Package ‘logspline’

April 25, 2022

Version 2.1.17
Date 2022-04-24
Maintainer Charles Kooperberg <clk@fredhutch.org>
Title Routines for Logspline Density Estimation
Description Contains routines for logspline density estimation. The function oldlogspline() uses the same algorithm as the logspline package version 1.0.x; i.e. the Kooperberg and Stone (1992) algorithm (with an improved interface). The recommended routine logspline() uses an algorithm from Stone et al (1997) <DOI:10.1214/aos/1031594728>.
Imports stats, graphics
License Apache License 2.0
NeedsCompilation yes
Author Charles Kooperberg [aut, cre], Cleve Moler [ctb] (LINPACK routines in src), Jack Dongarra [ctb] (LINPACK routines in src)
Repository CRAN
Date/Publication 2022-04-25 07:30:02 UTC

R topics documented:

  dlogspline ............................................ 2
  doldlogspline ....................................... 3
  logspline ........................................... 4
  oldlogspline ......................................... 7
  oldlogspline.to/logspline .......................... 9
  plot.logspline ...................................... 10
  plot.oldlogspline .................................. 12
  summary.logspline .................................. 13
  summary.oldlogspline ............................... 14
  unstrip .............................................. 15

Index 17
Description

Density (dlogspline), cumulative probability (plogspline), quantiles (qlogspline), and random samples (rlogspline) from a logspline density that was fitted using the 1997 knot addition and deletion algorithm (logspline). The 1992 algorithm is available using the oldlogspline function.

Usage

dlogspline(q, fit)
plogspline(q, fit)
qlogspline(p, fit)
rlogspline(n, fit)

Arguments

q  vector of quantiles. Missing values (NAs) are allowed.
p  vector of probabilities. Missing values (NAs) are allowed.
n  sample size. If length(n) is larger than 1, then length(n) random values are returned.
fit  logspline object, typically the result of logspline.

Details

Elements of q or p that are missing will cause the corresponding elements of the result to be missing.

Value

Densities (dlogspline), probabilities (plogspline), quantiles (qlogspline), or a random sample (rlogspline) from a logspline density that was fitted using knot addition and deletion.

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


doldlogspline

See Also

logspline, plot.logspline, summary.logspline, oldlogspline.

Examples

x <- rnorm(100)
fit <- logspline(x)
qq <- qlogspline((1:99)/100, fit)
plot(qnorm((1:99)/100), qq)  # qq plot of the fitted density
pp <- plogspline((-250:250)/100, fit)
plot((-250:250)/100, pp, type = "l")
lines((-250:250)/100, pnorm((-250:250)/100))  # assess the fit of the distribution
dd <- dlogspline((-250:250)/100, fit)
plot((-250:250)/100, dd, type = "l")
lines((-250:250)/100, dnorm((-250:250)/100))  # assess the fit of the density
rr <- rlogspline(100, fit)  # random sample from fit

Description

Probability density function (doldlogspline), distribution function (poldlogspline), quantiles (qoldlogspline), and random samples (roldlogspline) from a logspline density that was fitted using the 1992 knot deletion algorithm (oldlogspline). The 1997 algorithm using knot deletion and addition is available using the logspline function.

Usage

doldlogspline(q, fit)
poldlogspline(q, fit)
qoldlogspline(p, fit)
roldlogspline(n, fit)

Arguments

q vector of quantiles. Missing values (NAs) are allowed.
p vector of probabilities. Missing values (NAs) are allowed.
n sample size. If length(n) is larger than 1, then length(n) random values are returned.
fit oldlogspline object, typically the result of oldlogspline.

Details

Elements of q or p that are missing will cause the corresponding elements of the result to be missing.
Value

Densities (doldlogspline), probabilities (poldlogspline), quantiles (qoldlogspline), or a random sample (roldlogspline) from an oldlogspline density that was fitted using knot deletion.

