Package 'EDE'

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Title Extinction Date Estimation from Sighting Records

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Description Estimates the historic date of extinction of a species from a time-ordered record of sighting events. Given a table of sighting counts per year, computes extinction date estimators from the sighting-record literature: optimal linear estimation under a record-value model (Roberts & Solow, 2003), nonparametric and sighting-effort-weighted persistence tests (Solow, 1993; Solow, 2005), a sighting-rate persistence test comparable across records with different observation periods (McInerny, Roberts, Davy & Cribb, 2006), a classical confidence interval on the end of a temporal range (Strauss & Sadler, 1989), a truncation-point extrapolation (Robson & Whitlock, 1964), and a combinatorial persistence test based on inclusion-exclusion over sighting-gap occupancy (Burgman, Grimson & Ferson, 1995). Every estimator is built on a single validated input object and returns a common result class with, where defined, a point estimate, a confidence interval, or a full persistence-probability curve.

Language en-US

License GPL (>= 3)

URL https://github.com/rodrigosqrt3/EDE

BugReports https://github.com/rodrigosqrt3/EDE/issues

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RoxygenNote 7.3.3

Depends R (>= 4.1.0)

Suggests testthat (>= 3.0.0), knitr, rmarkdown, ggplot2

VignetteBuilder knitr

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Repository CRAN

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Contents

`burgman1995` *Burgman, Grimson & Ferson (1995) combinatorial persistence test*

Description

Computes the probability that, if sighting events were distributed uniformly at random over the candidate observation window, the largest observed gap between sightings would not exceed the gap actually seen in the data. Uses an inclusion-exclusion (Stirling-number) argument on the occupancy of time bins by sighting events.

Usage

```
burgman1995(sd, alpha = 0.05, test_year, data_out = FALSE)
```

Arguments

`sd`	A sighting_data object.
`alpha`	Significance level, in (0, 1). Persistence is rejected for the first candidate year at which the chance of persistence falls to or below `alpha`.
`test_year`	Latest year to test. Must be supplied as a number.
`data_out`	If `TRUE`, return the full chance-of-persistence curve instead of the single first-rejection year.

Value

An ede_estimate object, or (if `data_out = TRUE`) a data frame with columns `time` and `chance`.

References

Burgman, M. A., Grimson, R. C., & Ferson, S. (1995). Inferring threat from scientific collections. Conservation Biology, 9(4), 923-928.

`ede_estimate` *Extinction date estimate*

Description

Common S3 result class returned by every estimator in this package.

Format

A list with components:

estimate Point estimate, or `NA` if not defined for this method.

lower, upper Confidence interval bounds, or `NA` if not defined.

method Character string identifying the estimator.

alpha Significance level used to compute the estimate.

`mcinerny2006` *McInerny, Roberts, Davy & Cribb (2006) sighting-rate persistence test*

Description

A modification of the Solow (1993) persistence test that conditions on the sighting rate observed up to the last sighting, `n / tn`, instead of on the length of the whole observation window. This makes the test comparable across records with very different total observation periods: species discovered recently and species discovered long ago, but sighted at the same rate, are inferred extinct after the same length of silence.

Usage

```
mcinerny2006(sd, alpha = 0.05, test_year, data_out = FALSE)
```

Arguments

`sd`	A sighting_data object.
`alpha`	Significance level, in (0, 1). Persistence is rejected for the first candidate year at which the chance of persistence falls to or below `alpha`.
`test_year`	Latest year to test. Must be later than the last sighting.
`data_out`	If `TRUE`, return the full chance-of-persistence curve instead of the single first-rejection year.

Details

Following the source paper, the first sighting is used to anchor the time origin (`t = 0`) rather than counted as one of the `n` sighting events being tested, so the count entering the formula is `n - 1`, where `n` is the number of distinct sighting times with a positive count.

Value

An ede_estimate object, or (if `data_out = TRUE`) a data frame with columns `time` and `chance`.

References

McInerny, G. J., Roberts, D. L., Davy, A. J., & Cribb, P. J. (2006). Significance of sighting rate in inferring extinction and threat. Conservation Biology, 20(2), 562-567.

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ole *Optimal Linear Estimation of extinction date*

Description

Estimates the extinction date from the sighting times with a positive count, using the best linear unbiased estimator (BLUE) of Roberts & Solow (2003) under a Weibull-type record-value model for the spacing of the largest order statistics.

Usage

```
ole(sd, alpha = 0.05)
```

Arguments

`sd`	A sighting_data object.
`alpha`	Significance level for the confidence interval, in (0, 1).

Value

An ede_estimate object.

References

Roberts, D. L., & Solow, A. R. (2003). Flightless birds: When did the dodo become extinct? Nature, 426(6964), 245.

`robson1964` *Robson & Whitlock (1964) truncation point estimator*

Description

Extrapolates the extinction date from the gap between the two most recent sighting times, under the assumption that the sighting process near the true endpoint behaves like the tail of a uniform record process.

