Package 'effects'

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Title Effect Displays for Linear, Generalized Linear, and Other Models

Depends R (>= 3.2.0), carData

Suggests pbkrtest (>= 0.4-4), nlme, MASS, poLCA, heplots, splines, ordinal, car, knitr

Imports lme4, nnet, lattice, grid, colorspace, graphics, grDevices, stats, survey, utils, estimability

LazyLoad yes

LazyData yes

Description Graphical and tabular effect displays, e.g., of interactions, for various statistical models with linear predictors.

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Details

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This package creates effect displays for various kinds of models, as partly explained in the references. Typical usage is `plot(allEffects(model))` or `plot(predictorEffects(model))`, where `model` is an appropriate fitted-model object. Additional arguments to `allEffects`, `predictorEffects` and `plot` can be used to customize the resulting displays. The function `effect` can be employed to produce an effect display for a particular term in the model, or to which terms in the model are marginal. The function `predictorEffect` can be used to construct an effect display for a particularly predictor. The function `Effect` may similarly be used to produce an effect display for any combination of predictors. In any of the cases, use `plot` to graph the resulting effect object. For linear and generalized linear models it is also possible to plot partial residuals to obtain (multidimensional) component+residual plots. See `?effect`, `?Effect`, `?predictorEffect`, and `?plot.eff` for details.

Author(s)

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References

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`effect` *Functions For Constructing Effect Displays*

Description

`Effect` and `effect` construct an `"eff"` object for a term (usually a high-order term) in a linear model (fit by `lm` or `gls`) or generalized linear model (fit by `glm`), or an `"effpoly"` object for a term in a multinomial or proportional-odds logit model (fit respectively by `multinom` or `polr`), absorbing the lower-order terms marginal to the term in question, and averaging over other terms in the model. For multivariate linear models (of class `"mlm"`, fit by `lm`), the function constructs a list of `"eff"` objects separately for the various response variables.

`effect` builds the required object by specifying explicity a focal term like `"a:b"` for an `a` by `b` interaction. `Effect` specifies the predictors in the term, for example `c("a", "b")`, rather than the term itself. `Effect` is consequently more flexible and robust than `effect`, and will succeed with some models for which `effect` fails. The `effect` function works by constructing a call to `Effect`.

The `Effect` and `effect` functions can also be used with many other models; see `Effect.default` and a vignette for this package.

`allEffects` identifies all of the high-order terms in a model and returns a list of `"eff"` or `"effpoly"` objects (i.e., an object of type `"efflist"`).

For information on computing and displaying *predictor effects*, see `predictorEffect` and `plot.predictoreff`.

For further information about plotting effects, see `plot.eff`.

Usage

```
effect(term, mod, vcov.=vcov, ...)

## Default S3 method:
effect(term, mod, vcov.=vcov, ...)

Effect(focal.predictors, mod, ...)

## S3 method for class 'lm'
Effect(focal.predictors, mod, xlevels=list(),
    fixed.predictors, vcov. = vcov, se=TRUE,
    transformation = list(link = family(mod)$linkfun,
        inverse = family(mod)$linkinv),
    residuals=FALSE, quantiles=seq(0.2, 0.8, by=0.2),
    x.var=NULL,  ...,
    #legacy arguments:
    given.values, typical, offset, confint, confidence.level,
    partial.residuals)

## S3 method for class 'multinom'
Effect(focal.predictors, mod,
    xlevels=list(), fixed.predictors,
    vcov. = vcov, se=TRUE, ...,
    #legacy arguments:
    confint, confidence.level, given.values, typical)

## S3 method for class 'polr'
Effect(focal.predictors, mod,
    xlevels=list(), fixed.predictors,
    vcov.=vcov, se=TRUE, latent=FALSE, ...,
    #legacy arguments:
    confint, confidence.level, given.values, typical)

## S3 method for class 'svyglm'
Effect(focal.predictors, mod, fixed.predictors, ...)

allEffects(mod, ...)

## Default S3 method:
allEffects(mod, ...)

## S3 method for class 'eff'
as.data.frame(x, row.names=NULL, optional=TRUE,
    transform=x$transformation$inverse, ...)

## S3 method for class 'effpoly'
as.data.frame(x, row.names=NULL, optional=TRUE, ...)
```

```
## S3 method for class 'efflatent'
as.data.frame(x, row.names=NULL, optional=TRUE, ...)

## S3 method for class 'eff'
vcov(object, ...)
```

Arguments

`term` the quoted name of a term, usually, but not necessarily, a high-order term in the model. The term must be given exactly as it appears in the printed model, although either colons (`:`) or asterisks (`*`) may be used for interactions. If `term` is NULL, the function returns the formula for the linear predictor.

