Package ‘cpsurvsim’

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Type Package

Title Simulating Survival Data from Change-Point Hazard Distributions

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Description Simulates time-to-event data with type I right censoring using two methods: the inverse CDF method and our proposed memoryless method. The latter method takes advantage of the memoryless property of survival and simulates a separate distribution between change-points. We include two parametric distributions: exponential and Weibull. Inverse CDF method draws on the work of Rainer Walke (2010), <https://www.demogr.mpg.de/papers/technicalreports/tr-2010-003.pdf>.

Depends R (>= 3.6.0)

License GPL (>= 3)

Encoding UTF-8

Imports plyr (>= 1.8.5), stats, Hmisc (>= 4.3.0), knitr (>= 1.27)

Suggests rmarkdown, testthat

RoxygenNote 7.1.2

VignetteBuilder knitr

URL https://github.com/camillejo/cpsurvsim

BugReports https://github.com/camillejo/cpsurvsim/issues

NeedsCompilation no

Repository CRAN

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cpsurvsim

cpsurvsim: Simulating Survival Data from Change-Point Hazard Distributions

Description

The cpsurvsim package simulates time-to-event data with type I right censoring using two methods: the inverse CDF method and a memoryless method (for more information on simulation methods, see the vignette). We include two parametric distributions: exponential and Weibull.

cpsurvsim functions

For the exponential distribution, the exp_icdf function simulates values from the inverse exponential distribution. exp_cdfsim and exp_memsim return time-to-event datasets simulated using the inverse CDF and memoryless methods respectively.

For the Weibull distribution, the weib_icdf function simulates values from the inverse Weibull distribution. weib_cdfsim and weib_memsim return time-to-event datasets simulated using the inverse CDF and memoryless methods respectively.

exp_cdfsim

Inverse CDF simulation for the exponential change-point hazard distribution

Description

exp_cdfsim simulates time-to-event data from the exponential change-point hazard distribution by implementing the inverse CDF method.

Usage

exp_cdfsim(n, endtime, theta, tau = NA)
**exp_icdf**

**Arguments**

- **n**: Sample size
- **endtime**: Maximum study time, point at which all participants are censored
- **theta**: Scale parameter $\theta$
- **tau**: Change-point(s) $\tau$

**Details**

This function simulates data for the exponential change-point hazard distribution with $K$ change-points by simulating values of the exponential distribution and substituting them into the inverse hazard function. This method applies Type I right censoring at the endtime specified by the user. This function allows for up to four change-points.

**Value**

Dataset with $n$ participants including a survival time and censoring indicator (0 = censored, 1 = event).

**Examples**

```r
nochangepoint <- exp_cdfsim(n = 10, endtime = 20, theta = 0.05)
onechangepoint <- exp_cdfsim(n = 10, endtime = 20,
  theta = c(0.05, 0.01), tau = 10)
twochangepoints <- exp_cdfsim(n = 10, endtime = 20,
  theta = c(0.05, 0.01, 0.05), tau = c(8, 12))
```

---

**exp_icdf**

*Inverse CDF for the exponential distribution*

**Description**

exp_icdf simulates values from the inverse CDF of the exponential distribution.

**Usage**

`exp_icdf(n, theta)`

**Arguments**

- **n**: Number of output exponential values
- **theta**: Scale parameter $\theta$
Details

This function uses the exponential distribution of the form

\[ f(t) = \theta \exp(-\theta t) \]

to get the inverse CDF

\[ F^{-1}(u) = \left(-\log(1-u)\right)/\theta \]

where \( u \) is a uniform random variable. It can be implemented directly and is also called by the function `exp_memsim`.

Value

Output is a value or a vector of values from the exponential distribution.

Examples

```r
simdta <- exp_icdf(n = 10, theta = 0.05)
```

exp_memsim

Memoryless simulation for the exponential change-point hazard distribution

Description

`exp_memsim` simulates time-to-event data from the exponential change-point hazard distribution by implementing the memoryless method.

Usage

```r
exp_memsim(n, endtime, theta, tau = NA)
```

Arguments

- `n` Sample size
- `endtime` Maximum study time, point at which all participants are censored
- `theta` Scale parameter \( \theta \)
- `tau` Change-point(s) \( \tau \)

Details

This function simulates time-to-event data between \( K \) change-points from independent exponential distributions using the inverse CDF implemented in `exp_icdf`. This method applies Type I right censoring at the endtime specified by the user.
weib_cdfs

Value

Dataset with n participants including a survival time and censoring indicator (0 = censored, 1 = event).

