

# Package ‘forward’

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**Depends** R (>= 3.5), MASS

**Description** Robust analysis using forward search in linear and generalized linear regression models, as described in Atkinson, A.C. and Riani, M. (2000), Robust Diagnostic Regression Analysis, First Edition. New York: Springer.

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ar	<i>ar data</i>
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**Description**

The ar data frame has 60 rows and 4 columns.

**Usage**

data(ar)

**Format**

This data frame contains the following columns:

- x1** a numeric vector
- x2** a numeric vector
- x3** a numeric vector
- y** a numeric vector

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.2

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bliss	<i>Bliss data</i>
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**Description**

The bliss data frame has 8 rows and 4 columns.

**Usage**

```
data(bliss)
```

**Format**

This data frame contains the following columns:

**Dose** a numeric vector

**Killed** a numeric vector

**Total** a numeric vector

**y** a numeric vector

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.20

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calcium	<i>Calcium data</i>
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**Description**

Calcium uptake of cells suspended in a solution of radioactive calcium.

The calcium data frame has 27 rows and 2 columns.

**Usage**

```
data(calcium)
```

**Format**

This data frame contains the following columns:

**Time** a numeric vector

**y** a numeric vector

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.13

---

carinsuk

*Car insurance data*

---

## Description

The carinsuk data frame has 128 rows and 5 columns.

## Usage

```
data(carinsuk)
```

## Format

This data frame contains the following columns:

**OwnerAge** a factor with levels: 17-20, 21-24, 25-29, 30-34, 35-39, 40-49, 50-59, 60+

**Model** a factor with levels: A, B, C, D

**CarAge** a factor with levels: 0-3, 10+, 4-7, 8-9

**NClaims** a numeric vector

**AvCost** a numeric vector

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.16

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carr

*n-Pentane data*

---

## Description

Reaction rate for Catalytic Isomerization of n-Pentane to Isopentane

The carr data frame has 24 rows and 4 columns.

## Usage

```
data(carr)
```

**Format**

This data frame contains the following columns:

**hydrogen** partial pressure of hydrogen

**npentane** partial pressure of n-pentane

**isopentane** partial pressure of iso-pentane

**rate** rate of disappearance of n-pentane

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.15

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cellular	<i>Cellular differentiation data</i>
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**Description**

The cellular data frame has 16 rows and 3 columns.

**Usage**

```
data(cellular)
```

**Format**

This data frame contains the following columns:

**TNF** Dose of TNF (U/ml)

**IFN** Dose of IFN (U/ml)

**y** Number of cells differentiating

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.19

chapman

*Chapman data*

---

**Description**

The chapman data frame has 200 rows and 7 columns.

**Usage**

```
data(chapman)
```

**Format**

This data frame contains the following columns:

**age** a numeric vector

**highbp** a numeric vector

**lowbp** a numeric vector

**chol** a numeric vector

**height** a numeric vector

**weight** a numeric vector

**y** a numeric vector

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.24

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derailme

*British Train Accidents.*

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**Description**

These data are obtained from Atkinson and Riani (2000), which is a simplified version of the data in Evans (2000). The outcome is the number of deaths that occurred in a train accident with a categorical covariate describing the type of rolling stock, and an exposure variable giving the annual distance travelled by trains in that year, and was originally analysed using a Poisson model. As the data does not include observations with zero deaths, it will be analysed here as a zero-truncated Poisson with an offset of log of the train distance. The derailme data frame has 67 rows and 5 columns.

**Usage**

```
data(derailme)
```

**Format**

This data frame contains the following columns:

**Month** Month of accident

**Year** Year of accident

**Type** Type of rolling stock 1=Mark 1 train, 2=Post-Mark 1 train, 3=Non-passenger

**TrainKm** Amount of traffic on the railway system (billions of train km)

**y** Number of deaths that occurred in the train accident

**Source**

Atkinson and Riani (2000)

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.18

Evans, A. W. (2000). Fatal train accidents on Britain's mainline railways. *Journal Royal Statistical Society A*, 163(1), 99-119.