`focal.predictors`
a character vector of one or more predictors in the model in any order.

`mod` an object of the appropriate class. If no method exists for that class, `Effect.default` will be called.

`xlevels` this argument is used to set the number of levels for any focal predictor that is not a factor. If `xlevels=NULL`, then each numeric predictor is represented by five values equally spaced over its range and then rounded to 'nice' numbers. If `xlevels=n` is an integer, then each numeric predictor is represented by `n` equally spaced values rounded to 'nice' numbers. More generally, `xlevels` can be a named list of values at which to set each numeric predictor. For example, `xlevels=list(x1=c(2, 4, 7), x2=5)` would use the values 2, 4 and 7 for the levels of `x1`, use 5 equally spaced levels for the levels of `x2`, and use the default for any other numeric predictors. If partial residuals are computed, then the focal predictor that is to appear on the horizontal axis of an effect plot is evaluated at 100 equally spaced values along its full range, and, by default, other numeric predictors are evaluated at the quantiles specified in the `quantiles` argument, unless their values are given explicitly in `xlevels`.

`fixed.predictors`
an optional list of specifications affecting the values at which fixed predictors for an effect are set, potentially including:

given.values `given.values="default"` specifies averaging over levels of a non-focal factor using the default that weights levels of the factor by sample size. `given.values="equal"` uses unweighted averages over factor levels for non-focal factors. For finer control, the user can also provide a named numeric vector of weights for particular columns of the model matrix that correspond to regressors for the factor. For example, for a factor `X` with three levels `a`, `b` and `c`, the regressors generated using the default parameterization for a factor will be named `Xb` and `Xc` as the regressor for level `a` is usually excluded. The specification `given.values=c(Xb=1/2, Xc=1/4)` would average over the levels of `X` with weight 1/2 for level `b`, 1/4 for `c`, and weight 1 = 1/2 - 1/4 = 1/4 for the baseline level `a`. Setting `given.values=c(Xb=1)` will fix `X` and level `b`.

typical a function to be applied to the columns of the model matrix over which the effect is "averaged"; with the exception of the `"svyglm"` method, the default is `mean`. For`"svyglm"` objects, the default is to use the survey-design weighted mean.

apply.typical.to.factors It generally doesn't make sense to apply typical values that aren't means (e.g., medians) to the columns of the model-matrix representing contrasts for factors. This value generally defaults to FALSE except for "svyglm" objects, for which the default is TRUE, using the the survey-design weighted mean.

offset a function to be applied to the offset values (if there is an offset) in a linear or generalized linear model, or a mixed-effects model fit by lmer or glmer; or a numeric value, to which the offset will be set. The default is the mean function, and thus the offset will be set to its mean; in the case of "svyglm" objects, the default is to use the survey-design weighted mean. *Note:* Only offsets defined by the offset argument to lm, glm, svyglm, lmer, or glmer will be handled correctly; use of the offset function in the model formula is not supported.

vcov. A function or the name of a function that will be used to get the estimated variance-covariance matrix of the estimated coefficients. This will ordinarily be the default, vcov, which will result in the function call vcov(mod) to get the variance-covariance matrix. You can use the name of any function that takes the model object as its first argument and returns an estimated sample covariance matrix, such as the hccm function in the **car** package, which returns a heteroscedasticity corrected estimate for a linear model.

se TRUE (the default), FALSE, or a list with any or all of the following elements, controlling whether and how standard errors and confidence limits are computed for the effects: compute (default TRUE), whether or not to compute standard errors and confidence limits; level (default 0.95), confidence level for confidence limits; type, one of "pointwise" (the default), "Scheffe", or "scheffe", whether to compute confidence limits with specified coverage at each point for an effect or to compute limits for a Scheffe-type confidence envelope. For mer, merMod, and lme objects, the normal distribution is used to get confidence limits.

transformation a two-element list with elements link and inverse. For a generalized linear model, these are by default the link function and inverse-link (mean) function. For a linear model, these default to NULL. If NULL, the identity (or inhibit) function, I, is used; this effect can also be achieved by setting the argument to NULL. The inverse-link may be used to transform effects when they are printed or plotted; the link may be used in positioning axis labels (see below). If the link is not given, an attempt will be made to approximate it from the inverse-link.

