# Package 'cpsurvsim'

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**Type** Package

**Title** Simulating Survival Data from Change-Point Hazard Distributions

**Version** 1.2.1

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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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# R topics documented:



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`cpsurvsim` *cpsurvsim: Simulating Survival Data from Change-Point Hazard Distributions*

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## 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.

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`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)
```

### 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

```
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

$$F^{(}-1)(u) = (-log(1-u))/\theta$$

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

```
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

```
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.

## 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))
```

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`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

```
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))
```

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# 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

```
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

| | |
|---|---|
| `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 = censored, 1 = event).

## Examples

```
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))
```

# Index