Package 'hSSALT'

August 27, 2025

Type Package

Title Simple Heterogeneous Step Stress Accelerated Life Testing (hSSALT) Model

Version 0.1.0

Author Who wrote it

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Description This package offers a comprehensive framework for analyzing a simple heterogeneous step stress accelerated life testing (hSSALT) model, assuming the cumulative exposure (CE) model and heterogeneity with two subgroups under the second stress level for both continuous and interval monitoring. The supported life time distribution is the exponential distribution. The hSSALT model considers exponential lifetime distributions. For continuous monitoring, the package supports both Type-I and Type-II censoring, while for interval monitoring, it supports only Type-I censoring with equally spaced inspections. Additionally, the package can examine whether a dataset from an SSALT experiment justifies the implementation of an hSSALT model by a homogeneity test. However, only continuous monitoring under the exponential distribution is supported. The package includes four core functions and one example dataset.

License What license is it under?

Encoding UTF-8

LazyData true

RoxygenNote 7.3.2

Depends R (>= 3.5)

LinkingTo Rmpfr,
numDeriv,
parallel,
Rcpp,
RcppArmadillo,
BH

Imports Rmpfr,
numDeriv,
parallel,
Rcpp (>= 1.0.10),
RcppArmadillo (>= 0.12.2),
BH

R topics documented:

CIhSSALT   *Confidence Intervals for hSSALT*

Description

Provide interval estimation of a simple hSSALT model with exponential (continuous) or geometric (interval) distribution.

Usage

```
CIhSSALT(data, n, MLEhSSALT_Obj, censoring = 1, tau, r = NULL,
        monitoring = "continuous", delta = NULL, CImethod = "asymptotic",
        alpha = 0.05, B = 1000, maxit = 1000, tol = 1e-8, language = "CPP",
        parallel = FALSE, ncores = 2)
```

Arguments

data	sample, a vector. The given data should be a censored vector with observations less than or equal to n. When censoring type is 2, the length of data should be r.
n	sample size, a positive integer.
MLEhSSALT_Obj	an MLEhSSALT object, returned by MLEhSSALT().
censoring	1 for Type-I censoring or 2 for Type-II censoring. Default value is 1.
tau	If censoring type is 1, tau is a vector with length 2; if censoring type is 2, tau is a positive numeric value.
r	If censoring type is 2, r provides the pre-specified number of failures, a positive integer.
monitoring	"continuous" or "interval". Default value is "continuous". For interval monitoring, only equally spaced inspection is supported.
delta	if interval monitoring, interval length, a positive numeric value. Default value is NULL.
CImethod	"asymptotic", "percentile" or "bca" for asymptotic CIs, bootstrap percentile CIs and bootstrap bias-corrected and accelerated (BCa) bootstrap intervals. Default value is "asymptotic".
alpha	significance level. Default value is 0.05.
B	number of bootstrap repetitions, a positive integer, default value is 1000.
maxit	The maximum number of iterations allowed, a positive integer. Only for bootstrap methods. Default value is 1000.

`tol`	Tolerance limit for declaring algorithm convergence based on the change between two consecutive iterations. Only for bootstrap methods. Default value is `1e-8`.
`language`	`"R"` or `"CPP"`. Only for bootstrap methods. Default value is `"CPP"`.
`parallel`	support parallel computation, a logical value. Only for bootstrap methods. Default value is `FALSE`.
`ncores`	the number of cores that are used in parallelization, a positive integer.

Value

A `CIhSSALT` object that includes the type of returned CIs and the CIs for four parameters at a given significance level.

Examples

```
MLE <- MLEhSSALT(data = hSSALTdata$data, n = 35, censoring = 1, tau = c(8, 20),
        theta21 = 1, theta22 = 8, p = 0.4)
ci <- CIhSSALT(data = hSSALTdata$data, n = 35, MLEhSSALT = MLE, tau = c(8, 20))
```

---

hello	*Hello, World!*

Description

Prints 'Hello, world!'.

Usage

```
hello()
```

Examples

```
hello()
```

HomohSSALT	*Homogeneity test for hSSALT*

Description

Perform a homogeneity test under the second stress level `s2` of a simple hSSALT model with exponential (continuous) distribution.

Usage

```
HomohSSALT(data, n, censoring=1, tau, r, alpha = 0.05, M = 10000)
```

Arguments

data	sample, a vector. The given data should be a censored vector with observations less than or equal to `n`. When censoring type is 2, the length of `data` should be `r`.
n	sample size, a positive integer.
censoring	1 for Type-I censoring or 2 for Type-II censoring. Default value is 1.
tau	If censoring type is 1, `tau` is a vector with length 2; if censoring type is 2, `tau` is a positive numeric value.
r	If censoring type is 2, `r` provides the pre-specified number of failures, a positive integer.
alpha	significance level. Default value is 0.05.
M	number of simulations used to generate critical values, a positive integer. Default value is 10000.