---

dialectric

*Dialectric data*

---

**Description**

The `dialectric` data frame has 128 rows and 3 columns.

**Usage**

```
data(dialectric)
```

**Format**

This data frame contains the following columns:

**time** Time (weeks)

**temp** Temperature (degrees Celsius)

**y** dielectric breakdown strength in kilovolts

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.17

---

`fwd.combn`*Generate all combinations of elements of x taken m at a time*

---

**Description**

Generate all combinations of the elements of  $x$  taken  $m$  at a time. If  $x$  is a positive integer, returns all combinations of the elements of  $\text{seq}(x)$  taken  $m$  at a time. If argument `fun` is not null, applies a function given by the argument to each point. If `simplify` is `FALSE`, returns a list; else returns a vector or an array. Optional arguments `...` are passed unchanged to the function given by argument `fun`, if any.

**Usage**

```
fwd.combn(x, m, fun = NULL, simplify = TRUE, ...)  
fwd.nCm(n, m, tol = 1e-08)
```

**Arguments**

<code>x</code>	a vector or a single value.
<code>n</code>	a positive integer.
<code>m</code>	a positive integer.
<code>fun</code>	a function to be applied to each combination.
<code>simplify</code>	logical, if <code>TRUE</code> returns a vector or an array, otherwise a list.
<code>tol</code>	optional, tolerance value.
<code>...</code>	optional arguments passed to <code>fun</code> .

**Value**

Returns a vector or an array if `simplify = TRUE`, otherwise a list.

**Note**

Renamed by Kjell Konis for inclusion in the Forward Library 11/2002

**Author(s)**

Scott Chasalow

**References**

Nijenhuis, A. and Wilf, H.S. (1978) *Combinatorial Computers and Calculators*. NY: Academic Press.



**Examples**

```
fwd.combn(letters[1:4], 2)
fwd.combn(10, 5, min)      # minimum value in each combination
# Different way of encoding points:
fwd.combn(c(1,1,1,1,2,2,2,3,3,4), 3, tabulate, nbins = 4)
# Compute support points and (scaled) probabilities for a
# Multivariate-Hypergeometric(n = 3, N = c(4,3,2,1)) p.f.:
table(t(fwd.combn(c(1,1,1,1,2,2,2,3,3,4), 3, tabulate, nbins=4)))
```

fwdglm

*Forward Search in Generalized Linear Models***Description**

This function applies the forward search approach to robust analysis in generalized linear models.

**Usage**

```
fwdglm(formula, family, data, weights, na.action, contrasts = NULL, bsb = NULL,
        balanced = TRUE, maxit = 50, epsilon = 1e-06, nsamp = 100, trace = TRUE)
```

**Arguments**

formula	a symbolic description of the model to be fit. The details of the model are the same as for <code>glm</code> .
family	a description of the error distribution and link function to be used in the model. See <a href="#">family</a> for details.
data	an optional data frame containing the variables in the model. By default the variables are taken from the environment from which the function is called.
weights	an optional vector of weights to be used in the fitting process.
na.action	a function which indicates what should happen when the data contain NA's. The default is set by the <code>na.action</code> setting of options, and is <code>na.fail</code> if that is unset. The default is <code>na.omit</code> .
contrasts	an optional list. See the <code>contrasts.arg</code> of <code>model.matrix.default</code> .
bsb	an optional vector specifying a starting subset of observations to be used in the forward search. By default the "best" starting subset is chosen using the function <code>lmsglm</code> with control arguments provided by <code>nsamp</code> .
balanced	logical, for a binary response if TRUE the proportion of successes on the full dataset is approximately balanced during the forward search algorithm.
maxit	integer giving the maximal number of IWLS iterations. See <code>glm.control</code> for details.
epsilon	positive convergence tolerance epsilon. See <code>glm.control</code> for details.

nsamp	the initial subset for the forward search in generalized linear models is found by the function <code>lmsglm</code> . This argument allows to control how many subsets are used in the robust fitting procedure. The choices are: the number of samples (100 by the default) or "all". Note that the algorithm tries to find nsamp good subsets or a maximum of 2*nsamp subsets.
trace	logical, if TRUE a message is printed for every ten iterations completed during the forward search.

