Package ‘bfsl’

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Title Best-Fit Straight Line

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Description How to fit a straight line through a set of points with errors in both coordinates? The 'bfsl' package implements the York regression (York, 2004 <doi:10.1119/1.1632486>). It provides unbiased estimates of the intercept, slope and standard errors for the best-fit straight line to independent points with (possibly correlated) normally distributed errors in both x and y. Other commonly used errors-in-variables methods, such as orthogonal distance regression, geometric mean regression or Deming regression are special cases of the 'bfsl' solution.

Depends R (>= 3.5.0)

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URL https://github.com/pasturm/bfsl

BugReports https://github.com/pasturm/bfsl/issues

Encoding UTF-8

LazyData true

RoxygenNote 7.1.2

Suggests testthat, tibble, dplyr

Imports generics

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Augment Data with Information from a bfsl Object

**Description**

Broom tidier method to augment data with information from a bfsl object.

**Usage**

```r
## S3 method for class 'bfsl'
augment(x, data = x$data, newdata = NULL, ...)
```

**Arguments**

- `x` A `bfsl` object created by `bfsl::bfsl()`
- `data` A `[base::data.frame()]` or `[tibble::tibble()]` containing all the original predictors used to create `x`. Defaults to NULL, indicating that nothing has been passed to `newdata`. If `newdata` is specified, the data argument will be ignored.
- `newdata` A `[base::data.frame()]` or `[tibble::tibble()]` containing all the original predictors used to create `x`. Defaults to NULL, indicating that nothing has been passed to `newdata`. If `newdata` is specified, the data argument will be ignored.
- `...` Unused, included for generic consistency only.

**Value**

A `[tibble::tibble()]` with columns:

- `.fitted` Fitted or predicted value.
- `.se.fit` Standard errors of fitted values.
- `.resid` The residuals, that is y observations minus fitted values. (Only returned if `newdata = NULL`).
**Examples**

```r
fit = bfsl(pearson_york_data)
augment(fit)
```

---

**bfsl**  
*Calculates the Best-fit Straight Line*

---

**Description**

`bfsl` calculates the best-fit straight line to independent points with (possibly correlated) normally distributed errors in both coordinates.

**Usage**

```r
bfsl(...)
```

## Default S3 method:

```r
bfsl(x, y = NULL, sd_x = 0, sd_y = 1, r = 0, control = bfsl_control(), ...)
```

## S3 method for class 'formula'

```r
bfsl(formula, data = parent.frame(), sd_x, sd_y, r = 0, control = bfsl_control(), ...)
```

---

**Arguments**

- `...`: Further arguments passed to or from other methods.
- `x`: A vector of x observations or a data frame (or an object coercible by `as.data.frame` to a data frame) containing the named vectors x, y, and optionally sd_x, sd_y and r. If weights w_x and w_y are given, then sd_x and sd_y are calculated from sd_x = 1/sqrt(w_x) and sd_y = 1/sqrt(w_y). Specifying y, sd_x, sd_y or r directly as function arguments overwrites these variables in the data structure.
- `y`: A vector of y observations.
- `sd_x`: A vector of x measurement error standard deviations. If it is of length one, all data points are assumed to have the same x standard deviation.
- `sd_y`: A vector of y measurement error standard deviations. If it is of length one, all data points are assumed to have the same y standard deviation.
A vector of correlation coefficients between errors in \(x\) and \(y\). If it is of length one, all data points are assumed to have the same correlation coefficient.

classbfsl

A list of control settings. See `bfsl_control` for the names of the settable control values and their effect.

formula

A formula specifying the bivariate model (as in `lm`, but here only \(y \sim x\) makes sense).

data

A data.frame containing the variables of the model.

Details

`bfsl` provides the general least-squares estimation solution to the problem of fitting a straight line to independent data with (possibly correlated) normally distributed errors in both \(x\) and \(y\).

