Package 'ReliaGrowR'

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Title Reliability Growth Analysis

Version 0.2

Description Modeling and plotting functions for Reliability Growth Analysis (RGA). Models include the Duane (1962) <doi:10.1109/TA.1964.4319640>, Non-Homogeneous Poisson Process (NHPP) by Crow (1975) <https://apps.dtic.mil/sti/citations/ADA020296>, Piecewise Weibull NHPP by Guo et al. (2010) <doi:10.1109/RAMS.2010.5448029>, and Piecewise Weibull NHPP with Change Point Detection based on the 'segmented' package by Muggeo (2024) <https://cran.r-project.org/package=segmented>.

Imports stats, graphics, segmented

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Encoding UTF-8

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Language en-US

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BugReports https://github.com/paulgovan/ReliaGrowR/issues

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duane *Duane Analysis*

Description

This function performs a Duane analysis (1962) doi:10.1109/TA.1964.4319640 on failure data by fitting a log-log linear regression of cumulative MTBF versus cumulative time.

Usage

```
duane(times, failures, conf.level = 0.95)
```

Arguments

`times`	A numeric vector of cumulative failure times.
`failures`	A numeric vector of the number of failures at each corresponding time in `times`.
`conf.level`	Confidence level for the confidence bounds (default: `0.95`).

Value

A list of class `"duane"` containing:

`model`	The fitted `lm` object.
`logLik`	The log-likelihood of the fitted model.
`AIC`	Akaike Information Criterion.
`BIC`	Bayesian Information Criterion.
`conf.level`	The confidence level.
`Cumulative_Time`	The cumulative operating times.
`Cumulative_MTBF`	The cumulative mean time between failures.

`Fitted_Values` The fitted values on the MTBF scale.

`Confidence_Bounds`
Matrix of fitted values and confidence bounds on the MTBF scale.

See Also

Other Duane functions: `plot.duane()`, `print.duane()`

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
fit <- duane(times, failures, conf.level = 0.90)
print(fit)
```

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plot.duane *Plot Method for Duane Analysis*

Description

Generates a Duane plot (log-log or linear scale) with fitted regression line and optional confidence bounds.

Usage

```
## S3 method for class 'duane'
plot(
  x,
  log = TRUE,
  conf.int = TRUE,
  legend = TRUE,
  legend.pos = "topleft",
  ...
)
```

Arguments

`x`	An object of class `"duane"`.
`log`	Logical; whether to use logarithmic scales for axes (default: `TRUE`).
`conf.int`	Logical; whether to plot confidence bounds (default: `TRUE`).
`legend`	Logical; whether to include a legend (default: TRUE).
`legend.pos`	Position of the legend (default: "topleft").
`...`	Further arguments passed to `plot()`.

Value

Invisibly returns NULL.

See Also

Other Duane functions: duane(), print.duane()

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
fit <- duane(times, failures)
plot(fit, main = "Duane Plot", xlab = "Cumulative Time", ylab = "Cumulative MTBF")
```

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plot.rga *Plot Method for RGA Objects*

Description

This function generates plots for objects of class rga.

Usage

```
## S3 method for class 'rga'
plot(
  x,
  conf_bounds = TRUE,
  legend = TRUE,
  log = FALSE,
  legend_pos = "bottomright",
  ...
)
```

Arguments

x	An object of class rga, which contains the results from the RGA model.
conf_bounds	Logical; include confidence bounds (default: TRUE).
legend	Logical; show the legend (default: TRUE).
log	Logical; use a log-log scale (default: FALSE).
legend_pos	Position of the legend (default: "bottomright").
...	Additional arguments passed to plot().

Value

Invisibly returns NULL.

See Also

Other Reliability Growth Analysis: `print.rga()`, `rga()`

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
result <- rga(times, failures)
plot(result, main = "Reliability Growth Analysis",
xlab = "Cumulative Time", ylab = "Cumulative Failures")
```

`ppplot.rga` *P-P Plot for RGA Objects*

Description

This function creates a P-P plot for a fitted Reliability Growth Analysis (RGA) model Currently only supports the Crow-AMSAA model.

Usage

```
ppplot.rga(x, main = "P-P Plot", ...)
```

Arguments

`x`	An object of class `rga`.
`main`	Title of the plot.
`...`	Additional arguments passed to `plot()`.

Value

A P-P plot comparing empirical and theoretical CDFs.

See Also

Other goodness-of-fit: `qqplot.rga()`

Examples

```
times <- c(5, 10, 15, 20, 25)
failures <- c(1, 2, 1, 3, 2)
fit <- rga(times, failures)
ppplot.rga(fit)
```

print.duane *Print method for duane objects.*

Description

This function prints a summary of the Duane analysis result.

Usage

```
## S3 method for class 'duane'
print(x, ...)
```

Arguments

x	An object of class "duane" returned by the duane_plot function.
...	Additional arguments (not used).

Value

Invisibly returns the input object.

See Also

Other Duane functions: duane(), plot.duane()

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
fit <- duane(times, failures)
print(fit)
```

print.rdt *Print method for rdt objects*

Description

This function provides a formatted print method for objects of class rdt.

Usage

```
## S3 method for class 'rdt'
print(x, ...)
```

Arguments

x	An object of class rdt.
...	Additional arguments (not used).

Value

Invisibly returns the input object.