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

logspline, oldlogspline, plot.oldlogspline, summary.oldlogspline

Examples

```r
x <- rnorm(100)
fit <- oldlogspline(x)
qq <- qoldlogspline((1:99)/100, fit)
plot(qnorm((1:99)/100), qq) # qq plot of the fitted density
pp <- poldlogspline((-250:250)/100, fit)
plot((-250:250)/100, pp, type = "l")
lines((-250:250)/100, pnorm((-250:250)/100)) # asses the fit of the distribution
dd <- doldlogspline((-250:250)/100, fit)
plot((-250:250)/100, dd, type = "l")
lines((-250:250)/100, dnorm((-250:250)/100)) # asses the fit of the density
rr <- roldlogspline(100, fit) # random sample from fit
```

Description

Fits a logspline density using splines to approximate the log-density using the 1997 knot addition and deletion algorithm (logspline). The 1992 algorithm is available using the oldlogspline function.

Usage

```r
logspline(x, lbound, ubound, maxknots = 0, knots, nknots = 0, penalty, silent = TRUE, mind = -1, error.action = 2)
```
Arguments

\textbf{\texttt{x}} \quad \text{data vector. The data needs to be uncensored. \texttt{oldlogspline} can deal with right- left- and interval-censored data.}

\textbf{\texttt{lbound, ubound}} \quad \text{lower/upper bound for the support of the density. For example, if there is a priori knowledge that the density equals zero to the left of 0, and has a discontinuity at 0, the user could specify \texttt{lbound = 0}. However, if the density is essentially zero near 0, one does not need to specify \texttt{lbound}.}

\textbf{\texttt{maxknots}} \quad \text{the maximum number of knots. The routine stops adding knots when this number of knots is reached. The method has an automatic rule for selecting \texttt{maxknots} if this parameter is not specified.}

\textbf{\texttt{knots}} \quad \text{ordered vector of values (that should cover the complete range of the observations), which forces the method to start with these knots. Overrules \texttt{knots}. If \texttt{knots} is not specified, a default knot-placement rule is employed.}

\textbf{\texttt{nknots}} \quad \text{forces the method to start with \texttt{nknots} knots. The method has an automatic rule for selecting \texttt{nknots} if this parameter is not specified.}

\textbf{\texttt{penalty}} \quad \text{the parameter to be used in the AIC criterion. The method chooses the number of knots that minimizes \(-2 \times \text{loglikelihood} + \text{penalty} \times (\text{number of knots} - 1)\). The default is to use a penalty parameter of \texttt{penalty = log(samplesize)} as in BIC. The effect of this parameter is summarized in \texttt{summary.logspline}.}

\textbf{\texttt{silent}} \quad \text{should diagnostic output be printed?}

\textbf{\texttt{mind}} \quad \text{minimum distance, in order statistics, between knots.}

\textbf{\texttt{error.action}} \quad \text{how should \texttt{logspline} deal with non-convergence problems? Very-very rarely in some extreme situations \texttt{logspline} has convergence problems. The only two situations that I am aware of are when there is effectively a sharp bound, but this bound was not specified, or when the data is severely rounded. \texttt{logspline} can deal with this in three ways. If \texttt{error.action} is 2, the same data is re-run with the slightly more stable, but less flexible \texttt{oldlogspline}. The object is translated in a \texttt{logspline} object using \texttt{oldlogspline.to.logspline}, so this is almost invisible to the user. It is particularly useful when you run simulation studies, as the code can seamlessly continue. Only the \texttt{lbound} and \texttt{ubound} options are passed on to \texttt{oldlogspline}, other options revert to the default. If \texttt{error.action} is 1, a warning is printed, and \texttt{logspline} returns nothing (but does not crash). This is useful if you run a simulation, but do not like to revert to \texttt{oldlogspline}. If \texttt{error.action} is 0, the code crashes using the \texttt{stop} function.}

Value

Object of the class \texttt{logspline}, that is intended as input for \texttt{plot.logspline} (summary plots), \texttt{summary.logspline} (fitting summary), \texttt{dlogspline} (densities), \texttt{plogspline} (probabilities), \texttt{qlogspline} (quantiles), \texttt{rlogspline} (random numbers from the fitted distribution).