residuals if TRUE, residuals for a linear or generalized linear model will be computed and saved; if FALSE (the default), residuals are suppressed. If residuals are saved, partial residuals are computed when the effect is plotted: see plot.eff. This argument may also be used for mixed-effects and some other models.

quantiles quantiles at which to evaluate numeric focal predictors *not* on the horizontal axis, used only when partial residuals are displayed; superceded if the xlevels argument gives specific values for a predictor.

x.var the name or index of the numeric predictor to define the horizontal axis of an effect plot for a linear or generalized linear model; the default is NULL, in which case the first numeric predictor in the effect will be used *if* partial residuals are to be computed. This argument is intended to be used when residuals is TRUE;

otherwise, the variable on the horizontal axis can be chosen when the effect object is plotted: see plot.eff.

latent — if TRUE, effects in a proportional-odds logit model are computed on the scale of the latent response; if FALSE (the default) effects are computed as individual-level probabilities and logits.

x — an object of class "eff", "effpoly", or "efflatent".

transform — a transformation to be applied to the effects and confidence limits, by default taken from the inverse link function saved in the "eff" object.

row.names, optional — not used.

object — an object of class "eff" for which the covariance matrix of the effects is desired.

... — arguments to be passed down.

confint, confidence.level, given.values, typical, offset, partial.residuals — legacy arguments retained for backwards compatability; if present, these arguments take precedence over level element of the confint list argument and the given.values, typical, and offset elements of the fixed.predictors list argument; confint may be used in place of the se argument; partial.residuals may be use din place of the residuals argument. See LegacyArguments for details.

Details

Normally, the functions to be used directly are allEffects, to return a list of high-order effects, and the generic plot function to plot the effects. (see plot.efflist, plot.eff, and plot.effpoly). Alternatively, Effect can be used to vary a subset of predictors over their ranges, while other predictors are held to typical values. Plots are drawn using the xyplot (or in some cases, the densityplot) function in the **lattice** package. Effects may also be printed (implicitly or explicitly via print) or summarized (using summary) (see print.efflist, summary.efflist, print.eff, summary.eff, print.effpoly, and summary.effpoly).

If asked, the effect function will compute effects for terms that have higher-order relatives in the model, averaging over those terms (which rarely makes sense), or for terms that do not appear in the model but are higher-order relatives of terms that do. For example, for the model Y ~ A*B + A*C + B*C, one could compute the effect corresponding to the absent term A:B:C, which absorbs the constant, the A, B, and C main effects, and the three two-way interactions. In either of these cases, a warning is printed.

The as.data.frame methods convert effect objects to data frames to facilitate the construction of custom displays. In the case of "eff" objects, the se element in the data frame is always on the scale of the linear predictor, and the transformation used for the fit and confidence limits is saved in a "transformation" attribute.

See predictorEffects for an alternative paradigm for getting effects.

Value

For lm, glm,svyglm, mer and lme, effect and Effect return an "eff" object, and for multinom, polr, clm, clmm and clm2, an "effpoly" object, with the components listed below. For an "mlm" object with one response specified, an "eff" object is returned, otherwise an "efflist" object is returned, containing one "eff" object for each response.

term	the term to which the effect pertains.
formula	the complete model formula.
response	a character string giving the name of the response variable.
y.levels	(for "effpoly" objects) levels of the polytomous response variable.
variables	a list with information about each predictor, including its name, whether it is a factor, and its levels or values.
fit	(for "eff" objects) a one-column matrix of fitted values, representing the effect on the scale of the linear predictor; this is a ravelled table, representing all combinations of predictor values.
prob	(for "effpoly" objects) a matrix giving fitted probabilities for the effect for the various levels of the the response (columns) and combinations of the focal predictors (rows).
logit	(for "effpoly" objects) a matrix giving fitted logits for the effect for the various levels of the the response (columns) and combinations of the focal predictors (rows).
x	a data frame, the columns of which are the predictors in the effect, and the rows of which give all combinations of values of these predictors.
model.matrix	the model matrix from which the effect was calculated.
data	a data frame with the data on which the fitted model was based.
discrepancy	the percentage discrepancy for the 'safe' predictions of the original fit; should be very close to 0. Note: except for gls models, this is now necessarily 0.
offset	value to which the offset is fixed; 0 if there is no offset.
model	(for "effpoly" objects) "multinom" or "polr", as appropriate.
vcov	(for "eff" objects) a covariance matrix for the effect, on the scale of the linear predictor.
se	(for "eff" objects) a vector of standard errors for the effect, on the scale of the linear predictor.
se.prob, se.logit	(for "effpoly" objects) matrices of standard errors for the effect, on the probability and logit scales.
lower, upper	(for "eff" objects) one-column matrices of confidence limits, on the scale of the linear predictor.
lower.prob, upper.prob, lower.logit, upper.logit	(for "effpoly" objects) matrices of confidence limits for the fitted logits and probabilities; the latter are computed by transforming the former.
confidence.level	for the confidence limits.
transformation	(for "eff" objects) a two-element list, with element link giving the link function, and element inverse giving the inverse-link (mean) function.
residuals	(working) residuals for linear or generalized linear models, to be used by plot.eff to plot partial residuals.

