Package ‘tlm’

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**Type**  Package

**Title**  Effects under Linear, Logistic and Poisson Regression Models with Transformed Variables

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**Description**

Computation of effects under linear, logistic and Poisson regression models with transformed variables. Logarithm and power transformations are allowed. Effects can be displayed both numerically and graphically in both the original and the transformed space of the variables.

**License**  GPL (>= 2)

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tlm-package
Effects under Linear, Logistic and Poisson Regression Models with Transformed Variables

Description

Computation of effects under linear, logistic and Poisson regression models with transformed variables. Logarithm and power transformations are allowed. Effects can be displayed both numerically and graphically in both the original and the transformed space of the variables.

Details

Package: tlm
Type: Package
Version: 0.1.3
Date: 2014-12-05
License: GPL (>=2)
URL: http://www.creal.cat/xbasagana/software.html
LazyLoad: yes

Author(s)

Jose Barrera-Gomez and Xavier Basagana
Maintainer: Jose Barrera-Gomez <jbarrera@creal.cat>

References


Examples

# linear regression model with log-log transformation:
data(feld1)
head(feld1)
modcat <- tlm(y = logroom, x = logmattress, z = cat, ypow = 0, xpow = 0, data = feld1)

# print and summary:
modcat
summary(modcat)

# plotting the fitted model in the original space:
plot(modcat, xname = "Mattress levels", yname = "room levels")
# plotting the fitted model in the transformed space (and adding the observations):
plot(modcat, xname = "Mattress levels", yname = "room levels", type = "transformed",
    observed = TRUE)

# diagnosis plot for the fitted model:
plot(modcat, type = "diagnosis")

# Expected geometric mean of the response, adjusting for variable 'cat':
MY(modcat)

# Expected mean of the transformed response, adjusting for variable 'cat':
MY(modcat, space = "transformed")

# Information on how to interpret effects:
effectInfo(modcat)

# Summary effect (default effect):
effect(modcat)

---

**cotinine**

*Birth Weight and Cord Serum Cotinine*

**Description**
Simulated data for birth weight and cord serum cotinine levels in 351 newborns.

**Usage**
data(cotinine)

**Format**
A data frame with 351 observations on the following 4 variables.
cotinine numeric cord serum cotinine level in the mother (ng/ml).
logcotinine logarithm of cotinine.
weight numeric birth weight (g).
underweight a factor with levels no and yes, indicating underweight (weight < 2500 g).

**Details**
Data were simulated to emulate true data pattern observed in a real study (see ‘References’).

**Source**
See ‘References’.
References


Examples

data(cotinine)
par(las = 1, mfrow = c(2, 2))
with(cotinine, plot(cotinine, weight))
with(cotinine, plot(logcotinine, weight))
with(cotinine, boxplot(cotinine ~ underweight))
with(cotinine, boxplot(logcotinine ~ underweight))

effect

*Effects Estimate in Linear, Logistic and Poisson Regression Models with Transformed Variables*

Description

This function estimates the effect of an explanatory variable of interest on a response variable, under a fitted linear, logistic or Poisson regression model with transformed variables. The effect is estimated in the original scale of the variables.

Usage

effect(object, x1 = NULL, x2 = NULL, c = NULL, q = NULL, r = NULL, npoints = NULL, level = 0.95, nboot = 999, seed = 4321, verbose = TRUE)

## S3 method for class 'effect'
print(x, ...)

Arguments

object
an object of class "tlm", a result of a call to `tlim`.

x1
numeric. The values of the explanatory variable where the effect should be computed. See ‘Details’.

x2
numeric. The alternative values of the explanatory variable (changing from x1) for which the effect should be computed. See ‘Details’.

c
numeric. The additive change in the explanatory variable. See ‘Details’.

q
numeric. The multiplicative change in the explanatory variable. See ‘Details’.

r
numeric. The percent change in the explanatory variable. See ‘Details’.

npoints
numeric. The number of points where the effect should be computed. See ‘Details’.

level
numeric. Confidence level for the effect estimate. Default is 0.95.

nboot
numeric. The number of non parametric bootstrap samples to compute confidence intervals. Default is 999. See ‘Details’.
**effect**

- **seed**: numeric. A single value, the seed for bootstrapping. Default is 4321.
- **verbose**: logical. Whether to print detailed progress on R prompt. Default is **TRUE**.
- **x**: an object of class "effect", a result of a call to `effect`.
- **...**: further additional arguments passed to the method `print`.