The object has the following members:

\textbf{\texttt{call}} \quad \text{the command that was executed.}

\textbf{\texttt{nknots}} \quad \text{the number of knots in the model that was selected.}
coef.pol

coefficients of the polynomial part of the spline. The first coefficient is the constant term and the second is the linear term.

coeff.kts

coefficients of the knots part of the spline. The k-th element is the coefficient of 
\((x - t(k))^3\) (where \(x^+\) means the positive part of the third power of \(x\), and \(t(k)\) means knot \(k\)).

knots

vector of the locations of the knots in the logspline model.

maxknots

the largest number of knots minus one considered during fitting (i.e. with \(\text{maxknots} = 6\) the maximum number of knots is 5).

penalty

the penalty that was used.

bound

first element: 0 - \(\text{lbound}\) was \(-\infty\) it was something else; second element: \(\text{lbound}\), if specified; third element: 0 - \(\text{ubound}\) was \(\infty\), 1 it was something else; fourth element: \(\text{ubound}\), if specified.

samples

the sample size.

logl

matrix with 3 columns. Column one: number of knots; column two: model fitted during addition (1) or deletion (2); column 3: log-likelihood.

range

range of the input data.

mind

minimum distance in order statistics between knots required during fitting (the actual minimum distance may be much larger).

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

plot.logspline, summary.logspline, dlogspline, plogspline, qlogspline, rlogspline, oldlogspline, oldlogspline.to.logspline.

Examples

```r
y <- rnorm(100)
fit <- logspline(y)
plot(fit)
# # as (4 == length(-2, -1, 0, 1, 2) -1), this forces these initial knots, # and does no knot selection
fit <- logspline(y, knots = c(-2, -1, 0, 1, 2), maxknots = 4, penalty = 0)
# # the following example give one of the rare examples where logspline
```r
# crashes, and this shows the use of error.action = 2.
#
set.seed(118)
zz <- rnorm(300)
zz <- round(zz)
fit <- logspline(zz)

# # you could rerun this with
# fit <- logspline(zz, error.action = 0)
# or
# fit <- logspline(zz, error.action = 1)
```

---

**oldlogspline**  
*Logspline Density Estimation - 1992 version*

**Description**

Fits a logspline density using splines to approximate the log-density using the 1992 knot deletion algorithm (*oldlogspline*). The 1997 algorithm using knot deletion and addition is available using the *logspline* function.

**Usage**