`x.var` the name of the predictor to appear on the horizontal axis of an effect plot made from the returned object; will usually be `NULL` if partial residuals aren't computed.

`family` for a `"glm"` model, the name of the distributional family of the model; for an `"lm"` model, this is `"gaussian"`; otherwise `NULL`. The `family` controls how partial residuals are smoothed in plots.

`allEffects` returns an `"efflist"` object, a list of `"eff"` or `"effpoly"` objects corresponding to the high-order terms of the model.

If `mod` is of class `"poLCA"` (from the `poLCA` package), representing a polytomous latent class model, effects are computed for the predictors given the estimated latent classes. The result is of class `"eff"` if the latent class model has 2 categories and of class `"effpoly"` with more than 2 categories.

Warnings and Limitations

The `Effect` function handles factors and covariates differently, and is likely to be confused if one is changed to the other in a model formula. Consequently, formulas that include calls to `as.factor`, `factor`, or `numeric` (as, e.g., in `y ~ as.factor(income)`) will cause errors. Instead, create the modified variables outside of the model formula (e.g., `fincome <- as.factor(income)`) and use these in the model formula.

Factors cannot have colons in level names (e.g., `"level:A"`); the `effect` function will confuse the colons with interactions; rename levels to remove or replace the colons (e.g., `"level.A"`).

The functions in the **effects** package work properly with predictors that are numeric or factors; consequently, e.g., convert logical predictors to factors, and dates to numeric.

Empty cells in crossed-factors are now permitted for `"lm"`, `"glm"`, and `"multinom"` models. For `"multinom"` models with two or more crossed factors with an empty cell, stacked area plots apparently do not work because of a bug in the `barchart` function in the **lattice** package. However, the default line plots do work.

Offsets in linear and generalized linear models are supported, as are offsets in mixed models fit by `lmer` or `glmer`, but must be supplied through the `offset` argument to `lm`, `glm`, `lmer` or `glmer`; offsets supplied via calls to the `offset` function on the right-hand side of the model formula are not supported.

Fitting ordinal mixed-models using `clmm` or `clmm2` permits many options, including a variety of link functions, scale functions, nominal regressors, and various methods for setting thresholds. Effects are currently generated only for the default values of the arguments `scale`, `nominal`, `link` and `threshold`, which is equivalent to fitting an ordinal response mixed effects model with a logit link. The effect methods can also be used with objects created using `clm` or `clm2` fitting ordinal response models with the same links permitted by polr with no random effects, with results similar to those from `polr` in the **MASS** package.

Calling any of these functions from within a user-written function may result in errors due to R's scoping rules. See the vignette `embedding.pdf` for the **car** package for a solution to this problem.

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Fox, J. (1987). Effect displays for generalized linear models. *Sociological Methodology* **17**, 347–361.

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Weisberg, S. (2014). *Applied Linear Regression*, 4th edition, Wiley, http://z.umn.edu/alr4ed.

See Also

LegacyArguments. For information on printing, summarizing, and plotting effects: print.eff, summary.eff, plot.eff, print.summary.eff, print.effpoly, summary.effpoly, plot.effpoly, print.efflist, summary.efflist, plot.efflist, xyplot, densityplot.

