Package ‘cpsurvsim’

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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>.

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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

\[ f(t) = \theta e^{-\theta t} \]

To get the inverse CDF

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

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
simdata <- 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_cdfsim

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_cdfsim

Inverse CDF simulation for the Weibull change-point hazard distribution

Description

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

Usage

weib_cdfsim(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).
Examples

```r
nochangepoint <- weib_cdfsim(n = 10, endtime = 20, gamma = 2, 
    theta = 0.5)
oonechangepoint <- 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

Inverse CDF value generation for the Weibull distribution

Description

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

Usage

```r
weib_icdf(n, gamma, theta)
```

Arguments

- `n` Number of output Weibull values
- `gamma` Shape parameter γ
- `theta` Scale parameter θ

Details

This function uses the Weibull density of the form

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

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

```r
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

- **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 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 ($0 = \text{censored}, \ 1 = \text{event}$).

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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