```r
oldlogspline(uncensored, right, left, interval, lbound, ubound, nknots, knots, penalty, delete = TRUE)
```

**Arguments**

- **uncensored** vector of uncensored observations from the distribution whose density is to be estimated. If there are no uncensored observations, this argument can be omitted. However, either uncensored or interval must be specified.
- **right** vector of right censored observations from the distribution whose density is to be estimated. If there are no right censored observations, this argument can be omitted.
- **left** vector of left censored observations from the distribution whose density is to be estimated. If there are no left censored observations, this argument can be omitted.
- **interval** two column matrix of lower and upper bounds of observations that are interval censored from the distribution whose density is to be estimated. If there are no interval censored observations, this argument can be omitted.
- **lbound, ubound** lower/upper bound for the support of the density. For example, if there is a priori knowledge that the density equals zero to the left of 0, and has a discontinuity at 0, the user could specify lbound = 0. However, if the density is essentially zero near 0, one does not need to specify lbound. The default for lbound is `-inf` and the default for ubound is `inf`. 
nknots forces the method to start with nknots knots (delete = TRUE) or to fit a density with nknots knots (delete = FALSE). The method has an automatic rule for selecting nknots if this parameter is not specified.

knots ordered vector of values (that should cover the complete range of the observations), which forces the method to start with these knots (delete = TRUE) or to fit a density with these knots delete = FALSE). Overrules nknots. If knots is not specified, a default knot-placement rule is employed.

penalty the parameter to be used in the AIC criterion. The method chooses the number of knots that minimizes $-2 \times \text{loglikelihood} + \text{penalty} \times (\text{number of knots} - 1)$. The default is to use a penalty parameter of penalty = log(samplesize) as in BIC. The effect of this parameter is summarized in summary.oldlogspline.

delete should stepwise knot deletion be employed?

Value

Object of the class oldlogspline, that is intended as input for plot.oldlogspline, summary.oldlogspline, doldlogspline (densities), poldlogspline (probabilities), qoldlogspline (quantiles), r.oldlogspline (random numbers from the fitted distribution). The function oldlogspline.to.logspline can translate an object of the class oldlogspline to an object of the class logspline.

The object has the following members:

call the command that was executed.
knots vector of the locations of the knots in the oldlogspline model. old coef coefficients of the spline. The first coefficient is the constant term, the second is the linear term and the k-th ($k > 2$) is the coefficient of $(x - t(k-2))^3_+$ (where $x^3_+$ means the positive part of the third power of $x$, and $t(k-2)$ means knot $k - 2$). If a coefficient is zero the corresponding knot was deleted from the model.

bound first element: $0 - \text{lbound}$ was $-\infty$ it was something else; second element: lbound, if specified; third element: $0 - \text{ubound}$ was $\infty$, 1 it was something else; fourth element: ubound, if specified.

logl the k-th element is the log-likelihood of the fit with $k+2$ knots.

penalty the penalty that was used.

sample the sample size that was used.
delete was stepwise knot deletion employed?

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

`logspline, oldlogspline, plot.oldlogspline, summary.oldlogspline, doldlogspline, poldlogspline, qoldlogspline, roldlogspline, oldlogspline.to.logspline`.

Examples

```r
# A simple example
y <- rnorm(100)
fit <- oldlogspline(y)
plot(fit)
# An example involving censoring and a lower bound
y <- rlnorm(1000)
censoring <- rexp(1000) * 4
delta <- 1 * (y <= censoring)
y[delta == 0] <- censoring[delta == 0]
fit <- oldlogspline(y[delta == 1], y[delta == 0], lbound = 0)
```

oldlogspline.to.logspline

*Logspline Density Estimation - 1992 to 1997 version*

Description

Translates an `oldlogspline` object into a `logspline` object. This routine is mostly used in `logspline`, as it allows the routine to use `oldlogspline` for some situations where `logspline` crashes. The other use is when you have censored data, and thus have to use `oldlogspline` to fit, but wish to use the auxiliary routines from `logspline`.

Usage

`oldlogspline.to.logspline(obj, data)`

Arguments

- `obj` object of class `logspline`
- `data` the original data. Used to compute the `range` component of the new object. If `data` is not available, the `1/(n+1)` and `n/(n+1)` quantiles of the fitted distribution are used for `range`.

Value

object of the class `logspline`. The `call` component of the new object is not useful. The `delete` component of the old object is ignored.
Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

`logspline`, `oldlogspline`.

Examples

```r
x <- rnorm(100)
fit.old <- oldlogspline(x)
fit.translate <- oldlogspline.to.logspline(fit.old, x)
fit.new <- logspline(x)
plot(fit.new)
plot(fit.old, add=TRUE, col=2)
#
# should look almost the same, the differences are the
# different fitting routines
#
```

plot.logspline

Logspline Density Estimation

Description

Plots a logspline density, distribution function, hazard function or survival function from a logspline density that was fitted using the 1997 knot addition and deletion algorithm (`logspline`). The 1992 algorithm is available using the `oldlogspline` function.

Usage