Examples

```
# Note: Some examples are marked "don't run" to save time in CRAN
#       package checking; others are marked "don't test" to save
#       time in routine package checks.

mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion,
                  data=Cowles, family=binomial)
eff.cowles <- allEffects(mod.cowles, xlevels=list(extraversion=seq(0, 24, 6)),
                   fixed.predictors=list(given.values=c(sexmale=0.5)))
eff.cowles
as.data.frame(eff.cowles[[2]])


# the following are equivalent:
eff.ne <- effect("neuroticism*extraversion", mod.cowles)
Eff.ne <- Effect(c("neuroticism", "extraversion"), mod.cowles)
all.equal(eff.ne$fit, Eff.ne$fit)

plot(eff.cowles, 'sex', axes=list(y=list(lab="Prob(Volunteer)")))

plot(eff.cowles, 'neuroticism:extraversion',
     axes=list(y=list(lab="Prob(Volunteer)",
        ticks=list(at=c(.1,.25,.5,.75,.9)))))

plot(Effect(c("neuroticism", "extraversion"), mod.cowles,
```

```
            se=list(type="Scheffe"),
            xlevels=list(extraversion=seq(0, 24, 6)),
            fixed.predictors=list(given.values=c(sexmale=0.5))),
     axes=list(y=list(lab="Prob(Volunteer)",
        ticks=list(at=c(.1,.25,.5,.75,.9)))))

plot(eff.cowles, 'neuroticism:extraversion', lines=list(multiline=TRUE),
     axes=list(y=list(lab="Prob(Volunteer)")))

plot(effect('sex:neuroticism:extraversion', mod.cowles,
            xlevels=list(extraversion=seq(0, 24, 6))),
     lines=list(multiline=TRUE))

# a nested model:

mod <- lm(log(prestige) ~ income:type + education, data=Prestige)

plot(Effect(c("income", "type"), mod, transformation=list(link=log, inverse=exp)),
     axes=list(y=list(lab="prestige")))


if (require(nnet)){
    mod.beps <- multinom(vote ~ age + gender + economic.cond.national +
                           economic.cond.household + Blair + Hague + Kennedy +
                           Europe*political.knowledge, data=BEPS)
    plot(effect("Europe*political.knowledge", mod.beps,
                xlevels=list(political.knowledge=0:3)))

    plot(Effect(c("Europe", "political.knowledge"), mod.beps,
                xlevels=list(Europe=1:11, political.knowledge=0:3),
                fixed.predictors=list(given.values=c(gendermale=0.5))),
         lines=list(col=c("blue", "red", "orange")),
         axes=list(x=list(rug=FALSE), y=list(style="stacked")))

    plot(effect("Europe*political.knowledge", mod.beps, # equivalent
                xlevels=list(Europe=1:11, political.knowledge=0:3),
                fixed.predictors=list(given.values=c(gendermale=0.5))),
         lines=list(col=c("blue", "red", "orange")),
         axes=list(x=list(rug=FALSE), y=list(style="stacked")))
}


## Not run:
if (require(MASS)){
    mod.wvs <- polr(poverty ~ gender + religion + degree + country*poly(age,3),
                    data=WVS)
    plot(effect("country*poly(age, 3)", mod.wvs))

    plot(Effect(c("country", "age"), mod.wvs),
         axes=list(y=list(style="stacked")))

    plot(effect("country*poly(age, 3)", mod.wvs),
         axes=list(y=list(style="stacked"))) # equivalent
```

```
    plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs))
    plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs,
         se=list(type="scheffe"))) # Scheffe-type confidence envelopes
}

## End(Not run)

mod.pres <- lm(prestige ~ log(income, 10) + poly(education, 3) + poly(women, 2),
               data=Prestige)
eff.pres <- allEffects(mod.pres, xlevels=50)
plot(eff.pres)
plot(eff.pres[1],
     axes=list(x=list(income=list(
             transform=list(trans=log10, inverse=function(x) 10^x),
             ticks=list(at=c(1000, 2000, 5000, 10000, 20000))
    ))))
## Not run:
# linear model with log-response and log-predictor
# to illustrate transforming axes and setting tick labels
mod.pres1 <- lm(log(prestige) ~ log(income) + poly(education, 3) + poly(women, 2),
                data=Prestige)
# effect of the log-predictor
eff.log <- Effect("income", mod.pres1)
# effect of the log-predictor transformed to the arithmetic scale
eff.trans <- Effect("income", mod.pres1, transformation=list(link=log, inverse=exp))
#variations:
# y-axis:  scale is log, tick labels are log
# x-axis:  scale is arithmetic, tick labels are arithmetic
plot(eff.log)

# y-axis:  scale is log, tick labels are log
# x-axis:  scale is log, tick labels are arithmetic
plot(eff.log, axes=list(x=list(income=list(
    transform=list(trans=log, inverse=exp),
    ticks=list(at=c(5000, 10000, 20000)),
    lab="income, log-scale"))))

# y-axis:  scale is log, tick labels are arithmetic
# x-axis:  scale is arithmetic, tick labels are arithmetic
plot(eff.trans, axes=list(y=list(lab="prestige")))

