-prey Model

Description

The Lotka-Volterra predator-prey model, for use with ode in the deSolve package.

Usage

```
predpreyLV(t, y, params)
```

Arguments

| | |
|--------|--|
| t | Argument for time |
| y | A vector of length 2, for population 1 and 2 |
| params | Vector or list of parameters |

Value

Returns a list of length one, for use with ode in the deSolve package.

Component 1 vector of the state variables, y.

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Lotka, A.J. (1956) *Elements of Mathematical Biology*. Dover Publications, Inc.
Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[predpreyRM](#)

Examples

```
params1 <- c(b=.5, a=.01, s=.2, e=.1)
Time <- seq(0,100, by=.1) # Set time here
LV.out <- ode(c(H0=25,P0=5), Time, predpreyLV, params1)
matplot(Time, (LV.out[,2:3]), type="l", ylab="Population Size")
```

predpreyRM

Rosenzweig-MacArthur Predator-prey Model

Description

An implementation of a predator-prey model, after Rosenzweig and MacArthur (1963). Includes prey density-dependence, and a type-II predator functional response. For use with ode in the deSolve package.

Usage

```
predpreyRM(t, y, p)
```

Arguments

| | |
|---|--|
| t | Argument for time |
| y | A vector of length 2, for population 1 and 2 |
| p | Vector or list of parameters |

Value

Returns a list of length one, for use with ode in the deSolve package.

Component 1 vector of the state variables, y.

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Rosenzweig, M.L. and MacArthur, R.H. (1963) Graphical representation and stability conditions of predator-prey interactions. *The American Naturalist*, **97**, 209–223.
- Stevens. M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[predpreyLV](#)

Examples

```
library(deSolve)
pars <- c(b = .8, e = 0.07, s = .2, w = 5, D = 400, alpha = 0.001)
Time <- 50
RM1 <- ode(c(900,120), 1:Time, predpreyRM, pars)
matplot(1:Time, RM1[, -1], type='l')
```

ross

Weekly deaths from bubonic plague in Bombay in 1905–06

Description

Kermack and McCormick (1927) provided data on the number of plague deaths per week in Bombay in 1905–06 (Bombay is the former name for the Indian coastal city Mumbai. It is the capital of Maharashtra and is one of the largest cities in the world).

Format

A data frame with 32 observations on the following 2 variables.

Week a numeric vector

CumulativeDeaths a numeric vector

Source

Data provided kindly by S.P. Ellner (Cornell University)

References

- Kermack, W.O. and McCormick, W.G. (1927) A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society, Series A*, **115**, 700–721.

Examples

```
data(ross)
str(ross) ; plot(CumulativeDeaths ~ Week, data=ross, type='b')
```

 scheffer

A resource-based model of alternative stable states

Description

A model of floating vs. submerged plant dominance in shallow aquatic systems, after Scheffeer *et al.* (2003). For use with `ode` in the `deSolve` package. Floating plants are better competitors for light, as long as submerged plants cannot drive down nitrogen levels.

Usage

```
scheffer(t, y, p)
```

Arguments

| | |
|----------------|--|
| <code>t</code> | the time point for a realization of the integration. |
| <code>y</code> | the vector of populations, at each time <code>t</code> . |
| <code>p</code> | a vector or list containing the necessary parameters. |

Value

Returns a list of length one which is the vector of the rates of increase (required by `ode`).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Scheffer, M., Szabo, S., Gragnani, A., van Nes, E.H., Rinaldi, S., Kautsky, N., Norberg, J., Roijackers, R.M.M. and Franken, R.J.M. (2003) Floating plant dominance as a stable state. *Proceeding of the National Academy of Sciences, U.S.A.*, **100**, 4040–4045.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[lvcompg](#), [igp](#)

Examples

```
p <- c(N=2.5, as=0.01, af=0.01, b=0.02, qs=0.075, qf=0.005,
      hs=0, hf=0.2, ls=0.05, lf=0.05, rs=0.5, rf=0.5, W=0)
t <- 1:200
Initial <- c(F=10, S=10)
S.out1 <- ode(Initial, t, scheffer, p)
matplot(t, S.out1[,-1], type='l')
legend('right', c("F", "S"), lty=1:2, col=1:2, bty='n')
```

SIRbd

The S-I-R Epidemiological Disease Model with Births and Deaths

Description

The S-I-R epidemiological disease model with births and deaths (population dynamics), for use with ode in the deSolve package. This model uses mass action transmission.