### Value

The function returns an object of class "fwdglm" with the following components:

call	the matched call.
Residuals	a $(nx(n - p + 1))$ matrix of residuals.
Unit	a matrix of units added (to a maximum of 5 units) at each step.
included	a list with each element containing a vector of units included at each step of the forward search.
Coefficients	a $((n - p + 1)xp)$ matrix of coefficients.
tStatistics	a $((n - p + 1)xp)$ matrix of t statistics for the coefficients, i.e. <code>coef.est/SE(coef.est)</code> .
Leverage	a $(nx(n - p + 1))$ matrix of leverage values.
MaxRes	a $((n - p)x2)$ matrix of max deviance residuals in the best subsets and $m$ -th deviance residuals.
MinDelRes	a $((n - p - 1)x2)$ matrix of minimum deviance residuals out of best subsets and $(m + 1)$ -th deviance residuals.
ScoreTest	a $((n - p)x1)$ matrix of score test statistics for a goodness of link test.
Likelihood	a $((n - p)x4)$ matrix with columns containing: deviance, residual deviance, psuedo $R^2$ (computed as $1 - deviance/null.deviance$ ), dispersion parameter (computed as $\sum(pearson.residuals^2)/(m - p)$ ).
CookDist	a $((n - p)x1)$ matrix of forward Cook's distances.
ModCookDist	a $((n - p)x5)$ matrix of forward modified Cook's distances for the units (to a maximum of 5 units) included at each step.
Weights	a $(nx(n - p))$ matrix of weights used at each step of the forward search.
inibsb	a vector giving the best starting subset chosen by <code>lmsglm</code> .
binary.response	logical, equal to TRUE if binary response.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 6.

**See Also**

[summary.fwdglm](#), [plot.fwdglm](#), [fwdlm](#), [fwdsco](#).

**Examples**

```
data(cellular)
cellular$TNF <- as.factor(cellular$TNF)
cellular$IFN <- as.factor(cellular$IFN)
mod <- fwdglm(y ~ TNF + IFN, data=cellular, family=poisson(log), nsamp=200)
summary(mod)
## Not run: plot(mod)
plot(mod, 1)
plot(mod, 5)
plot(mod, 6, ylim=c(-3, 20))
plot(mod, 7)
plot(mod, 8)
```

fwdlm

*Forward Search in Linear Regression***Description**

This function applies the forward search approach to robust analysis in linear regression models.

**Usage**

```
fwdlm(formula, data, nsamp = "best", x = NULL, y = NULL, intercept = TRUE,
      na.action, trace = TRUE)
```

**Arguments**

formula	a symbolic description of the model to be fit. The details of the model are the same as for <code>lm</code> .
data	an optional data frame containing the variables in the model. By default the variables are taken from the environment from which the function is called.
nsamp	the initial subset for the forward search in linear regression is found by fitting the regression model with the R function <a href="#">lmsreg</a> . This argument allows to control how many subsets are used in the Least Median of Squares regression. The choices are: the number of samples or "best" (the default) or "exact" or "sample". For details see <a href="#">lmsreg</a> .
x	A matrix of predictors values (if no formula is provided).
y	A vector of response values (if no formula is provided).
intercept	Logical for the inclusion of the intercept (if no formula is provided).
na.action	a function which indicates what should happen when the data contain NA's. The default is set by the <code>na.action</code> setting of options, and is <code>na.fail</code> if that is unset. The default is <code>na.omit</code> .

trace            logical, if TRUE a message is printed for every ten iterations completed during the forward search.