# y-axis:  scale is arithmetic, tick labels are arithmetic
# x-axis:  scale is arithmetic, tick labels are arithmetic
plot(eff.trans, axes=list(y=list(type="response", lab="prestige")))

# y-axis:  scale is log, tick labels are arithmetic
# x-axis:  scale is log, tick labels are arithmetic
plot(eff.trans, axes=list(
       x=list(income=list(
            transform=list(trans=log, inverse=exp),
            ticks=list(at=c(1000, 2000, 5000, 10000, 20000)),
            lab="income, log-scale")),
```

```
        y=list(lab="prestige, log-scale")),
     main="Both response and X in log-scale")

# y-axis:  scale is arithmetic, tick labels are arithmetic
# x-axis:  scale is log, tick labels are arithmetic
plot(eff.trans, axes=list(
        x=list(
            income=list(transform=list(trans=log, inverse=exp),
                        ticks=list(at=c(1000, 2000, 5000, 10000, 20000)),
                        lab="income, log-scale")),
        y=list(type="response", lab="prestige")))

## End(Not run)

## Not run:
if (require(nlme)){ # for gls()
    mod.hart <- gls(fconvict ~ mconvict + tfr + partic + degrees, data=Hartnagel,
                    correlation=corARMA(p=2, q=0), method="ML")
    plot(allEffects(mod.hart))
    detach(package:nlme)
}


if (require(lme4)){
    data(cake, package="lme4")
    fm1 <- lmer(angle ~ recipe * temperature + (1|recipe:replicate), cake,
                REML = FALSE)
    plot(Effect(c("recipe", "temperature"), fm1))
    plot(effect("recipe:temperature", fm1),
         axes=list(grid=TRUE)) # equivalent (plus grid)
    if (any(grepl("pbkrtest", search()))) detach(package:pbkrtest)
    detach(package:lme4)
}


if (require(nlme) && length(find.package("lme4", quiet=TRUE)) > 0){
    data(cake, package="lme4")
    cake$rep <- with(cake, paste( as.character(recipe), as.character(replicate), sep=""))
    fm2 <- lme(angle ~ recipe * temperature, data=cake,
               random = ~ 1 | rep, method="ML")
    plot(Effect(c("recipe", "temperature"), fm2))
    plot(effect("recipe:temperature", fm2),
         axes=list(grid=TRUE))  # equivalent (plus grid)
    }
    detach(package:nlme)

if (require(poLCA)){
    data(election)
    f2a <- cbind(MORALG,CARESG,KNOWG,LEADG,DISHONG,INTELG,
                 MORALB,CARESB,KNOWB,LEADB,DISHONB,INTELB)~PARTY*AGE
    nes2a <- poLCA(f2a,election,nclass=3,nrep=5)
    plot(Effect(c("PARTY", "AGE"), nes2a),
         axes=list(y=list(style="stacked")))
```

```
}

## End(Not run)

# mlm example
if (require(heplots)) {
    data(NLSY, package="heplots")
    mod <- lm(cbind(read,math) ~ income+educ, data=NLSY)
    eff.inc <- Effect("income", mod)
    plot(eff.inc)
    eff.edu <- Effect("educ", mod)
    plot(eff.edu, axes=list(x=list(rug=FALSE), grid=TRUE))

    plot(Effect("educ", mod, response="read"))

    detach(package:heplots)
}

# svyglm() example (adapting an example from the survey package)

## Not run:
if (require(survey)){
  data(api)
  dstrat<-svydesign(id=~1, strata=~stype, weights=~pw,
    data=apistrat, fpc=~fpc)
  mod <- svyglm(sch.wide ~ ell + meals + mobility, design=dstrat,
    family=quasibinomial())
  plot(allEffects(mod),
    axes=list(y=list(lim=log(c(0.4, 0.99)/c(0.6, 0.01)),
      ticks=list(at=c(0.4, 0.75, 0.9, 0.95, 0.99)))))
}

## End(Not run)

# component + residual plot examples


Prestige$type <- factor(Prestige$type, levels=c("bc", "wc", "prof"))

mod.prestige.1 <- lm(prestige ~ income + education, data=Prestige)
plot(allEffects(mod.prestige.1, residuals=TRUE)) # standard C+R plots
plot(allEffects(mod.prestige.1, residuals=TRUE,
    se=list(type="scheffe"))) # with Scheffe-type confidence bands

mod.prestige.2 <- lm(prestige ~ type*(income + education), data=Prestige)
plot(allEffects(mod.prestige.2, residuals=TRUE))

mod.prestige.3 <- lm(prestige ~ type + income*education, data=Prestige)
plot(Effect(c("income", "education"), mod.prestige.3, residuals=TRUE),
     partial.residuals=list(span=1))


## Not run:
```

```
#  artificial data

set.seed(12345)
x1 <- runif(500, -75, 100)
x2 <- runif(500, -75, 100)
y <- 10 + 5*x1 + 5*x2 + x1^2 + x2^2 + x1*x2 + rnorm(500, 0, 1e3)
Data <- data.frame(y, x1, x2)
mod.1 <- lm(y ~ poly(x1, x2, degree=2, raw=TRUE), data=Data)
# raw=TRUE necessary for safe prediction
mod.2 <- lm(y ~ x1*x2, data=Data)
mod.3 <- lm(y ~ x1 + x2, data=Data)

plot(Effect(c("x1", "x2"), mod.1, residuals=TRUE)) # correct model
plot(Effect(c("x1", "x2"), mod.2, residuals=TRUE)) # wrong model
plot(Effect(c("x1", "x2"), mod.3, residuals=TRUE)) # wrong model

## End(Not run)
```