Usage

```
SIRbd(t, y, p)
```

Arguments

| | |
|---|---|
| t | times points for which values will be returned |
| y | the vector of disease states of hosts (S, I, R) |
| p | a vector of parameters |

Details

The user does not put these directly into this function, but rather uses ode in the deSolve package.

Value

Returns of list of one component (required by ode).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Ellner, S.P. and Guckenheimer, J. (2006) *Dynamic Models in Biology*, Princeton University Press.
- Kermack, W.O. and McCormick, W.G. (1927) A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society, Series A*, **115**, 700–721.
- Stevens, M.H.H. (2009) *A Primer of Ecology with R*, Use R! Series. Springer.

See Also

[ross](#), [SIRf](#), [SIRd](#)

Examples

```

library(deSolve)
N <- 10^6; R <- 0; I <- 1; S <- N - I - R
g <- 1/(13/365); b <- 1/50;
age <- 5; R0 <- 1 + 1/(b*age)
B <- R0 * (g + b) / N
parms <- c(B = B, g = g, b = b, m=b)
years <- seq(0,30, by=.1)
SIRbd.out <- data.frame(ode(c(S=S,I=I,R=R), years, SIRbd, parms, hmax=.01))
matplot(SIRbd.out[,1], sqrt(SIRbd.out[,-1]), type='l',
        lty=1:3, ylab="sqrt(No. of Individuals)", xlab='Years')
legend('right', c('S','I','R'), lty=1:3, col=1:3, bty='n')

```

SIRd

*The S-I-R Epidemiological Disease Model***Description**

The S-I-R epidemiological disease model with density-dependent transmission, for use with ode in the deSolve package.

Usage

```
SIRd(t, y, p)
```

Arguments

| | |
|---|---|
| t | times points for which values will be returned |
| y | the vector of disease states of hosts (S, I, R) |
| p | a vector of parameters |

Details

The user does not put these directly into this function, but rather uses ode in the deSolve package.

Value

Returns of list of one component (required by ode).

Author(s)

Hank Stevens <Hank.Stevens@miamioh.edu>

References

- Ellner, S.P. and Guckenheimer, J. (2006) *Dynamic Models in Biology*, Princeton University Press.
- Kermack, W.O. and McCormick, W.G. (1927) A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society, Series A*, **115**, 700–721.
- Stevens, M.H.H. (2009) *A Primer of Ecology with R*, Use R! Series. Springer.

See Also

[ross](#), [SIRf](#), [SIRbd](#)

Examples

```
N <- 10^3; I <- R <- 1; S <- N - I - R
parms <- c(B=.01, g=4)
months <- seq(0, 3, by=0.01)
require(deSolve)
SIR.out <- data.frame( ode(c(S,I,R), months, SIRd, parms) )
matplot(months, SIR.out[,-1], type='l')
legend('right', c('R', 'I', 'S'), lty=3:1, col=3:1, bty='n')
```

SIRf

The S-I-R Epidemiological Disease Model with Frequency Dependent Transmission

Description

The S-I-R epidemiological disease model with frequency dependent transmission, for use with `ode` in the `deSolve` package.

Usage

```
SIRf(t, y, p)
```

Arguments

| | |
|---|---|
| t | times points for which values will be returned |
| y | the vector of disease states of hosts (S, I, R) |
| p | a vector of parameters |

Details

The user does not put these directly into this function, but rather uses `ode` in the `deSolve` package.

Value

Returns of list of one component (required by `ode`).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

- Ellner, S.P. and Guckenheimer, J. (2006) *Dynamic Models in Biology*, Princeton University Press.
- Kermack, W.O. and McCormick, W.G. (1927) A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society, Series A*, **115**, 700–721.
- Stevens, M.H.H. (2009) *A Primer of Ecology with R*, Use R! Series. Springer.