Usage

```
robson1964(sd, alpha = 0.05)
```

Arguments

`sd`	A sighting_data object.
`alpha`	Significance level, in (0, 1). Not a coverage-calibrated CI here: it directly scales the extrapolated gap, following the original formula, so there is no `lower`/`upper` in the returned estimate.

Value

An ede_estimate object.

References

Robson, D. S., & Whitlock, J. H. (1964). Estimation of a truncation point. Biometrika, 51(1/2), 33-39.

`sighting_data` *Construct a validated sighting record*

Description

Builds the common input object used by every estimator in the package: a time-ordered table of sighting counts, checked for the conditions each estimator in the sighting-record literature assumes (numeric, non-negative, no duplicated times).

Usage

```
sighting_data(data, time_col = 1L, count_col = 2L)
```

Arguments

`data`	A data frame or matrix. By default the first column is read as time (e.g. year) and the second as the number of sightings recorded at that time.
`time_col, count_col`	Column name or position for time and sighting count.

Value

An object of class `sighting_data`: a data frame with columns `time` and `count`, sorted by time.

`solow1993` *Solow (1993) nonparametric persistence test*

Description

Nonparametric test of the null hypothesis that a species was still extant at a candidate test year, based on the ratio of the time since the last sighting to the total observation window, under a homogeneous sighting process.

Usage

```
solow1993(sd, alpha = 0.05, test_year, data_out = FALSE)
```

Arguments

`sd`	A sighting_data object.
`alpha`	Significance level, in (0, 1). Persistence is rejected for the first candidate year at which the chance of persistence falls to or below `alpha`.
`test_year`	Latest year to test. Must be supplied as a number.
`data_out`	If `TRUE`, return the full chance-of-persistence curve instead of the single first-rejection year.

Value

An ede_estimate object, or (if `data_out = TRUE`) a data frame with columns `time` and `chance`.

References

Solow, A. R. (1993). Inferring extinction from sighting data. Ecology, 74(3), 962-964.

solow1993b *Solow (1993b) declining-population persistence test*

Description

Nonparametric test of the null hypothesis that a declining species was still extant at a candidate test year, based on the ratio of Fisher's gap distribution for a non-stationary Poisson process with an exponential declining rate.

Usage

```
solow1993b(sd, alpha = 0.05, test_year, data_out = FALSE)
```

Arguments

sd	A sighting_data object.
alpha	Significance level, in (0, 1).
test_year	Latest year to test. Must be later than the last sighting.
data_out	If TRUE, return the full chance-of-persistence curve instead of the single first-rejection year.

Value

An ede_estimate object, or (if data_out = TRUE) a data frame with columns time and chance.

References

Solow, A. R. (1993b). Inferring extinction in a declining population. Journal of Mathematical Biology, 32(1), 79-82.

solow2005 *Solow (2005) sighting-effort-weighted persistence test*

Description

Parametric extension of solow1993() that weights the observation window by cumulative sighting effort (sighting count x time since first sighting) instead of raw elapsed time, giving a more realistic null model when sighting effort was not constant over the record.

Usage

```
solow2005(sd, alpha = 0.05, test_year, data_out = FALSE)
```

Arguments

sd	A sighting_data object.
alpha	Significance level, in (0, 1). Persistence is rejected for the first candidate year at which the chance of persistence falls to or below alpha.
test_year	Latest year to test. Must be supplied as a number.
data_out	If TRUE, return the full chance-of-persistence curve instead of the single first-rejection year.

Value

An ede_estimate object, or (if data_out = TRUE) a data frame with columns time and chance.

References

Solow, A. R. (2005). Inferring extinction from a sighting record. Mathematical Biosciences, 195(1), 47-55.

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strauss1989 *Strauss & Sadler (1989) confidence interval for the end of a range*

Description

Classical confidence interval for the true endpoint of a temporal range, derived from the distribution of the sample range under a uniform occurrence model. Originally developed for stratigraphic ranges, applied here to sighting records.

Usage

```
strauss1989(sd, alpha = 0.05)
```

Arguments

sd	A sighting_data object.
alpha	Significance level, in (0, 1).

Value

An ede_estimate object. Only upper is defined: the method gives a one-sided bound on how much later than the last sighting extinction could plausibly have occurred, not a point estimate with a two-sided interval.

References

Strauss, D., & Sadler, P. M. (1989). Classical confidence intervals and Bayesian probability estimates for ends of local taxon ranges. Mathematical Geology, 21(4), 411-427.

`strauss1989_curve` *Full confidence curve for the Strauss & Sadler (1989) estimator*

Description

Same estimator as `strauss1989()`, evaluated over a grid of alpha values from 0.01 to 1, for plotting the confidence curve instead of a single bound.

Usage

```
strauss1989_curve(sd)
```

Arguments

`sd`	A sighting_data object.

Value

A data frame with columns `time` and `chance` (1 - alpha).

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