### Value

The function returns an object of class "fwdlm" with the following components:

call            the matched call.  
 Residuals      a  $(n \times (n - p + 1))$  matrix of residuals.  
 Unit            a matrix of units added (to a maximum of 5 units) at each step.  
 included        a list with each element containing a vector of units included at each step of the forward search.  
 Coefficients   a  $((n - p + 1) \times p)$  matrix of coefficients.  
 tStatistics     a  $((n - p + 1) \times p)$  matrix of t statistics for the coefficients.  
 CookDist        a  $((n - p) \times 1)$  matrix of forward Cook's distances.  
 ModCookDist    a  $((n - p) \times 5)$  matrix of forward modified Cook's distances for the units (to a maximum of 5 units) included at each step.  
 Leverage        a  $(n \times (n - p + 1))$  matrix of leverage values.  
 S2              a  $((n - p + 1) \times 2)$  matrix with 1st column containing  $S^2$  and the 2nd column  $R^2$ .  
 MaxRes          a  $((n - p) \times 1)$  matrix of max studentized residuals.  
 MinDelRes       a  $((n - p - 1) \times 1)$  matrix of minimum deletion residuals.  
 StartingModel   a "lqs" object providing the the Least Median of Squares regression fit used to select the starting subset.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
 Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapters 2-3.

### See Also

[summary.fwdlm](#), [plot.fwdlm](#), [fwdsc](#), [fwdglm](#), [lmsreg](#).

### Examples

```
library(MASS)
data(forbes)
plot(forbes, xlab="Boiling point", ylab="Pressure")
mod <- fwdlm(100*log10(pres) ~ bp, data=forbes)
summary(mod)
## Not run: plot(mod)
```

```
plot(mod, 1)
plot(mod, 6, ylim=c(-3, 1000))
```

fwdsc

*Forward Search Transformation in Linear Regression***Description**

This function applies the forward search approach to the Box-Cox transformation of response in linear regression models.

**Usage**

```
fwdsc(formula, data, nsamp = "best", lambda = c(-1, -0.5, 0, 0.5, 1),
      x = NULL, y = NULL, intercept = TRUE, na.action, trace = TRUE)
```

**Arguments**

formula	a symbolic description of the model to be fit. The details of the model are the same as for <code>lm</code> .
data	an optional data frame containing the variables in the model. By default the variables are taken from the environment from which the function is called.
nsamp	the initial subset for the forward search in linear regression is found by fitting the regression model with the R function <code>lmsreg</code> . This argument allows to control how many subsets are used in the Least Median of Squares regression. The choices are: the number of samples or "best" (the default) or "exact" or "sample". For details see <code>lmsreg</code> .
lambda	a vector (or a single numerical value) of lambda values for the response transformation.
x	A matrix of predictors values (if no formula is provided).
y	A vector of response values (if no formula is provided).
intercept	Logical for the inclusion of the intercept (if no formula is provided).
na.action	a function which indicates what should happen when the data contain NA's. The default is set by the <code>na.action</code> setting of options, and is <code>na.fail</code> if that is unset. The default is <code>na.omit</code> .
trace	logical, if TRUE a message is printed for every ten iterations completed during the forward search.

**Value**

The function returns an object of class "fwdsc" with the following components:

call	the matched call.
Likelihood	a $((n - p + 1) \times n \times \text{lambda})$ matrix of likelihood values.
ScoreTest	a $((n - p + 1) \times n \times \text{lambda})$ matrix of score test statistic values.

Unit	a list with an element for each lambda values. Each element provides a matrix of units added (to a maximum of 5 units) at each step of the forward search.
Input	a list with $n$ , $p$ and the vector of lambda values used.
x	The design matrix.
y	The vector for the response.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 4.

### See Also

[summary.fwdsco](#), [plot.fwdsco](#), [fwdlm](#), [fwdglm](#).

### Examples

```
data(wool)
mod <- fwdsco(y ~ x1 + x2 + x3, data = wool)
summary(mod)
plot(mod, plot.mle=FALSE)
plot(mod, plot.Sco=FALSE, plot.Lik=TRUE)
```

---

hawkins

*Hawkins' data*

---

### Description

The hawkins data frame has 128 rows and 9 columns.

### Usage

```
data(hawkins)
```

### Format

This data frame contains the following columns:

- x1** a numeric vector
- x2** a numeric vector
- x3** a numeric vector
- x4** a numeric vector

**x5** a numeric vector  
**x6** a numeric vector  
**x7** a numeric vector  
**x8** a numeric vector  
**y** a numeric vector

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.4

---

kinetics

*Kinetics data*

---

## Description

Kinetics data (from Becton-Dickenson)  
The kinetics data frame has 19 rows and 5 columns.