Value

An `hSSALTtest` object containing a hypothesis test table that reports the test statistic, the simulated critical value at the given significance level, the alternative hypothesis, and the test decision.

Examples

```
test <- HomohSSALT(data = hSSALTdata$data, n = 35, tau = c(8, 20))
```

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hSSALTdata	*A simulated simple hSSALT dataset based on Balakrishnan, Xie & Kundu (2009)*

Description

A list of simulated complete data based on Balakrishnan, Xie & Kundu (2009) for a simple hSSALT model.

Usage

```
data(hSSALTdata)
```

Format

A list with 5 elements:

data A numeric vector containing the simulated failure times.

tau A numeric value indicating the switching point where the stress level increases from `s1` to `s2`.

n An integer specifying the sample size.

params The true parameter values used to generate the simulated data.

complete A logical value indicating whether the dataset is complete (i.e., without censoring).

Source

N. Balakrishnan, Q. Xie, D. Kundu. Exact inference for a simple step-stress model from the expo-
nential distribution under time constraint. Annals of the Institute of Statistical Mathematics, Vol.
61, pp. 251-274, 2009.

See Also

MLEhSSALT CIhSSALT HomohSSALT

Examples

```
data(hSSALTdata)
```

MLEhSSALT *Maximum Likelihood Estimation for hSSALT*

Description

Provide point estimation of a simple hSSALT model with exponential (continuous) or geometric
(interval) distribution.

Usage

```
MLEhSSALT(data, n, censoring = 1, tau, r = NULL, monitoring = "continuous",
         delta = NULL, theta21, theta22, p, maxit = 1000,
         tol = 1e-8, language = "CPP", parallel = FALSE, ncores = 2)
```

Arguments

data	sample, a vector. The given data should be a censored vector with observations less than or equal to n. When censoring type is 2, the length of data should be r.
n	sample size, a positive integer.
censoring	1 for Type-I censoring or 2 for Type-II censoring. Default value is 1.
tau	If censoring type is 1, tau is a vector with length 2; if censoring type is 2, tau is a positive numeric value.
r	If censoring type is 2, r provides the pre-specified number of failures, a positive integer.
monitoring	"continuous" or "interval". Default value is "continuous". For interval monitoring, only equally spaced inspection is supported.
delta	if interval monitoring, interval length, a positive numeric value. Default value is NULL.
theta21	initial value of theta21 for the EM algorithm, can be both a numeric value or a vector of values. For an initial-value vector, the (ultimate) value with the largest log-likelihood is returned as the MLE.
theta22	initial value of theta22 for the EM algorithm, can be both a numeric value or a vector of values.
p	initial value of mixture proportion p, can be both a numeric value or a vector of values.

maxit	The maximum number of iterations allowed, an integer. Default value is 1000.
tol	Tolerance limit for declaring algorithm convergence based on the change between two consecutive iterations. Default value is 1e-8.
language	"R" or "CPP". Only for bootstrap methods. Default value is "CPP".
parallel	support parallel computation for multiple initial values, a logical value. Default value is FALSE.
ncores	the number of cores that are used in parallelization, a positive integer.

See Also

[CIhSSALT](#)

Examples

```
mle <- MLEhSSALT(data = hSSALTdata$data, n = 35, censoring = 1, tau = c(8, 20),
        theta21 = 1, theta22 = 8, p = 0.4)
```

---

rhSSALT	*Simulate a simple hSSALT random dataset*

Description

Simulate a simple hSSALT random dataset with exponential (continuous) or geometric (interval) distribution.

Usage

```
rhSSALT(n, censoring = 1, tau, r = NULL, monitoring = "continuous",
        delta = NULL, theta1, theta21, theta22, p)
```

Arguments

n	sample size, an integer.
censoring	1 for Type-I censoring or 2 for Type-II censoring. Default value is 1.
tau	If censoring type is 1, tau is a vector with length 2; if censoring type is 2, tau is a positive numeric value.
r	If censoring type is 2, r provides the pre-specified number of failures, a positive integer.
monitoring	continuous or interval, default value is continuous. For interval monitoring, only equally spaced inspection is supported.
delta	if interval monitoring, interval length, a positive numeric value. Default value is NULL.
theta1	mean lifetime parameter in the exponential distribution under s1, a numeric value.
theta21	mean lifetime parameter in the exponential distribution of the first group under s2, a positive numeric value.
theta22	mean lifetime parameter in the exponential distribution of the second group under s2, a positive numeric value.
p	mixture proportion, a numeric value between 0 and 1.

Value

A list consisting of four sub-lists: censored sample, the observed number of censored failures under s1 and s2, complete sample, the observed number of failures under s1 and s2.

Examples

```
sample <- rhSSALT(n = 30, tau = c(5, 10), theta1 = 10, theta21 = 5,
        theta22 = 8, p = 0.4)
```

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