




univariateML: An R package for maximum likelihood estimation of univariate densities

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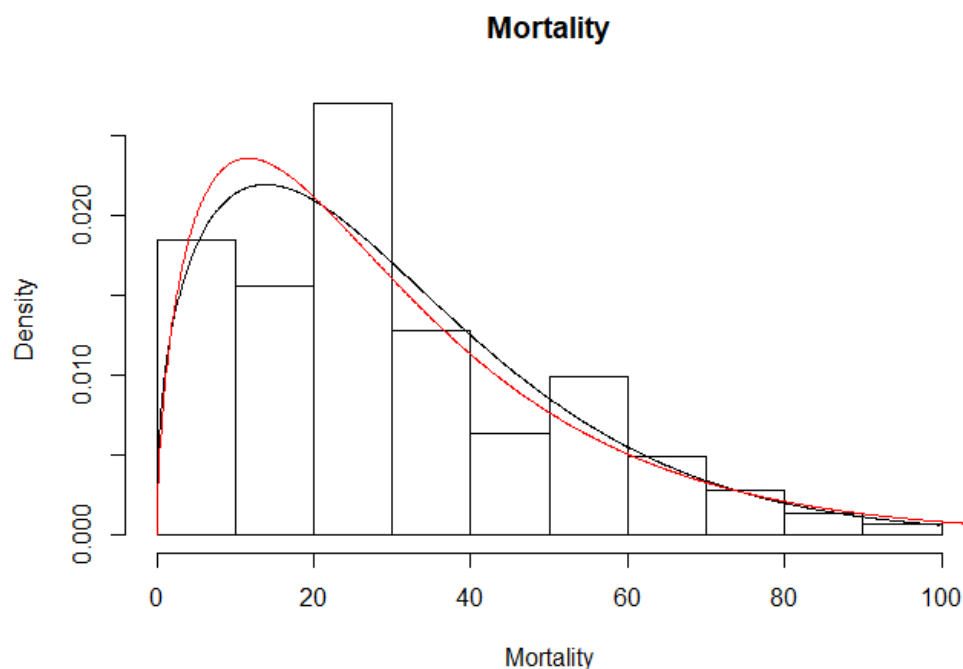
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Summary

univariateML is an R (R Core Team, 2019) package for user-friendly univariate maximum likelihood estimation (Cam, 1990). It supports more than 20 densities, the most popular generic functions such as `plot`, `AIC`, and `confint`, and a simple parametric bootstrap (Efron & Tibshirani, 1994) interface.

When looking at univariate data it is natural to ask if there is a known parametric density that fits the data well. The following example uses the `egypt` (Pearson, 1902) data set included in the package and a plot of the Weibull and Gamma densities (Johnson, Kotz, & Balakrishnan, 1995, Chapter 17 & 21).

```
# install.packages("univariateML")
library("univariateML")
hist(egypt$age, freq = FALSE, main = "Mortality", xlab = "Mortality")
lines(mlweibull(egypt$age)) # Plots a Weibull fit.
lines(mlgamma(egypt$age), col = "red") # Plots a Gamma fit.
```



A natural question to ask is which among several models fits the data best. This can be done using tools of model selection such as the AIC (Akaike, 1998).

```
AIC(mlweibull(egypt$age),  
    mlgamma(egypt$age))
```

```
##                df      AIC  
## mlweibull(egypt$age)  2 1230.229  
## mlgamma(egypt$age)   2 1234.772
```

Problems involving estimation of univariate densities are common in statistics. Estimation of univariate densities is used in for instance exploratory data analysis, in the estimation of copulas (Ko, Hjort, & Hobæk Haff, 2019), as parametric starts in density estimation (Hjort & Glad, 1995; Moss & Tveten, 2019), and is of interest in and of itself.

Analytic formulas for the maximum likelihood estimates are used whenever they exist. Most estimators without analytic solutions have a custom made Newton-Raphson solver. This is in contrast to the `mle` function in the built-in R package `stats4`, which supports more general maximum likelihood estimation through numerical optimization on a supplied negative log-likelihood function.

`Rfast` (Papadakis et al., 2019) is an R package with fast Newton-Raphson implementations of many univariate density estimators. `univariateML` differs from `Rfast` mainly in focus: While `univariateML` is focused on user-friendly univariate density estimation, `Rfast` aims to have the fastest possible implementations of many kinds of functions.

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