## Usage

```
data(kinetics)
```

## Format

This data frame contains the following columns:

**Substrate** substrate indicator  
**I0** Inhibitor concentration  
**I3** Inhibitor concentration  
**I10** Inhibitor concentration  
**I30** Inhibitor concentration  
**y** initial velocity

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.12

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lakes	<i>Lakes data</i>
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---

**Description**

The lakes data frame has 29 rows and 3 columns.

**Usage**

```
data(lakes)
```

**Format**

This data frame contains the following columns:

**NIN** average influent nitrogen concentration

**TW** water retention time

**TN** mean annual nitrogen concentration

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.14

---

leafpine	<i>Pine data</i>
----------	------------------

---

**Description**

The leafpine data frame has 70 rows and 3 columns.

**Usage**

```
data(leafpine)
```

**Format**

This data frame contains the following columns:

**girth** girth

**height** height

**volume** volume

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.10



lmsglm

*Forward Search in Generalized Linear Models***Description**

This function computes the Least Median Square robust fit for generalized linear models using deviance residuals.

**Usage**

```
lmsglm(x, y, family, weights, offset, n.samples = 100, max.samples = 200,
       epsilon = 1e-04, maxit = 50, trace = FALSE)
```

**Arguments**

x	a matrix or data frame containing the explanatory variables.
y	the response: a vector of length the number of rows of x.
family	a description of the error distribution and link function to be used in the model. See family for details.
weights	an optional vector of weights to be used in the fitting process.
offset	optional, a priori known component to be included in the linear predictor during fitting.
n.samples	number of good subsets to fit. It can be a numeric value or "all".
max.samples	maximal number of subsets to fit. By default is set to twice n.samples.
epsilon	positive convergence tolerance epsilon. See glm.control for details.
maxit	integer giving the maximal number of IWLS iterations. See glm.control for details.
trace	logical, if TRUE a message is printed for every ten iterations completed during the search.

**Details**

This function is used by fwdglm to select the starting subset for the forward search. For this reason, users do not generally need to use it.

**Value**

The function returns a list with the following components:

bsb	a vector giving the best subset found
dev.res	a vector giving the deviance residuals for all the observations
message	a short message about the status of the algorithm
model	the model provided by glm.fit using the units in the best subset found

**Author(s)**

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 6.

**See Also**

[fwdglm](#), [fwdlm](#), [lmsreg](#), [fwdsc0](#).

---

mice

*Mice data*

---

**Description**

The mice data frame has 14 rows and 4 columns.

**Usage**

```
data(mice)
```

**Format**

This data frame contains the following columns:

**dose** dose level

**prep** factor preparation: 0= Standard preparation, 1= Test preparation

**conv** number with convulsion

**total** Total

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.21

---

molar	<i>Molar data</i>
-------	-------------------

---

**Description**

Radioactivity versus molar concentration of nifedipene  
The molar data frame has 15 rows and 2 columns.

**Usage**

```
data(molar)
```

**Format**

This data frame contains the following columns:

**x** log10(NIF concentration)

**y** Total counts for  $5 \times 10^{-10}$  Molar NTD additive

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.1

---

mussels	<i>Mussels data</i>
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---

**Description**

The mussels data frame has 82 rows and 5 columns.

**Usage**

```
data(mussels)
```

**Format**

This data frame contains the following columns:

**W** width

**H** height

**L** length

**S** shell mass

**M** mass

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.9

---

ozone

*Ozone data*

---

## Description

Ozone concentration at Upland, CA.  
The ozone data frame has 80 rows and 9 columns.

## Usage

```
data(ozone)
```

## Format

This data frame contains the following columns:

**x1** a numeric vector

**x2** a numeric vector

**x3** a numeric vector

**x4** a numeric vector

**x5** a numeric vector

**x6** a numeric vector

**x7** a numeric vector

**x8** a numeric vector

**y** Ozone concentration (ppm)

## References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.7

**Description**

This function plots the results of a forward search analysis in generalized linear models.