```r
## S3 method for class 'logspline'
plot(x, n = 100, what = "d", add = FALSE, xlim, xlab = "", ylab = "", type = "l", ...)
```
Arguments

x      logspline object, typically the result of \texttt{logspline}.

n      the number of equally spaced points at which to plot the density.

what   what should be plotted: ”d” (density), ”p” (distribution function), ”s” (survival function) or ”h” (hazard function).

add    should the plot be added to an existing plot.

xlim   range of data on which to plot. Default is from the 1th to the 99th percentile of the density, extended by 10% on each end.

xlab, ylab labels plotted on the axes.

type    type of plot.

...     other plotting options, as desired

Details

This function produces a plot of a \texttt{logspline} fit at \( n \) equally spaced points roughly covering the support of the density. (Use \texttt{xlim = c(from, to)} to change the range of these points.)

Author(s)

Charles Kooperberg \texttt{<clk@fredhutch.org>}. 

References


See Also

\texttt{logspline, summary.logspline, dlogspline, plogspline, qlogspline, rlogspline, oldlogspline},

Examples

\begin{verbatim}
  y <- rnorm(100)
  fit <- logspline(y)
  plot(fit)
\end{verbatim}
plot.oldlogspline

Logspline Density Estimation - 1992 version

Description

Plots an oldlogspline density, distribution function, hazard function or survival function from a logspline density that was fitted using the 1992 knot deletion algorithm. The 1997 algorithm using knot deletion and addition is available using the logspline function.

Usage

```r
## S3 method for class 'oldlogspline'
plot(x, n = 100, what = "d", xlim, xlab = "", ylab = "", type = "l", add = FALSE, ...)
```

Arguments

- `x` logspline object, typically the result of `logspline`.
- `n` the number of equally spaced points at which to plot the density.
- `what` what should be plotted: "d" (density), "p" (distribution function), "s" (survival function) or "h" (hazard function).
- `xlim` range of data on which to plot. Default is from the 1th to the 99th percentile of the density, extended by 10% on each end.
- `xlab`, `ylab` labels plotted on the axes.
- `type` type of plot.
- `add` should the plot be added to an existing plot.
- `...` other plotting options, as desired

Details

This function produces a plot of a oldlogspline fit at n equally spaced points roughly covering the support of the density. (Use `xlim=c(from, to)` to change the range of these points.)

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

`logspline, oldlogspline, summary.oldlogspline, doldlogspline, poldlogspline, qoldlogspline, roldlogspline`.

Examples

```r
y <- rnorm(100)
fit <- oldlogspline(y)
plot(fit)
```

Description

This function summarizes both the stepwise selection process of the model fitting by `logspline`, as well as the final model that was selected using AIC/BIC. A `logspline` object was fit using the 1997 knot addition and deletion algorithm. The 1992 algorithm is available using the `oldlogspline` function.

Usage

```r
## S3 method for class 'logspline'
summary(object, ...)
## S3 method for class 'logspline'
print(x, ...)
```

Arguments

- `object, x`: `logspline` object, typically the result of `logspline`
- `...`: other arguments are ignored.

Details

These function produce identical printed output. The main body is a table with five columns: the first column is a possible number of knots for the fitted model; the second column is the log-likelihood for the fit; the third column is `-2 * loglikelihood + penalty * (number of knots -1)`, which is the AIC criterion; `logspline` selected the model with the smallest value of AIC; the fourth and fifth columns give the endpoints of the interval of values of penalty that would yield the model with the indicated number of knots. (NAs imply that the model is not optimal for any choice of penalty.) At the bottom of the table the number of knots corresponding to the selected model is reported, as is the value of penalty that was used.

Author(s)

Charles Kooperberg <clk@fredhutch.org>.
References


See Also

logspline, plot.logspline, dlogspline, plogspline, qlogspline, rlogspline, oldlogspline.

Examples

```r
y <- rnorm(100)
fit <- logspline(y)
summary(fit)
```

---

Summary.oldlogspline

Logspline Density Estimation - 1992 version

Description

This function summarizes both the stepwise selection process of the model fitting by oldlogspline, as well as the final model that was selected using AIC/BIC. A logspline object was fit using the 1992 knot deletion algorithm (oldlogspline). The 1997 algorithm using knot deletion and addition is available using the logspline function.

Usage