With \(sd_x = 0\) the (weighted) ordinary least squares solution is obtained. The calculated standard errors of the slope and intercept multiplied with \(\sqrt{\text{chisq}}\) correspond to the ordinary least squares standard errors.

With \(sd_x = c\), \(sd_y = d\), where \(c\) and \(d\) are positive numbers, and \(r = 0\) the Deming regression solution is obtained. If additionally \(c = d\), the orthogonal distance regression solution, also known as major axis regression, is obtained.

Setting \(sd_x = \text{sd}(x)\), \(sd_y = \text{sd}(y)\) and \(r = 0\) leads to the geometric mean regression solution, also known as reduced major axis regression or standardised major axis regression.

The goodness of fit metric \(\text{chisq}\) is a weighted reduced chi-squared statistic. It compares the deviations of the points from the fit line to the assigned measurement error standard deviations. If \(x\) and \(y\) are indeed related by a straight line, and if the assigned measurement errors are correct (and normally distributed), then \(\text{chisq}\) will equal 1. A \(\text{chisq} > 1\) indicates underfitting: the fit does not fully capture the data or the measurement errors have been underestimated. A \(\text{chisq} < 1\) indicates overfitting: either the model is improperly fitting noise, or the measurement errors have been overestimated.

Value

An object of class "bfsl", which is a list containing the following components:

coefficients

A 2x2 matrix with columns of the fitted coefficients (intercept and slope) and their standard errors.

chisq

The goodness of fit (see Details).

fitted.values

The fitted mean values.

residuals

The residuals, that is \(y\) observations minus fitted values.

df.residual

The residual degrees of freedom.

cov.ab

The covariance of the slope and intercept.

control

The control list used, see the control argument.

convInfo

A list with convergence information.

call

The matched call.

data

A list containing \(x, y, sd_x, sd_y\) and \(r\).
References


Examples

```r
x = pearson_york_data$x
y = pearson_york_data$y
sd_x = 1/sqrt(pearson_york_data$w_x)
sd_y = 1/sqrt(pearson_york_data$w_y)
bfsl(x, y, sd_x, sd_y)
bfsl(y~x, pearson_york_data, sd_x, sd_y)

fit = bfsl(pearson_york_data)
plot(fit)
```

---

**bfsl_control**  
*Controls the Iterations in the bfsl Algorithm*

Description

`bfsl_control` allows the user to set some characteristics of the `bfsl` best-fit straight line algorithm.

Usage

```r
bfsl_control(tol = 1e-10, maxit = 100)
```

Arguments

- `tol` A positive numeric value specifying the tolerance level for the convergence criterion
- `maxit` A positive integer specifying the maximum number of iterations allowed.

Value

A list with two components named as the arguments.

See Also

`bfsl`

Examples

```r
bfsl_control(tol = 1e-8, maxit = 1000)
```
glance.bfsl  
Glance at a bfsl Object

Description

Broom tidier method to glance at a bfsl object.

Usage

```r
## S3 method for class 'bfsl'
glance(x, ...)
```

Arguments

- `x`  
  A 'bfsl' object.
- `...`  
  Unused, included for generic consistency only.

Value

A `[tibble::tibble()]` with one row and columns:

- `chisq`  
  The goodness of fit.
- `p.value`  
  P-value.
- `df.residual`  
  Residual degrees of freedom.
- `nobs`  
  Number of observations.
- `isConv`  
  Did the fit converge?
- `iter`  
  Number of iterations.
- `finTol`  
  Final tolerance.

Examples

```r
fit = bfsl(pearson_york_data)

glance(fit)
```

Usage

`pearson_york_data`

Format

A data frame with 10 rows and 4 variables:

- `x` observations
- `w_x` weights of `x`
- `y` observations
- `w_y` weights of `y`

References


Examples

```
bfsl(pearson_york_data)
```

---

Plot Method for `bfsl` Results

Description

`plot.bfsl` plots the data points with error bars and the calculated best-fit straight line.