**Usage**

```
## S3 method for class 'fwdglm'
plot(x, which.plots = 1:11, squared = FALSE, scaled = FALSE,
     ylim = NULL, xlim = NULL, th.Res = 4, th.Lev = 0.25, sig.Tst = 2.58,
     sig.score = 1.96, plot.pf = FALSE, labels.in.plot = TRUE, ...)
```

**Arguments**

x	a "fwdglm" object.
which.plots	select which plots to draw, by default all. Each graph is addressed by an integer: <ol style="list-style-type: none"> <li>1. deviance residuals</li> <li>2. leverages</li> <li>3. maximum deviance residuals</li> <li>4. minimum deviance residuals</li> <li>5. coefficients</li> <li>6. t statistics, i.e. coef.est/SE(coef.est)</li> <li>7. likelihood matrix: deviance, deviance explained, pseudo R-squared, dispersion parameter</li> <li>8. score statistic for the goodness of link test</li> <li>9. forward Cook's distances</li> <li>10. modified forward Cook's distances</li> <li>11. weights used at each step of the forward search for the units included</li> </ol>
squared	logical, if TRUE plots squared deviance residuals.
scaled	logical, if TRUE plots scaled coefficient estimates.
ylim	a two component vector for the min and max of the y axis.
xlim	a two component vector for the min and max of the x axis.
th.Res	numerical, a threshold for labelling the residuals.
th.Lev	numerical, a threshold for labelling the leverages.
sig.Tst	numerical, a value used to draw the confidence interval on the plot of the t statistics.
sig.score	numerical, a value used to draw the confidence interval on the plot of the score test statistic.
plot.pf	logical, in case of binary response if TRUE graphs contain all the step of the forward search, otherwise only those in which there is no perfect fit.
labels.in.plot	logical, if TRUE units are labelled in the plots when required.
...	further arguments passed to or from other methods.

**Author(s)**

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 6.

**See Also**

[fwdglm](#), [fwdlm](#), [fwdsc](#).

**Examples**

```
## Not run:
data(cellular)
mod <- fwdglm(y ~ as.factor(TNF) + as.factor(IFN), data=cellular,
             family=poisson(log), nsamp=200)
summary(mod)
plot(mod)

## End(Not run)
```

---

plot.fwdlm

*Forward Search in Linear Regression*

---

**Description**

This function plots the results of a forward search analysis in linear regression models.

**Usage**

```
## S3 method for class 'fwdlm'
plot(x, which.plots = 1:10, squared = FALSE, scaled = TRUE,
     ylim = NULL, xlim = NULL, th.Res = 2, th.Lev = 0.25, sig.Tst = 2.58,
     labels.in.plot = TRUE, ...)
```

**Arguments**

x	a "fwdlm" object.
which.plots	select which plots to draw, by default all. Each graph is addressed by an integer: <ol style="list-style-type: none"><li>1. scaled residuals</li><li>2. leverages</li><li>3. maximum studentized residuals</li><li>4. minimum deletion residuals</li></ol>

	5. coefficients
	6. statistics
	7. forward Cook's distances
	8. modified forward Cook's distances
	9. $S^2$ values
	10. $R^2$ values
squared	logical, if TRUE plots squared residuals.
scaled	logical, if TRUE plots scaled coefficient estimates.
ylim	a two component vector for the min and max of the y axis.
xlim	a two component vector for the min and max of the x axis.
th.Res	numerical, a threshold for labelling the residuals.
th.Lev	numerical, a threshold for labelling the leverages.
sig.Tst	numerical, a value (on the scale of the t statistics) used to draw the confidence interval on the plot of the t statistics.
labels.in.plot	logical, if TRUE units are labelled in the plots when required.
...	further arguments passed to or from other methods.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapters 2-3.

### See Also

[fwdlm](#), [fwdsc0](#), [fwdglm](#).

