Package ‘leiv’

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Type     Package
Title    Bivariate Linear Errors-In-Variables Estimation
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Imports   methods, stats, graphics
Suggests  grDevices
Description Estimate the slope and intercept of a bivariate linear relationship by calculating a posterior density that is invariant to interchange and scaling of the coordinates.
License   GPL (>= 2)

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R topics documented:

leiv ................................................................. 2
leiv-internal .................................................... 5

Index 6
leiv  

Bivariate Linear Errors-In-Variables Estimation

Description

Generates a linear errors-in-variables object.

Usage

leiv(formula, data, subset, prior = NULL,
     n = NULL, cor = NULL, sdRatio = NULL, xMean = 0, yMean = 0,
     probIntCalc = FALSE, level = 0.95, subdivisions = 100,
     rel.tol = .Machine$double.eps^0.25, abs.tol = 0.1*rel.tol,...)

## S4 method for signature 'leiv'
print(x, digits = max(3,getOption("digits") - 3), ...)

## S4 method for signature 'leiv,missing'
plot(x, plotType = "density", xlim = NULL, ylim = NULL,
     xlab = NULL, ylab = NULL, col = NULL, lwd = NULL,...)

Arguments

formula  an optional object of class "formula" (or one that can be coerced to that class): a
symbolic description of the model to be fitted. The details of model specification
are given in the 'Details' section of the documentation for lm. An intercept is
always included and integrated out as a nuisance parameter: y ~ x, y ~ 0 + x,
and y ~ x - 1 are equivalent. If not provided, the sufficient statistics n, cor,
and sdRatio must be provided.

data  an optional data frame (or object coercible by as.data.frame to a data frame)
containing the variables in the model. If not found in data, the variables are
taken from environment(formula)), typically the environment from which leiv
is called.

subset  an optional vector specifying a subset of observations to be used in the fitting
process.

prior  an optional object of class leiv to use as the prior density of the scale invariant
slope; otherwise the rotationally invariant Cauchy density is used.

n  an optional sample size (if formula is missing).

cor, sdRatio  optional sample correlation cor(x,y) and ratio sd(y)/sd(x) (if formula is
missing).

xMean, yMean  optional sample means mean(x) and mean(y) (if formula is missing).

probIntCalc  logical; if TRUE returns the shortest (100*level)% probability intervals; if FALSE
(the default) no probability intervals are returned.

level  the probability level requested (if probIntCalc = TRUE).

subdivisions  the maximum number of subintervals (see integrate).
rel.tol  the relative accuracy requested (see integrate).
abs.tol  the absolute accuracy requested (see integrate).
x       a leiv object.
digits  controls formatting of numeric objects.
plotType specifies the type of plot; if plotType = "density" (the default) then the
         posterior density of the slope is plotted; if plotType = "scatter" then a scatter
         plot with the fitted line.
xlim, ylim x limits c(x1,x2) and y limits c(y1,y2) of the plot.
xlab, ylab labels for the x and y axes of the plot.
col, lwd  color and width of plotted lines.
...  additional argument(s) for generic methods.

Details

Use leiv to estimate the slope and intercept of a bivariate linear relationship when both variables
are observed with error. The method is exact when the true values and the errors are normally
distributed. The posterior density depends on the data only through the correlation coefficient and
ratio of standard deviations; it is invariant to interchange and scaling of the coordinates.

Value

leiv returns an object of class "leiv" with the following components:
slope  the (posterior median) slope estimate.
intercept the (maximum likelihood) intercept estimate.
slopeInt the shortest (100*level)% probability interval of the slope.
interceptInt the shortest (100*level)% probability interval of the intercept.
density the posterior probability density function.
n  the number of (x,y) pairs.
cor  the sample correlation cor(x,y).
sdRatio  the ratio sd(y)/sd(x).
xMean  the sample mean mean(x).
yMean  the sample mean mean(y).
call  the matched call.
probIntCalc  the logical probability interval request.
level  the probability level of the probability interval.
x  the x data.
y  the y data.
Note

Numerical integration is used to normalize the posterior density. When the data is nearly linear, normalization using the default tolerance parameters may fail. Specifying `abs.tol = 1e-6` (or smaller) may help, but expect a longer run time. In general, `rel.tol` cannot be less than `max(50*.Machine$double.eps, 0.5e-28)` if `abs.tol <= 0`. In addition, when using a sharply peaked `leiv` object as a prior density, normalization may fail. In this case, an alternative is to first fit using the default Cauchy prior, then multiply by the appropriate ratio of prior densities and tackle the normalization outside of the `leiv` environment.