See Also

[ross](#), [SIRd](#), [SIRbd](#), [ode](#)

Examples

```
R <- 0; S <- 1000; I <- 1000; N <- S+I+R
parmsf <- c(B=1, g=1)
Months <- seq(0, 8, by=0.1)
outf <- ode(c(S,I,R), Months, SIRf, parmsf)
matplot(Months, outf[,-1], type='l', ylab="Prevalence (I/N)")
legend('right', legend=c('S','I','R'), lty=1:3, col=1:3, bty='n')
```

SIRmod

The S-I-R Epidemiological Disease Model

Description

The S-I-R epidemiological disease model with births and deaths (population dynamics), for use with `ode` in the `deSolve` package. This model uses scaled transmission, where `z` controls the degree of density- and frequency-dependence.

Usage

```
SIRmod(t, y, p)
```

Arguments

| | |
|----------------|---|
| <code>t</code> | times points for which values will be returned |
| <code>y</code> | the vector of disease states of hosts (S, I, R) |
| <code>p</code> | a vector of parameters |

Details

The user does not put these directly into this function, but rather uses `ode` in the `deSolve` package.

Value

Returns of list of one component (required by ode).

Author(s)

Hank Stevens <Hank.Stevens@miamioh.edu>

References

- Ellner, S.P. and Guckenheimer, J. (2006) *Dynamic Models in Biology*, Princeton University Press.
- Kermack, W.O. and McCormick, W.G. (1927) A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society, Series A*, **115**, 700–721.
- Stevens, M.H.H. (2009) *A Primer of Ecology with R*, Use R! Series. Springer.

See Also

[ross](#), [SIRf](#), [SIRd](#)

Examples

```
library(deSolve)
N <- 10^6; R <- 0; I <- 1; S <- N - I - R
g <- 1/(13/365); b <- 1/50; z <- 0;
age <- 5; R0 <- 1 + 1/(b*age)
B <- R0 * (g + b) / N
parms <- c(B = B, g = g, b = b, mu=b)
years <- seq(0,30, by=.1)
SIR.out <- data.frame(ode(c(S=S,I=I,R=R), years, SIRmod, parms, hmax=.01))
matplot(SIR.out[,1], sqrt(SIR.out[,-1]), type='l',
        lty=1:3, ylab="sqrt(No. of Individuals)", xlab='Years')
legend('right', c('S','I','R'), lty=1:3, col=1:3, bty='n')
```

sparrows

Song Sparrow Data Set

Description

Song Sparrow (*Melospiza melodia*) counts in Darrrtown, OH, USA. From Sauer, J. R., J.E. Hines, and J. Fallon. 2005. The North American Breeding Bird Survey, Results and Analysis 1966–2004. Version 2005.2. USGS Patuxent Wildlife Research Center, Laurel, MD.

Format

A data frame with 36 observations on the following 3 variables.

Year a numeric vector

Count a numeric vector

ObserverNumber a numeric vector

Source

<http://www.pwrc.usgs.gov/BBS/>

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[PopSim](#)

Examples

```
data(sparrows)
## maybe
str(sparrows)
plot(Count ~ Year, sparrows)
```

spec_mimic

Function to mimic the power spectrum of an observed time series.

Description

This function rearranges one vector, X, to mimic the spectrum of another vector, Y.

Usage

```
spec_mimic(X, Y = NULL, gamma = 1)
```

Arguments

| | |
|-------|---|
| X | numeric vector. |
| Y | if not NULL, a numeric vector. |
| gamma | power of the 1/f noise; used only if Y is NULL. |

Details

If Y is NULL, this function will use `[one_over_f()]` to generate a random series with power = gamma.

Author(s)

Hank Stevens

References

J. M. Halley. Ecology, evolution and 1/f-noise. *Trends in Ecology & Evolution*, 11:33-37, 1996.
 O. L. Petchey, A. Gonzalez, and H. B. Wilson. Effects on population persistence: the interaction between environmental noise colour, intra-specific competition and space. *Proceedings of the Royal Society of London Series B*, 264:1841-1847, 1997.
 J. E. Cohen, C. M. Newman, A. E. Cohen, O. L. Petchey, and A. Gonzalez. Spectral mimicry: a method of synthesizing matching time series with different Fourier spectra. *Circuits, Systems and Signal Processing*, 18:431-442, 1999.

See Also

[one_over_f()] to generate 1/f noise; [plot_f()] to plot the time series and the spectrogram of the series.