### Examples

```
library(MASS)
data(forbes)
plot(forbes)
mod <- fwdlm(100*log10(pres) ~ bp, data=forbes)
summary(mod)
## Not run: plot(mod)
```

---

`plot.fwdsco`*Forward Search Transformation in Linear Regression*

---

### Description

This function plots the results of a forward search analysis for Box-Cox transformation of response in linear regression models.

### Usage

```
## S3 method for class 'fwdsco'  
plot(x, plot.Sco = TRUE, plot.Lik = FALSE, th.Sco = 2.58,  
      plot.mle = TRUE, ylim = NULL, xlim = NULL, ...)
```

### Arguments

<code>x</code>	a "fwdsco" object.
<code>plot.Sco</code>	logical, if TRUE plots the score test statistic at each step of the forward search for each lambda value.
<code>plot.Lik</code>	logical, if TRUE plots the likelihood value at each step of the forward search for each lambda value.
<code>th.Sco</code>	numerical, a value used to draw the confidence interval on the plot of the score test statistic.
<code>plot.mle</code>	logical, if TRUE adds a point at the maximum likelihood value for the transformation computed in the final step, i.e. on the full dataset.
<code>ylim</code>	a two component vector for the min and max of the y axis.
<code>xlim</code>	a two component vector for the min and max of the x axis.
<code>...</code>	further arguments passed to or from other methods.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapters 2-3.

### See Also

[fwdsco](#), [fwdlm](#), [fwdglm](#).



**Examples**

```
## Not run:
data(wool)
mod <- fwsco(y ~ x1 + x2 + x3, data = wool)
plot(mod, plot.mle=FALSE)
plot(mod, plot.Sco=FALSE, plot.Lik=TRUE)

## End(Not run)
```

---

poison	<i>Poison data</i>
--------	--------------------

---

**Description**

Box and Cox poison data. Survival times in 10 hour units of animals in a  $3 \times 4$  factorial experiment. The poison data frame has 48 rows and 3 columns.

**Usage**

```
data(poison)
```

**Format**

This data frame contains the following columns:

**time** a numeric vector

**poison** a factor

**treat** a factor with levels: A, B, C, D

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.8

---

rainfall	<i>Rainfall data</i>
----------	----------------------

---

**Description**

Toxoplasmosis data.

The rainfall data frame has 34 rows and 3 columns.

**Usage**

```
data(rainfall)
```

**Format**

This data frame contains the following columns:

**Rain** mm of rain

**Cases** cases of toxoplasmosis

**Total** total

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.22

---

salinity

*Salinity data*

---

**Description**

The salinity data frame has 28 rows and 4 columns.

**Usage**

```
data(salinity)
```

**Format**

This data frame contains the following columns:

**lagsalinity** Lagged salinity

**trend** Trend

**waterflow** Water flow

**salinity** Salinity

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.6

---

`scglm`*Goodness of Link Test in GLM*

---

**Description**

Computes the score test statistic for the goodness of link test in generalized linear models.

**Usage**

```
scglm(x, y, family, weights, beta, phi = 1, offset)
```

**Arguments**

<code>x</code>	a matrix or data frame containing the explanatory variables.
<code>y</code>	the response: a vector of length the number of rows of <code>x</code> .
<code>family</code>	a description of the error distribution and link function to be used in the model. See <a href="#">family</a> for details.
<code>weights</code>	an optional vector of weights to be used in the fitting process.
<code>beta</code>	a vector of coefficients estimates
<code>phi</code>	the dispersion parameter
<code>offset</code>	optional, a priori known component to be included in the linear predictor during fitting.

**Details**

See pag. 200–201 of Atkinson and Riani (2000).

**Value**

Return the value of the score test statistic.

**Author(s)**

Originally written for S-Plus by: Kjell Konis <[kkonis@insightful.com](mailto:kkonis@insightful.com)> and Marco Riani <[mriani@unipr.it](mailto:mriani@unipr.it)>  
Ported to R by Luca Scrucca <[luca@stat.unipg.it](mailto:luca@stat.unipg.it)>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 6.

**See Also**

[fwdglm](#), [fwdlm](#), [score.s](#).

