

RELDISTS: A COMPREHENSIVE R PACKAGE FOR RELIABILITY ANALYSIS AND DISTRIBUTION MODELING

RelDists: A Comprehensive R Package for Reliability Analysis and Distribution Modeling

Palabras clave: reliability, gamlss, regression model

Abstract

The RelDists package was created to facilitate the implementation of novel distributions introduced in the field of reliability analysis. This comprehensive package equips users with functions that enable the estimation of distribution parameters, regression models, and access to essential functions such as the probability density function (pdf), cumulative distribution function (cdf), hazard function (hf), quantile function (qf), and reliability function (rf). This package proves to be an invaluable resource for researchers and practitioners in the field, providing a streamlined approach to distribution modeling and reliability analysis.

Package RelDists

We developed the RelDists package in the language programming R to implement new distributions proposed in the reliability field. With the functions in the RelDists package, the user could estimate the distribution parameters, estimate effects for the regression model, and obtain the pdf, cdf, hf, qf and rf for the distribution. The package also provides useful tools commonly used in the reliability field, such as parameter estimation, graphic analysis, and regression analysis. The online documentation of the package can be consulted in the url <https://cran.r-project.org/web/packages/RelDists/index.html>.

Distribution functions

The functions implemented in RelDists package for the Reflected Weibull (RW) distributions, for example, are:

- Probability density function: `dRW(y, mu, sigma)`
- Cumulative density function: `pRW(q, mu, sigma)`
- Hazard function: `hRW(y, mu, sigma)`
- Quantile function: `qRW(p, mu, sigma)`
- Random function: `rRW(n, mu, sigma)`
- Reflected Weibull family: `RW(mu.link="log", sigma.link="log")`

The probability density function `dRW(y, mu, sigma)` allows the user to draw the probability density curve and identify the area in which the random variable Y is most likely to take values. In practice, the cumulative density function `pRW(q, mu, sigma)` allows the user to obtain the probability that the random variable is less than or equal to a specific value. The quantile function `qRW(p, mu, sigma)` is useful for identifying specific quantiles, for example, the 0.25, 0.50, and 0.75 quartiles. In the case of $Y \sim RW(\mu = 1, \sigma = 3)$, the median is obtained as follow: `qRW(p=0.5, mu=1, sigma=3)`. In practice, the random function `rRW(n, mu, sigma)` can be used to generate random samples from the RW distribution for creating simulation scenarios to validate something of interest in RW the distribution. For example, for the $Y \sim RW(\mu = 1, \sigma = 3)$ we can generate ten random numbers as follows: `rRW(n=10, mu=1, sigma=3)`.

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Regression model with gamlss framework

Finally, the family function `RW(mu.link="log", sigma.link="log")` is used in the fitting procedure to estimate the parameters for the RW distribution and the regression coefficients for the RW model. For example, if a user has a random sample stored in a vector called `ransam`, the code to estimate the parameters for the RW distribution is as follows:

```
fit <- gamlss(ransam ~ 1, family=RW)
coef(fit)
```

The RelDists package uses three methods for parameter estimation provided by GAMLSS models. The method is specified in the argument called `method`, with default `method=RS()`. The user may specify `method=CG()`, or a combination of both algorithms with `method=mixed()`. In the case of the RelDists distributions, it is recommended to use the CG method because the cross derivatives are calculated manually, offering less computation time to fit the models.