Package ‘nlstimedist’

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Type Package

Title Non-Linear Model Fitting of Time Distribution of Biological Phenomena

Version 2.0.0

Description Fit biologically meaningful distribution functions to time-sequence data (phenology), estimate parameters to draw the cumulative distribution function and probability density function and calculate standard statistical moments and percentiles. These methods are described in Steer et al. (2019) <doi:10.1111/2041-210X.13293>.

URL https://github.com/nathaneastwood/nlstimedist

BugReports https://github.com/nathaneastwood/nlstimedist/issues

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\textit{glance} \hspace{1cm} \textit{Take a glance at a model}

\textbf{Description}

Construct a single row of model summary statistics.

\textbf{Usage}

\texttt{glance(x)}

\textbf{Arguments}

\texttt{x} \hspace{1cm} An object of class \texttt{timedist}.

\textbf{Value}

\texttt{glance()} returns a one row \texttt{data.frame} with the columns

- \texttt{sigma} \hspace{1cm} the square root of the estimated residual variance
- \texttt{isConv} \hspace{1cm} whether the fit successfully converged
- \texttt{finTol} \hspace{1cm} the achieved convergence tolerance
- \texttt{logLik} \hspace{1cm} the data's log-likelihood under the model
- \texttt{AIC} \hspace{1cm} the Akaike Information Criterion
- \texttt{BIC} \hspace{1cm} the Bayesian Information Criterion
- \texttt{deviance} \hspace{1cm} deviance
- \texttt{df.residual} \hspace{1cm} residual degrees of freedom
- \texttt{RSS} \hspace{1cm} corrected residual sum of squares
- \texttt{nobs} \hspace{1cm} the number of observations from the model fit
Examples

```r
tdTilia <- tdData(tilia, x = "Day", y = "Trees")
model <- timedist(data = tdTilia, x = "Day", y = "propMax", r = 0.1, c = 0.5, t = 120)
glance(model)
```

---

**lobelia**

*Lobelia urens seeds data*

### Description

This data describes the number of germinating lobelia urens seeds at different temperatures.

### Usage

```r
lobelia
```

### Format

A data frame with 231 rows and 3 variables:

- **Day** The day number
- **Temperature** The temperature
- **Germination** The number which germinated

### Details

The total numbers which failed to germinate are 59, 52, 35, 22, 10, 7 and 12 for temperatures 9.8, 12.5, 16.7, 20.2, 24.3, 28.5 and 32.0, respectively.

### Examples

```r
lobelia
```

---

**nlstimedist**

*Fit the time-course of biological phenomena*

### Description

`nlstimedist` fits a biologically meaningful distribution function to time-sequence data (phenology), estimates parameters to draw the cumulative distribution function and probability density function and calculates standard statistical moments and percentiles.
pupae  

_Emergence of butterflies data_

**Description**

This data describes the emergence of butterflies from their pupae from four different cohorts.

**Usage**

`pupae`

**Format**

A data frame with 64 rows and 3 variables:

- **Day**  The day number
- **Cohort**  The cohort number
- **Emergence**  The number of butterflies to emerge

**Examples**

`pupae`

---

`tdCdfPlot`  

Plot the timedist PDF or CDF

**Description**

Given a model (or models) of class `timedist`, produce a cumulative distribution plot for each of them.

**Usage**

`tdCdfPlot(..., S = NULL, xVals = NULL)`

`tdPdfPlot(..., S = NULL, xVals = NULL)`

**Arguments**

- `...`  timedist model(s).
- `S`  numeric(1). Scaling factor for the PDF.
- `xVals`  numeric(n). A sequence of values between the x limits (x1, x2) of the plot.
Examples

```r
tdTilia <- tdData(tilia, x = "Day", y = "Trees")
model <- timedist(data = tdTilia, x = "Day", y = "propMax", r = 0.1, c = 0.5, t = 120)

tdCdfPlot(model)

tdPdfPlot(model)
```

---

Description

The data for `nlstimedist` needs to be in a particular format. This function prepares the data for the model.

Usage

```r
tdData(data, x, y, group = NULL)
```

Arguments

- **data**: A `data.frame`. The raw data to be cleaned.
- **x**: character(1). The time variable.
- **y**: character(1). The number of events.
- **group**: character(1). The run numbers. This is `NULL` by default if you are only using the function for one run.

Value

A `data.frame` of the cleaned data to be supplied to the `timedist()` function.

Examples

```r
tdData(tilia, x = "Day", y = "Trees")

tdData(lobelia, x = "Day", y = "Germination", group = "Temperature")
```
Calculate moments for the fitted timedist model

Description

Calculate individual model summary statistics or use the wrapper, tdMoments(), to calculate all model summary statistics.