---

`score.s`*Score test for the Box-Cox transformation of the response*

---

**Description**

Computes the approximate score test statistic for the Box-Cox transformation

**Usage**

```
score.s(x, y, la, tol = 1e-20)
lambda.mle(x, y, init = c(-2, 2), tol = 1e-04)
```

**Arguments**

<code>x</code>	a matrix or data frame containing the explanatory variables.
<code>y</code>	the response: a vector of length the number of rows of <code>x</code> .
<code>la</code>	the value of the lambda parameter.
<code>tol</code>	tolerance value used to check for full rank matrix.
<code>init</code>	range of values to search for MLE.

**Details**

See pag. 82–86 of Atkinson and Riani (2000).

**Value**

Return a list with two components:

Score	the value of the score test statistic
Likelihood	the value of the likelihood

**Author(s)**

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 4.

**See Also**

[fwdscs](#), [fwdlm](#), [fwdglm](#).

---

stackloss	<i>Stackloss data</i>
-----------	-----------------------

---

**Description**

Brownlee's stack loss data.  
The stackloss data frame has 21 rows and 4 columns.

**Usage**

```
data(stackloss)
```

**Format**

This data frame contains the following columns:

**Air** Air flow

**Temp** Cooling water inlet temperature

**Conc** Acid concentration

**Loss** Stack loss

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.5

---

summary.fwdglm	<i>Summarizing Fit of Forward Search in Generalized Linear Regression</i>
----------------	---

---

**Description**

summary method for class "fwdglm".

**Usage**

```
## S3 method for class 'fwdglm'
summary(object, steps = "auto", remove.perfect.fit = TRUE, ...)
```

**Arguments**

**object** an object of class "fwdglm".

**steps** the number of forward steps to show.

**remove.perfect.fit** logical, controlling if perfect fit steps should be removed (only apply to binary responses).

**...** further arguments passed to or from other methods.

**Author(s)**

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 6.

**See Also**

[fwdglm](#).

---

summary.fwdlm

*Summarizing Fit of Forward Search in Linear Regression*

---

**Description**

summary method for class "fwdlm".

**Usage**

```
## S3 method for class 'fwdlm'  
summary(object, steps = "auto", ...)
```

**Arguments**

object	an object of class "fwdlm".
steps	the number of forward steps to show.
...	further arguments passed to or from other methods.

**Author(s)**

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapters 2-3.

**See Also**

[fwdlm](#).

---

summary.fwdsco	<i>Summarizing Fit of Forward Search Transformation in Linear Regression</i>
----------------	--

---

### Description

summary method for class "fwdsco".

### Usage

```
## S3 method for class 'fwdsco'  
summary(object, steps = "auto", lambdaMLE = FALSE, ...)
```

### Arguments

object	an object of class "fwdsco".
steps	the number of forward steps to show.
lambdaMLE	logical, controlling if the MLE of lambda calculated on the full dataset must be shown.
...	further arguments passed to or from other methods.

### Author(s)

Originally written for S-Plus by: Kjell Konis <kkonis@insightful.com> and Marco Riani <mriani@unipr.it>  
Ported to R by Luca Scrucca <luca@stat.unipg.it>

### References

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Chapter 4.

### See Also

[fwdsco](#).

---

vaso	<i>Vaso data</i>
------	------------------

---

### Description

Finney's data on vaso-contraction in the skin of the digits.  
The vaso data frame has 39 rows and 3 columns.

### Usage

```
data(vaso)
```

**Format**

This data frame contains the following columns:

**volume** volume

**rate** rate

**y** response: 0= nonoccurrence, 1= occurrence

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.23

---

wool

*Wool data*

---

**Description**

Number of cycles to failure of samples of worsted yarn in a 33 experiment.  
The wool data frame has 27 rows and 4 columns.

**Usage**

```
data(wool)
```

**Format**

This data frame contains the following columns:

**x1** factor levels: -1, 0, 1

**x2** factor levels: -1, 0, 1

**x3** factor levels: -1, 0, 1

**y** cycles to failure a numeric vector

**References**

Atkinson, A.C. and Riani, M. (2000), *Robust Diagnostic Regression Analysis*, First Edition. New York: Springer, Table A.3



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