**Details**

In order to compute the effect, both the initial and the final values of the explanatory should be provided. It can be done in several ways. For instance, providing, `x1` and `x2`; `x1` and one of `c`, `q` or `r`; `x1`, `npoints` and one of `c`, `q` or `r`. Only one of the arguments `c`, `q` or `r` is used, prevailing `c` and then `q`. If no enough argument are passed, the interquartile range will be considered and a summary effect should be computed, if it exists.

Confidence intervals are computed by transforming the endpoints of the intervals in the transformed scale when it is possible, while non-parametric bootstrap is used otherwise.

**Value**

- **effect**: point estimate and confidence interval for the effect size.
- **info**: information on how to interpret the effect. Used by the function `effectInfo`.

**Author(s)**

Barrera-Gomez J and Basagana X.

**References**


**See Also**

`tlm`, `effectInfo`, `MY`.

**Examples**

```r
### Linear model with log transformation in the response variable:
data(imt)
head(imt)

# model fitting:
modimt <- tlm(y = logint, x = age, data = imt, ypow = 0)
modimt

# information on interpreting the effect:
effectInfo(modimt)

# the function effect provides as default the expected change in IMT for an additive change in age
# equal to the interquartile range:
effect(modimt)
```
# other effects:
(minage <- min(imt$age))
(maxage <- max(imt$age))
effect(modimt, c = maxage - minage)

## Not run:
effect(modimt, x1 = minage, r = 50, npoints = 3)

## End(Not run)

---

**effectInfo**

*Interpretation of Effects in Linear, Logistic and Poisson Models with Transformed Variables*

---

**Description**

This function provides information on interpreting effects in linear, logistic and Poisson models with transformed variables. Specifically, if a summary measure for the effect exists, the function details how to obtain it.

**Usage**

```r
effectInfo(object)
```

## S3 method for class 'effectInfo'

```r
print(x, ...)
```

**Arguments**

- `object` an object of class "tmodel", a result of a call to `tmodel`.
- `x` an object of class "effectInfo", a result of a call to `effectInfo`.
- `...` further additional arguments for the `print` method.

**Value**

- `beta` regression coefficient estimate in the fitted model which is associated to the effect of the explanatory variable of interest on the response variable. NA corresponds to those models for which a summary effect does not exist.
- `Xincrease` type of change in the exploratory variable of interest (additive or relative) for which a summary effect exists. NA corresponds to those models for which a summary effect does not exist.
- `effecttype` type of effect on the response variable for which a summary effect exists. NA corresponds to those models for which a summary effect is not available.
- `effectsize` formula for the summary effect size, if any. NA corresponds to those models for which a summary effect is not available.
- `furtherinfo` further information about how to interpret effects.
### References


### See Also

tlm, effect, MY.

### Examples

```r
### Linear model with log transformation in the explanatory variable:
data(cotinine)
head(cotinine)
# model fitting:
modcot <- tlm(y = weight, x = logcotinine, data = cotinine, xpow = 0)
modcot
# information on interpreting the effect:
effectInfo(modcot)

### Linear model with no summary measure of effect:
data(glucose)
head(glucose)
# transformations Y^(-2) and X^(-1/2):
modgluco <- tlm(y = inv2glu, x = inv12tri, data = glucose, ypow = -2, xpow = -1/2)
modgluco
effectInfo(modgluco)
```

---

**feld1**

*Cat Allergen Concentrations*

---

### Description

Simulated data for cat allergen concentrations (Fel d 1) in 471 homes, measured in both the living room and the bed mattress.

### Usage

data(feld1)
**Format**

A data frame with 471 observations on the following 5 variables.

- **mattress** numeric Feld d 1 concentration in the bed mattress (µg/g).
- **room** numeric Feld d 1 concentration in the living room (µg/g).
- **logmattress** logarithm of mattress.
- **logroom** logarithm of room.
- **cat** a factor with levels no and yes, indicating cat ownership.

**Details**

Data were simulated to emulate true data pattern observed in a real study (see ‘References’).

**Source**

See ‘References’.

**References**

Basagana X *et al.* Domestic aeroallergen levels in Barcelona and Menorca (Spain). *Pediatric Allergy and Immunology*. 2002;13(6):412-417.

**Examples**

data(feld1)
par(las = 1, mfrow = c(1,2))
with(feld1, plot(mattress, room, col = as.numeric(cat)))
with(feld1, plot(logmattress, logroom, col = as.numeric(cat)))

---

**glucose**

*Glucose and Triglycerides Levels in Blood*

**Description**

Simulated data for glucose and triglycerides levels in blood in 400 adults.

**Usage**

data(glucose)

**Format**

A data frame with 400 observations on the following 4 variables.