`EffectMethods` *Functions For Constructing Effect Displays for Many Modeling Paradigms*

Description

The `Effect`, `effect` and `predictorEffects` methods are used to draw effects plots to visualize a fitted regression surface. These plots can be drawn at least in principle for any model that uses a linear predictor. Methods for modeling paradigms than the basic `lm`, `glm`, `multinom` and `polr` methods are documented here.

Usage

```
## Default S3 method:
Effect(focal.predictors, mod,  ...,
    sources=NULL)

## S3 method for class 'gls'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clm2'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clmm'
Effect(focal.predictors, mod, ...)

## S3 method for class 'clm'
Effect(focal.predictors, mod, ...)
```

```
## S3 method for class 'merMod'
Effect(focal.predictors, mod, ...,
    KR=FALSE)

## S3 method for class 'rlmerMod'
Effect(focal.predictors, mod, ...)

## S3 method for class 'lme'
Effect(focal.predictors, mod, ...)

## S3 method for class 'poLCA'
Effect(focal.predictors, mod, ...)

## S3 method for class 'mlm'
Effect(focal.predictors, mod, response, ...)

## S3 method for class 'betareg'
Effect(focal.predictors, mod,  ...)
```

Arguments

`focal.predictors`	a character vector of one or more predictors in the model in any order.
`mod`	a fitted model object of the appropriate class.
`...`	additional arguments passed to other `Effect`. See `Effect` for all the arguments included.
`response`	for an `"mlm"` object, a vector containing the name(s) or indices of one or more response variable(s). The default is to use all responses in the model.
`sources`	This argument appears only in the default method for `Effect`, and allows the user to draw effects plots for fitting methods for which there are not existing methods in the effects package. Seven arguments are provided:

type the default is `"glm"`, which assumes the modeling method shares characteristics with a generalized linear model, including a univariate response, a linear predictor, and possibly a error family and link function.

call For S3 objects, the default is `ojbect$call`, returning the call that created the object. This is used to harvest standard arguments like `data`, `subset`, `family` an `dweights`.

formula the formula for the linear predictor, defaulting to `formula(object)`. If the formula may include terms for random effects that will be ignored.

family if the model object includes an error family, but it is not returned by `family(object)`, specify the family with this argument; otherwise it can be ignored.

link if the model object has a link function but not a family, specify the link with this argument; otherwise it can be ignored.

coefficients The estimates of the coefficents in the linear predictor, with default `coef(object)`.

vcov the estimated variance covariance materix to be used in computing errors in the effects plots; default is codevcov(object).

KR if TRUE and the **pbkrtest** package is installed, use the Kenward-Roger coefficient covariance matrix to compute effect standard errors for linear mixed models fit with lmer in the **lme4** package. The default is FALSE because the computation can be very slow.

Details

Most of these methods simply call the `Effect.default` method with the appropriate values in the arguement `sources`. See the vignettte Effect Methods in the vignettes for the effects package. All the iteresting work is done by the methods described in `Effect`.