Usage

```
## S3 method for class 'bfsl'
plot(x, grid = TRUE, ...)
```
Arguments

- **x**: An object of class "bfsl".
- **grid**: If TRUE (default) grid lines are plotted.
- **...**: Further parameters to be passed to the plotting routines.

---

**predict.bfsl**

*Predict Method for bfsl Model Fits*

Description

`predict.bfsl` predicts future values based on the bfsl fit.

Usage

```r
## S3 method for class 'bfsl'
predict(
  object, 
  newdata, 
  interval = c("none", "confidence"), 
  level = 0.95, 
  se.fit = FALSE, 
  ... 
)
```

Arguments

- **object**: Object of class "bfsl".
- **newdata**: A data frame with variable x to predict. If omitted, the fitted values are used.
- **interval**: Type of interval calculation. "none" or "confidence".
- **level**: Confidence level.
- **se.fit**: A switch indicating if standard errors are returned.
- **...**: Further arguments passed to or from other methods.

Value

`predict.bfsl` produces a vector of predictions or a matrix of predictions and bounds with column names `fit`, `lwr`, and `upr` if interval is set to "confidence".

If `se.fit` is TRUE, a list with the following components is returned:

- **fit**: Vector or matrix as above
- **se.fit**: Standard error of predicted means
Examples

```r
fit = bfsl(pearson_york_data)
predict(fit, interval = "confidence")
new = data.frame(x = seq(0, 8, 0.5))
predict(fit, new, se.fit = TRUE)

pred.clim = predict(fit, new, interval = "confidence")
matplot(new$x, pred.clim, lty = c(1,2,2), type = "l", xlab = "x", ylab = "y")
df = fit$data
points(df$x, df$y)
arrows(df$x, df$y-df$sd_y, df$x, df$y+df$sd_y,
    length = 0.05, angle = 90, code = 3)
arrows(df$x-df$sd_x, df$y, df$x+df$sd_x, df$y,
    length = 0.05, angle = 90, code = 3)
```

print.bfsl  
Print Method for bfsl Results

Description

print method for class "bfsl".

Usage

```r
## S3 method for class 'bfsl'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

- `x`: An object of class "bfsl".
- `digits`: The number of significant digits to use when printing.
- `...`: Further arguments passed to `print.default`.

print.summary.bfsl  
Print Method for summary.bfsl Objects

Description

print method for class "summary.bfsl".

Usage

```r
## S3 method for class 'summary.bfsl'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```
Arguments

- **x**: An object of class "summary.bfsl".
- **digits**: The number of significant digits to use when printing.
- **...**: Further arguments passed to `print.default`.

---

**summary.bfsl**  
*Summary Method for bfsl Results*

**Description**

summary method for class "bfsl".

**Usage**

```r
## S3 method for class 'bfsl'
summary(object, ...)
```

**Arguments**

- **object**: An object of class "bfsl".
- **...**: Further arguments passed to `summary.default`.

---

**tidy.bfsl**  
*Tidy a bfsl Object*

**Description**

Broom tidier method to tidy a bfsl object.

**Usage**

```r
## S3 method for class 'bfsl'
tidy(x, conf.int = FALSE, conf.level = 0.95, ...)
```

**Arguments**

- **x**: A 'bfsl' object.
- **conf.int**: Logical indicating whether or not to include a confidence interval in the tidied output. Defaults to FALSE.
- **conf.level**: The confidence level to use for the confidence interval if conf.int = TRUE. Must be strictly greater than 0 and less than 1. Defaults to 0.95, which corresponds to a 95 percent confidence interval.
- **...**: Unused, included for generic consistency only.
tidy.bfsl

Value

A tidy [tibble::tibble()] summarizing component-level information about the model

Examples

```r
fit = bfsl(pearson_york_data)

 tidy(fit)
```
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