```r
## S3 method for class 'oldlogspline'
summary(object, ...)
## S3 method for class 'oldlogspline'
print(x, ...)
```

Arguments

- `object, x` : oldlogspline object, typically the result of `oldlogspline`
- `...` : other arguments are ignored.

Details

These function produces the same printed output. The main body is a table with five columns: the first column is a possible number of knots for the fitted model; the second column is the log-likelihood for the fit;
the third column is \(-2 \times \text{loglikelihood} + \text{penalty} \times (\text{number of knots} - 1)\), which is the AIC criterion; \texttt{logspline} selected the model with the smallest value of AIC;

the fourth and fifth columns give the endpoints of the interval of values of penalty that would yield the model with the indicated number of knots. (\texttt{NA}s imply that the model is not optimal for any choice of penalty.) At the bottom of the table the number of knots corresponding to the selected model is reported, as is the value of penalty that was used.

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

References


See Also

\texttt{logspline}, \texttt{oldlogspline}, \texttt{plot.oldlogspline}, \texttt{doldlogspline}, \texttt{poldlogspline}, \texttt{qoldlogspline}, \texttt{roldlogspline}.

Examples

```r
y <- rnorm(100)
fit <- oldlogspline(y)
summary(fit)
```

---

**unstrip**

Reformat data as vector or matrix

Description

This function tries to convert a \texttt{data.frame} or a \texttt{matrix} to a no-frills \texttt{matrix} without labels, and a \texttt{vector} or \texttt{time-series} to a no-frills \texttt{vector} without labels.

Usage

```
unstrip(x)
```

Arguments

\(x\) one- or two-dimensional object.
Details

Many of the functions for `logspline`, `oldlogspline`, were written in the “before data.frame” era; `unstrip` attempts to keep all these functions useful with more advanced input objects. In particular, many of these functions call `unstrip` before doing anything else.

Value

If \( x \) is two-dimensional a matrix without names, if \( x \) is one-dimensional a numerical vector

Author(s)

Charles Kooperberg <clk@fredhutch.org>.

Examples

data(co2)
unstrip(co2)
data(iris)
unstrip(iris)
Index

* classes
  unstrip, 15
* distribution
  dlogspline, 2
  doldlogspline, 3
  logspline, 4
  oldlogspline, 7
  oldlogspline.to.logspline, 9
  plot.logspline, 10
  plot.oldlogspline, 12
  summary.logspline, 13
  summary.oldlogspline, 14
* smooth
  dlogspline, 2
  doldlogspline, 3
  logspline, 4
  oldlogspline, 7
  oldlogspline.to.logspline, 9
  plot.logspline, 10
  plot.oldlogspline, 12
  summary.logspline, 13
  summary.oldlogspline, 14
* utilities
  unstrip, 15

dlogspline, 2, 5, 6, 11, 14
doldlogspline, 3, 8, 9, 13, 15

logspline, 2–4, 4, 7, 9–16

oldlogspline, 2–7, 7, 9–16
oldlogspline.to.logspline, 6, 8, 9, 9

plogspline, 5, 6, 11, 14
plogspline (dlogspline), 2
plot.logspline, 3, 5, 6, 10, 14
plot.oldlogspline, 4, 8, 9, 12, 15
poldlogspline, 8, 9, 13, 15
poldlogspline (doldlogspline), 3
print.logspline (summary.logspline), 13

print.oldlogspline
  (summary.oldlogspline), 14

qlogspline, 5, 6, 11, 14
qlogspline (dlogspline), 2
qoldlogspline, 8, 9, 13, 15
qoldlogspline (doldlogspline), 3

rlogspline, 5, 6, 11, 14
rlogspline (dlogspline), 2
roldlogspline, 8, 9, 13, 15
roldlogspline (doldlogspline), 3

summary.logspline, 3, 5, 6, 11, 13
summary.oldlogspline, 4, 8, 9, 13, 14

unstrip, 15