Author(s)

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References


See Also

`lm` for formula syntax; `integrate` for control parameters.

Examples

```r
## generate artificial data
set.seed(1123)
n <- 20
X <- rnorm(n, mean=5, sd=4) # true x
x <- X + rnorm(n, mean=0, sd=5) # observed x
Y <- 2 + X # true y
y <- Y + rnorm(n, mean=0, sd=3) # observed y

## fit with default options
fit <- leiv(y ~ x)
print(fit)
plot(fit) # density plot
dev.new()
plot(fit,plotType="scatter")

## calculate a density to use as an informative prior density of
## the scale invariant slope in a subsequent fit
fit0 <- leiv(n=10, cor=0.5, sdRatio=1.0)
print(fit0)

## refit the data using the informative prior density
fit1 <- leiv(y ~ x, prior=fit0, abs.tol=1e-6)
print(fit1)
```
**Description**

\( p_u(0) \) calculates the median of the \texttt{leiv} posterior probability density. \texttt{probInt} calculates the shortest probability interval of the \texttt{leiv} posterior probability density for a given probability level.

**Usage**

\[
\begin{align*}
p_u(0, \text{interval}, \text{subdivisions} = 100, \\
& \quad \text{rel.tol} = \text{Machine$double$eps}^0.25, \\
& \quad \text{abs.tol} = \text{rel.tol})
\end{align*}
\]

\[
\begin{align*}
\text{probInt}(p, \text{interval}, \text{level}, \text{subdivisions} = 100, \\
& \quad \text{rel.tol} = \text{Machine$double$eps}^0.25, \\
& \quad \text{abs.tol} = \text{rel.tol})
\end{align*}
\]

**Arguments**

- \( p \) - a normalized probability density function.
- \( \text{interval} \) - a vector containing the endpoints of the interval to be searched.
- \( \text{level} \) - the probability level requested.
- \( \text{subdivisions} \) - the maximum number of subintervals (see \texttt{integrate}).
- \( \text{rel.tol} \) - the relative accuracy requested (see \texttt{integrate}).
- \( \text{abs.tol} \) - the absolute accuracy requested (see \texttt{integrate, optimize} and \texttt{uniroot}).

**Details**

Internal functions for integrating the posterior density returned by the function \texttt{leiv}. These functions are not meant to be called by the user.

**Value**

\( p_u(0) \) returns a numeric scalar. \texttt{probInt} returns a 2-dimensional numeric vector of interval endpoints.

**Note**

\( p \) must accept a vector of inputs and produce a vector of function evaluations at those points. \( \text{rel.tol} \) cannot be less than \( \max(50*\text{Machine$double$eps}, 0.5e-28) \) if \( \text{abs.tol} \leq 0 \).

**See Also**

- \texttt{leiv} for general information; \texttt{integrate} for control parameters.
Index

*Topic models
  leiv, 2

*Topic regression
  leiv, 2

as.data.frame, 2

formula, 2

integrate, 2–5

leiv, 2, 5
leiv-class (leiv), 2
leiv-internal, 5
leiv-package (leiv), 2
lm, 2, 4

numeric, 3

optimize, 5

p50 (leiv-internal), 5
plot, ANY, ANY-method (leiv), 2
plot, leiv, missing-method (leiv), 2
plot-methods (leiv), 2
print, ANY-method (leiv), 2
print, leiv-method (leiv), 2
print-methods (leiv), 2
probInt (leiv-internal), 5

unqroot, 5