Examples

```
N = 50
set.seed(1)
X1 <- runif(N)
Y <- one_over_f(gamma=2, N=N)
X2 <- spec_mimic(X1, Y)
series <- cbind(X1, Y, X2)
matplot(1:50, series, type='l')
legend("bottomright", legend=colnames(series), col=1:3, lty=1:3)
```

succniche

A Four-state model of Successional Dynamics

Description

This is the five-state, two-species model of the succession-niche model, after Pacala and Rees (1998). For use with ode in the deSolve package.

Usage

```
succniche(t, y, params)
```

Arguments

| | |
|--------|--|
| t | Argument for the time point at integration |
| y | A vector of length four, for states, E, M, S, and R. |
| params | Vector or list of parameters |

Value

Returns a list of length one, for use with ode in the deSolve package.

Component 1 vector of the state variable (a scalar for the proportion of sites occupied).

Author(s)

Hank Stevens <HStevens@muohio.edu>

References

Pacala, S.W. and Rees, M. (1998) Models suggesting field experiments to test two hypotheses explaining successional diversity. *The American Naturalist*, **152**, 729–737.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[levins](#), [compcol](#), [compcolM](#)

Examples

```
params.suc <- c(a=7, c=0.2, g=.1, m=0.04, D=0)
t=seq(0,50,.1)
init.suc <- c(S=0, E=0.5, M=0.5, R=0.00) # Free space is implicit, F=1-(S+E+M+R).
ccg.out <- data.frame(ode(init.suc, t, succniche, params.suc))
matplot(t, ccg.out[,-1], type="l", ylab="Relative Frequency",
        xlab="Time", ylim=c(0,1) )
legend("right", colnames(ccg.out)[5:2], lty=4:1, bty="n")
```

 thetalogistic

Continuous Theta-Logistic Growth

Description

A function for continuous theta-logistic growth, for use with ode in the deSolve package.

Usage

```
thetalogistic(times, y, parms)
```

Arguments

| | |
|-------|--|
| times | Times points that will return N |
| y | N |
| parms | a vector of logistic growth parameters |

Details

The user does not put these directly into this function, but rather uses ode in the deSolve package. See ode in the deSolve package.

Value

Returns of list of one component (required by ode).

Author(s)

Hank Stevens (HStevens@muohio.edu)

References

Sibly, R.M., Barker, D., Denham, M.C., Hone, J., and Pagel, M. (2005) On the regulation of populations of mammals, birds, fish, and insects. *Science*, **309**, 607–610.

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

See Also

[clogistic](#)

Examples

```
library(deSolve)
p <- c(r=1,alpha=.01, theta=.5)
time <- seq(1,10, by=.1)
initialN <- 10
out <- ode(y=initialN, times=time, func=thetalogistic, parms=p)
plot(time, out[,-1], type='l')
```

weeds

Percent cover of six perennial herbaceous plants

Description

Percent cover of six of the most common herbaceous perennial species from the Buell-Small long term succession study (<http://www.ecostudies.org/bss/>). Data are plot-level visual estimates of percent cover.

Format

A data frame with 15140 observations on the following 8 variables.

X a numeric vector

Genus a factor with levels Aster, Euthamia, Solidago

Epithet a factor with levels canadensis, gigantea, graminifolia, novae-angliae, pilosus, rugosa

FieldName a factor with levels C3, C4, C5, C6, C7, D1, D2, D3, E1, E2

Age a numeric vector indicating the number of years of succession, since abandonment from agriculture.

PlotId a numeric vector

Cover a numeric vector; percent cover, estimated visually.

Species a factor with levels A.novae-angliae, A.pilosus, E.graminifolia, S.canadensis, S.gigantea, S.rugosa

Source

Data graciously provided by Scott Meiners (Eastern Illinois University, <http://www.ecostudies.org/bss/>).

References

Stevens, M.H.H. (2009) *A Primer of Ecology with R*. Use R! Series. Springer.

Examples

```
data(weeds)
str(weeds);
# lattice::xyplot(Cover ~ Age, data=weeds, groups=Species,
# type=c("a"), auto.key=list(lines=TRUE, points=FALSE, columns=3),
# ylim=c(-1,20))
```

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