Examples

nochangepoint <- exp_memsim(n = 10, endtime = 20, theta = 0.05)
onechangepoint <- exp_memsim(n = 10, endtime = 20,
  theta = c(0.05, 0.01), tau = 10)
twochangepoints <- exp_memsim(n = 10, endtime = 20,
  theta = c(0.05, 0.01, 0.05), tau = c(8, 12))

weib_cdfs

Inverse CDF simulation for the Weibull change-point hazard distribution

Description

weib_cdfs simulates time-to-event data from the Weibull change-point hazard distribution by implementing the inverse CDF method.

Usage

weib_cdfs(n, endtime, gamma, theta, tau = NA)

Arguments

n        Sample size
endtime  Maximum study time, point at which all participants are censored
gamma   Shape parameter $\gamma$
theta   Scale parameter $\theta$
tau     Change-point(s) $\tau$

Details

This function simulates data from the Weibull change-point hazard distribution with $K$ change-points by simulating values of the exponential distribution and substituting them into the inverse hazard function. This method applies Type I right censoring at the endtime specified by the user. This function allows for up to four change-points and $\gamma$ is held constant.

Value

Dataset with n participants including a survival time and censoring indicator (0 = censored, 1 = event).
weib_icdf

Inverse CDF value generation for the Weibull distribution

Examples

nochangepoint <- weib_cdfsim(n = 10, endtime = 20, gamma = 2, theta = 0.5)
onechangepoint <- weib_cdfsim(n = 10, endtime = 20, gamma = 2, theta = c(0.05, 0.01), tau = 10)
twochangepoints <- weib_cdfsim(n = 10, endtime = 20, gamma = 2, theta = c(0.05, 0.01, 0.05), tau = c(8, 12))

weib_icdf

Weibull distribution

Description

weib_icdf returns a value from the Weibull distribution by using the inverse CDF.

Usage

weib_icdf(n, gamma, theta)

Arguments

- n: Number of output Weibull values
- gamma: Shape parameter \( \gamma \)
- theta: Scale parameter \( \theta \)

Details

This function uses the Weibull density of the form

\[
f(t) = \theta t^{\gamma - 1} \exp(-\theta / \gamma t^\gamma)
\]

to get the inverse CDF

\[
F^{-1}(u) = (-\gamma / \theta \log(1 - u))^{1/\gamma}
\]

where \( u \) is a uniform random variable. It can be implemented directly and is also called by the function weib_memsim.

Value

Output is a value or vector of values from the Weibull distribution.

Examples

simdta <- weib_icdf(n = 10, theta = 0.05, gamma = 2)
weib_memsim

Memoryless simulation for the Weibull change-point hazard distribution

Description

weib_memsim simulates time-to-event data from the Weibull change-point hazard distribution by implementing the memoryless method.

Usage

weib_memsim(n, endtime, gamma, theta, tau = NA)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>Sample size</td>
</tr>
<tr>
<td>endtime</td>
<td>Maximum study time, point at which all participants are censored</td>
</tr>
<tr>
<td>gamma</td>
<td>Shape parameter $\gamma$</td>
</tr>
<tr>
<td>theta</td>
<td>Scale parameter $\theta$</td>
</tr>
<tr>
<td>tau</td>
<td>Change-point(s) $\tau$</td>
</tr>
</tbody>
</table>

Details

This function simulates time-to-event data between $K$ change-points $\tau$ from independent Weibull distributions using the inverse Weibull CDF implemented in `weib_icdf`. This method applies Type I right censoring at the endtime specified by the user. $\gamma$ is held constant.

Value

Dataset with n participants including a survival time and censoring indicator (0 = censored, 1 = event).

Examples

```r
nochangepoint <- weib_memsim(n = 10, endtime = 20, gamma = 2, theta = 0.05)
onechangepoint <- weib_memsim(n = 10, endtime = 20, gamma = 2, theta = c(0.05, 0.01), tau = 10)
twochangepoints <- weib_memsim(n = 10, endtime = 20, gamma = 2, theta = c(0.05, 0.01, 0.05), tau = c(8, 12))
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