- **trigly** numeric triglycerides levels in blood (mg/dl).
- **gluco** numeric glucose levels in blood (mg/dl).
- **inv2tri** numeric reciprocal of the square root of trigly (i.e., -1/2 power transformation).
- **inv2glu** numeric reciprocal of the gluco square (i.e., -2 power transformation).
Details

Data were simulated to emulate true data pattern observed in a real study (see ‘References’).

Source

See ‘References’.

References


Examples

data(glucose)
par(las = 1, mfrow = c(1, 2))
with(glucose, plot(trigly, gluco))
with(glucose, plot(inv12tri, inv2glu))

---

**Intima Media Thickness of the Carotid Artery**

Description

Simulated data for intima media thickness of the carotid artery and age in 2784 adults.

Usage

data(imt)

Format

A data frame with 2784 observations on the following 3 variables.

- **age** numeric age of the individual (years).
- **imt** numeric intima media thickness of the carotid artery (mm).
- **logimt** logarithm of **imt**.

Details

Data were simulated to emulate true data pattern observed in a real study (see ‘References’).

Source

See ‘References’.
References


Examples

```r
data(imt)
par(las = 1L, mfrow = c(1L, 2L))
with(imt, plot(age, imt))
with(imt, plot(age, logimt))
```

---

**MY**

*Expected Adjusted Median or Generalized Mean*

Description

This function computes expected measures of the response variable under a linear, logistic or Poisson regression fitted model with transformed variables. Measures can be calculated in both the original and the transformed space. The function automatically provides the name of the measure depending on the fitted model.

Usage

```r
MY(object, x = NULL, npoints = 10L, space = c("original", "transformed"), level = 0.95)
```

## S3 method for class 'MY'

```r
print(x, ...)''')

Arguments

- **object**: an object of class "t1m", a result of a call to `t1m`.
- **x**: for `MY`: numeric. a number or a numeric vector containing the values of the explanatory variable of interest for which the expected measure of the response variable are required. Default is NULL. For `print.MY`: an object of class "MY", a result of a call to MY.
- **npoints**: numeric. If x is NULL, the number of points where the measure should be measured. Default is 10. See ‘Details’.
- **space**: character. If "original" (default), the measure is computed in the original space of the variables. If "transformed", the measure is computed in the transformed space of the variables, where the model is fitted.
- **level**: numeric. The confidence level for measures. Default is 0.95.
- **...**: further additional arguments for the `print.MY` method.
Details
In order to compute adjusted measures, all explanatory variables in the model different than the explanatory variable of interest are set at their means.

If space is "original", then the mean (for Poisson response) or the probability (for binary response) is computed. For gaussian response, the mean is computed if the response variable is not transformed; otherwise, the geometric mean (for log transformation in the response) or the median (for power transformation) is computed.

If space is “transformed”, then the mean (for Poisson response or transformed gaussian response), or the logodds (for binary response) is computed.

If x is NULL, the measure is computed in npoints values of the explanatory variable of interest. Those values are choosen to be in arithmetic progression in the given space, inside the observed range of the explanatory variable.

Value
- \( M \): adjusted measure of the response variable. See ‘Details’.
- \( ymeasure \): the type of measure for \( M \).
- \( space \): space where measures has been computed ("original" or "transformed").
- \( ypow \): numeric power transformation assumed in the response variable. See \texttt{tlm}.
- \( xpow \): numeric power transformation assumed in the explanatory variable of interest. See \texttt{tlm}.

Author(s)
Barrera-Gomez J and Basagana X.

References

See Also
\texttt{tlm}, \texttt{effectInfo}, \texttt{effect}.

Examples
```r
data(feldI)
head(feldI)

# Linear model with log-log transformation, adjusting for variable 'cat':
modcat <- \texttt{tlm(y = logroom, x = logmattress, z = cat, data = feldI, ypow = 0, xpow = 0)}
summary(modcat)