Usage

   tdMoments(r, c, t, ...)  
   tdMean(r, c, t, upper = t * 10, ...)  
   tdVariance(r, c, t, upper = t * 10, ...)  
   tdSkew(r, c, t, upper = t * 10, ...)  
   tdKurtosis(r, c, t, upper = t * 10, alternative = FALSE, ...)  
   tdEntropy(r, c, t, upper = t * 10, ...)  

Arguments

   r, c, t       numeric(1). Parameters of the Franco distribution.  
   ...       Additional arguments to be passed to stats::integrate().  
   upper       numeric(1). The upper limit of integration. Defaults to \( t \times 10 \). Can be infinite for all moment functions except for entropy. 
   alternative       logical(1). Whether to use the alternative calculation method (TRUE) or not (default: FALSE).

Value

For the individual summary statistic functions, a single numeric; for tdMoments(), a single row data.frame of numerics containing all of the summary statistics as individual columns.

Examples

   tdMoments(r = 0.1, c = 0.5, t = 120)  
   tdMean(r = 0.1, c = 0.5, t = 120)  
   tdVariance(r = 0.1, c = 0.5, t = 120)  
   tdSkew(r = 0.1, c = 0.5, t = 120)  
   tdKurtosis(r = 0.1, c = 0.5, t = 120)  
   tdKurtosis(r = 0.1, c = 0.5, t = 120, alternative = TRUE)  
   tdEntropy(r = 0.1, c = 0.5, t = 120)
tdPDF

Calculate the PDF and CDF

Description
Calculate values of the probability density function (PDF) and the cumulative distribution function (CDF).

Usage

\[
\begin{align*}
\text{tdPDF}(x, r, c, t, S = 1) \\
\text{tdCDF}(x, r, c, t, S = 1)
\end{align*}
\]

Arguments

- \(x\): numeric(n). Points at which to calculate the the PDF.
- \(r, c, t\): numeric(1). Parameter values within the model.
- \(S\): numeric(1). Scaling factor for the PDF.

Value
A vector of values from the PDF or CDF.

See Also

- \text{tdPdfPlot()}, \text{tdCdfPlot()}

---

tdPercentiles

Calculate percentiles

Description
Calculate the percentiles for a given model.

Usage

\[
\text{tdPercentiles(model, n, upper = model$m$getPars()$["t"] * 10, ...)}
\]

Arguments

- \(model\): An object of class timedist.
- \(n\): numeric(n). A vector of percentiles to be calculated.
- \(upper\): numeric(1). The upper end point of the interval to search.
- \(\ldots\): Additional parameters to be passed to \text{stats::uniroot()}.
Examples

tdTilia <- tdData(tilia, x = "Day", y = "Trees")
model <- timedist(data = tdTilia, x = "Day", y = "propMax", r = 0.1, c = 0.5, t = 120)
 tdPercentiles(model, n = 0.5)
 tdPercentiles(model, n = seq(0, 0.9, 0.1))

---

tdRSS

*Calculate the corrected residual sum of squares*

Description

Calculate the corrected residual sum of squares for a timedist model.

Usage

```
tdRSS(model)
```

Arguments

- **model**: An object of class `timedist`.

Value

- numeric(1).

Examples

```
tdTilia <- tdData(tilia, x = "Day", y = "Trees")
model <- timedist(data = tdTilia, x = "Day", y = "propMax", r = 0.1, c = 0.5, t = 120)
 model
tdRSS(model)
```

---

tilia

*Leafing phenology of tilia cordata*

Description

This data describes the leafing phenology of lime trees (tilia cordata).

Usage

```
tilia
```
Format

A data frame with 34 rows and 2 variables:

Day  The day number
Trees The number of trees

Examples

tilia

timedist

Fit the Franco model

Description

Fit the time-course of biological phenomena.

Usage

timedist(data, x, y, r, c, t, ...)

Arguments

data  A data.frame. The data to be included in the model.
x, y  character(1). The x and y values in the data, where the y values are the proportions.
r, c, t  numeric(1). The starting parameters for the model.
...  Additional parameters to be passed to minpack.lm::nlsLM().

Details

The minpack.lm::nlsLM() function is used instead of the stats::nls() function in order to use the Levenberg-Marquardt algorithm which is an extremely robust method of curve-fitting as it is able to switch between Gauss-Newton and gradient descent. This allows it to cope with far-off-optimal starting values. The standard nls function does not use Levenberg-Marquardt; it instead uses the Gauss-Newton type, the PORT routines and a partial linear fit.

See Also

tdPDF(), tdCDF(), tdRSS(), glance(), tdMoments(), tdPercentiles()

Examples

tdTilia <- tdData(tilia, x = "Day", y = "Trees")
model <- timedist(data = dTilia, x = "Day", y = "propMax", r = 0.1, c = 0.5, t = 120)
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