Examples

```
plan <- rdt(target=0.9, mission_time=1000, conf_level=0.9, beta=1, n=10)
print(plan)
```

---

print.rga *Print method for rga objects.*

Description

Print method for rga objects.

Usage

```
## S3 method for class 'rga'
print(x, ...)
```

Arguments

x	An object of class rga, which contains the results from the RGA model.
...	Additional arguments (not used).

Value

Invisibly returns the input object.

See Also

Other Reliability Growth Analysis: plot.rga(), rga()

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
result <- rga(times, failures)
print(result)
```

qqplot.rga *Q-Q Plot for RGA Objects*

Description

This function creates a Q-Q plot for a fitted Reliability Growth Analysis (RGA) model Currently only supports the Crow-AMSAA model.

Usage

```
qqplot.rga(x, main = "Q-Q Plot", ...)
```

Arguments

x	An object of class rga.
main	Title of the plot.
...	Additional arguments passed to stats::qqplot().

Value

A Q-Q plot comparing empirical and theoretical quantiles.

See Also

Other goodness-of-fit: pppplot.rga()

Examples

```
times <- c(5, 10, 15, 20, 25)
failures <- c(1, 2, 1, 3, 2)
fit <- rga(times, failures)
qqplot.rga(fit)
```

rdt *Reliability Demonstration Test (RDT) Plan Calculator*

Description

This function calculates the required test time or sample size for a Reliability Demonstration Test (RDT) based on specified reliability, mission time, confidence level, and Weibull shape parameter.

Usage

```
rdt(target, mission_time, conf_level, beta = 1, n = NULL, test_time = NULL)
```

Arguments

target	Required reliability at mission time (0 < target < 1).
mission_time	Mission duration (time units).
conf_level	Desired confidence level (e.g., 0.9 for 90% confidence).
beta	Weibull shape parameter (beta=1 corresponds to exponential distribution).
n	Sample size (optional, supply if solving for test_time).
test_time	Test time per unit (optional, supply if solving for n).

Value

The function returns an object of class rdt that contains:

Distribution	Type of distribution used (Exponential or Weibull).
Beta	Weibull shape parameter.
Target_Reliability	Specified target reliability.
Mission_Time	Specified mission time.
Required_Test_Time	Calculated required test time (if n is provided).
Input_Sample_Size	Provided sample size (if test_time is calculated).
Required_Sample_Size	Calculated required sample size (if test_time is provided).
Input_Test_Time	Provided test time (if n is calculated).

Examples

```
#' # Example 1: Calculate required test time
plan1 <- rdt(target=0.9, mission_time=1000, conf_level=0.9, beta=1, n=10)
print(plan1)
# Example 2: Calculate required sample size
plan2 <- rdt(target=0.9, mission_time=1000, conf_level=0.9, beta=1, test_time=2000)
print(plan2)
```

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rga *Reliability Growth Analysis.*

Description

This function performs reliability growth analysis using the Crow-AMSAA model by Crow (1975) https://apps.dtic.mil/sti/citations/ADA020296 or piecewise NHPP model by Guo et al. (2010) doi:10.1109/RAMS.2010.5448029.

Usage

```
rga(
  times,
  failures,
  model_type = "Crow-AMSAA",
  breaks = NULL,
  conf_level = 0.95
)
```

Arguments

times	A vector of cumulative failure times.
failures	A vector of the number of failures at each corresponding time in times.
model_type	The model type. Either Crow-AMSAA (default) or Piecewise NHPP with change point detection.
breaks	An optional vector of breakpoints for the Piecewise NHPP model.
conf_level	The desired confidence level, which defaults to 95%.

Value

The function returns an object of class rga that contains:

model	The fitted model object (lm or segmented).
logLik	The log-likelihood of the fitted model.
AIC	Akaike Information Criterion.
BIC	Bayesian Information Criterion.
breakpoints	Breakpoints (log scale) if applicable.
fitted_values	Fitted cumulative failures on the original scale.
lower_bounds	Lower confidence bounds (original scale).
upper_bounds	Upper confidence bounds (original scale).
betas	Estimated beta(s).
lambdas	Estimated lambda(s).

See Also

Other Reliability Growth Analysis: plot.rga(), print.rga()

Examples

```
times <- c(100, 200, 300, 400, 500)
failures <- c(1, 2, 1, 3, 2)
result <- rga(times, failures)
print(result)
```

`weibull_to_rga` *Weibull to RGA*

Description

Converts Weibull data (failure, suspension, and interval-censored times) into a format suitable for reliability growth analysis (RGA).

Usage

```
weibull_to_rga(
  failures,
  suspensions = NULL,
  interval_starts = NULL,
  interval_ends = NULL
)
```

Arguments

`failures`	A numeric vector of exact failure times.
`suspensions`	A numeric vector of suspension (right-censored) times.
`interval_starts`	A numeric vector of interval start times (lower bound of censoring).
`interval_ends`	A numeric vector of interval end times (upper bound of censoring).

Value

A data frame with cumulative time and failure counts suitable for RGA.

Examples

```
failures <- c(100, 200, 200, 400)
suspensions <- c(250, 350, 450)
interval_starts <- c(150, 300)
interval_ends <- c(180, 320)
result <- weibull_to_rga(failures, suspensions, interval_starts, interval_ends)
print(result)
```

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