# Geometric mean of the response as a function of the explanatory variable, adjusted for
# variable 'cat':
MY(modcat)
MY(modcat, npoints = 3)
```
# computed at 1st and 3rd quartiles of the explanatory variable:
MY(modcat, x = quantile(feld1$mattress, probs = c(1, 3)/4))

# Mean of the log(response) as a function of the log explanatory variable, adjusted for # variable 'cat':
MY(modcat, space = "transformed")

summary.tlm

Summarizing Linear, Logistic and Poisson Models Fits with Transformed Variables.

Description

summary method for an object created by the function tlm.

Usage

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

Arguments

- `object` an object of class "tlm", a result of a call to tlm.
- `x` an object of class "summary.tlm", a result of a call to summary.tlm.
- `...` further additional arguments for summary and print methods.

Details

Essentially, the output of summary.lm or summary.glm is displayed. In addition, further information on the fitted model is also displayed.

Value

- `model` the fitted model in the transformed space.
- `ypow` the value of ypow.
- `xpow` the value of xpow.
- `summary` the summary of the fitted model provide by summary.lm (for gaussian response) or summary.glm (otherwise).

Author(s)

Barrera-Gomez J and Basagana X.
References

See Also
tlm, summary.lm, summary.glm.

Examples
### linear model with log-log transformation:
data(feld1)
modcat <- tlm (y = logroom, x = logmattress, z = cat, data = feld1, ypow = 0, xpow = 0)
modcat
summary(modcat)

---

**tlm**

*Fitting Linear, Logistic and Poisson Regression Models with Transformed Variables*

**Description**
This function fits a linear, logistic or Poisson regression model with transformed variables and creates an object which can be used to extract effects of the explanatory variable of interest on the response variable, in the original scale of the variables.

**Usage**
tlm(y, x, z = "none", family = gaussian, data, ypow = 1, xpow = 1, ...)
## S3 method for class 'tlm'
print(x, ...)
## S3 method for class 'tlm'
plot(x, type = c("original", "transformed", "diagnosis"), observed = FALSE, xname = "x", yname = "y", level = 0.95, ...)

**Arguments**

- **y** name of the response variable (unquoted).
- **x** name of the explanatory variable of interest (unquoted).
- **z** additional explanatory variables in the model. Default is "none". For a single variable, the name of the variable (unquoted); for more than one variable, the names should be passed unquoted and separated by the plus sign; for all the remaining variables in data, use just a period (.). No interaction terms are allowed.
- **family** the link function. For linear model, gaussian (default); for logistic regression, binomial; for Poisson regression, poisson. Quoted values are optional. In the case of binomial, the logit link is assumed.
data a data.frame containing the variables in the model.
ypow numeric power transformation already done in y. See ‘Details’.
xpow numeric power transformation already done in x. See ‘Details’.
type character indicating the type of plot for the fitted model. If "original" (default), the fitted model is plotted in the original space of the variables; if "transformed", the fitted model is plotted in the transformed space of the variables (where the model has been fitted); if "diagnosis", a model diagnostics plot is shown.
observed logical indicating whether the observations should be added to the plot. Assumed to be FALSE if x is categorical. Default is FALSE.
xname character. The name of the x variable for labeling the horizontal plot axis. Default is "x".
yname character. The name of the y variable for labeling the vertical plot axis. Default is "y". The name of the measure for the response variable is automatically added before yname.
level numeric. Confidence level for the prediction of the measure of y plotted. Default is 0.95.
... further additional arguments passed to tlm or methods print and plot.

Details
The transformations already done in y and x are passed by ypow and xpow, respectively. They should be a number. Default is 1 (no transformation). The value 0 corresponds to the logarithmic transformation. If family is not gaussian, y is assumed non transformed. If x is categorical or presents only two different values, the value of xpow is assumed to be 1.

Value
model the fitted model in the transformed space.
ypow the value of ypow.
xpow the value of xpow.

Author(s)
Barrera-Gomez J and Basagana X.

References

See Also
my, effect.
Examples

```r
### Linear model with log-log transformation:
data(feld1)
head(feld1)
# model fitting in the transformed space:
modcat <- tlm(y = log(room), x = log(mattress), z = cat, data = feld1, ypow = 0, xpow = 0)
summary(modcat)
# plot of the geometric mean of the response (original space), adjusting for variable 'cat':
plot(modcat, xname = "Mattress levels", yname = "room levels")
# plot of the mean of the log of response (transformed space), adjusting for variable 'cat' and adding the observations:
plot(modcat, type = "transformed", xname = "mattress levels", yname = "room levels",
     observed = TRUE)
# diagnosis plot:
plot(modcat, type = "diagnosis")
```

```r
### The same model but now considering 'cat' as the explanatory variable of interest:
modcat2 <- tlm(y = log(room), x = cat, z = log(mattress), data = feld1, ypow = 0)
summary(modcat2)
# plot of the geometric mean of the response (original space), adjusting for mattress levels:
plot(modcat2, xname = "Cat", yname = "room levels")
# plot of the mean of the log of response (transformed space), adjusting for mattress levels:
plot(modcat2, type = "transformed", xname = "Cat", yname = "room levels")
```
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