Value

See `Effect`

Author(s)

John Fox <jfox@mcmaster.ca>, Sanford Weisberg <sandy@umn.edu>

References

Vignette for this package

See Also

`Effect` and the links therein.

Examples

```
## Not run:
# lme
require(nlme)
fm1 <- lme(distance ~ age + Sex, data = Orthodont, random = ~ 1)
plot(predictorEffects(fm1))

# gls
library(nlme)
g <- gls(Employed ~ GNP + Population,
         correlation=corAR1(form= ~ Year), data=longley)
print(predictorEffects(g))

# lmer  uses method Effect.lmerMod
if("package:nlme"
require(lme4)
data("Orthodont", package="nlme")
fm2 <- lmer(distance ~ age + Sex + (1 |Subject), data = Orthodont)
plot(allEffects(fm2))

# glmer  uses method Effect.lmerMod
```

```
require(lme4)
gm1 <- glmer(cbind(incidence, size - incidence) ~ period + (1 | herd),
             data = cbpp, family = binomial)
as.data.frame(predictorEffect("period", gm1))

# rlmer  uses method Effect.rlmerMod
require(robustlmm)
fm3 <- rlmer(distance ~ age + Sex + (1 |Subject), data = Orthodont)
plot(effect("age:Sex", fm3))
plot(predictorEffects(fm3, ~ age + Sex))

# clm in ordinal
require(ordinal)
require(MASS)
mod.wvs1 <- clm(poverty ~ gender + religion + degree + country*poly(age,3),data=WVS)
plot(Effect(c("country", "age"), mod.wvs1), lines=list(multiline=TRUE))

# clm2
require(ordinal)
require(MASS)
v2 <- clm2(poverty ~ gender + religion + degree + country*poly(age,3),data=WVS)
as.data.frame(emod2 <- Effect(c("country", "age"), v2))

# clmm
require(ordinal)
require(MASS)
mm1 <- clmm(SURENESS ~ PROD + (1|RESP) + (1|RESP:PROD), data = soup,
            link = "logit", threshold = "flexible")
as.data.frame(Effect("PROD", mm1))

# poLCA
library(poLCA)
data(election)
f2a <- cbind(MORALG,CARESG,KNOWG,LEADG,DISHONG,INTELG,
             MORALB,CARESB,KNOWB,LEADB,DISHONB,INTELB)~PARTY
nes2a <- poLCA(f2a,election,nclass=3,nrep=5)    # log-likelihood: -16222.32
allEffects(nes2a)

# betareg from the betareg package
library(betareg)
library(effects4)
data("GasolineYield", package = "betareg")
gy_logit <- betareg(yield ~ batch + temp, data = GasolineYield)
summary(gy_logit)
Effect("batch", gy_logit)
predictorEffects(gy_logit)

## End(Not run)
```

`effectsTheme` *Set the lattice Theme for Effect Plots*

Description

Set the **lattice** theme (see `trellis.device`) appropriately for effect plots. This function is invoked automatically when the **effects** package is loaded *if* the **lattice** package hasn't previously been loaded. A typical call is `lattice::trellis.par.set(effectsTheme())`.

Usage

```
effectsTheme(strip.background = list(col = gray(seq(0.95, 0.5, length = 3))),
    strip.shingle = list(col = "black"), clip = list(strip = "off"),
    superpose.line = list(lwd = c(2, rep(1, 6))))
```

Arguments

`strip.background`	colors for the background of conditioning strips at the top of each panel; the default uses shades of gray and makes allowance for up to three conditioning variables.
`strip.shingle`	when lines rather than numeric values are used to indicate the values of conditioning variables, the default sets the color of the lines to black.
`clip`	the default allows lines showing values of conditioning variables to extend slightly beyond the boundaries of the strips—making the lines more visible at the extremes.
`superpose.line`	the default sets the line width of the first (of seven) lines to 2.

Value

a list suitable as an argument for `trellis.par.set`; current values of modified parameters are supplied as an attribute.

Author(s)

John Fox `<jfox@mcmaster.ca>`

See Also

`trellis.device`, `trellis.par.set`

Examples

```
## Not run:
lattice::trellis.par.set(effectsTheme())

## End(Not run)
```

LegacyArguments *Legacy Arguments for* plot *and* Effect *Methods*

Description

Prior to verson 4.0-0 of the **effects** package, there were many (literally dozens) of arguments to the plot methods for "eff" and "effpoly" objects.

In version 4.0-0 of the package, we have consolidated these arguments into a much smaller number of arguments (e.g., lines, points, axes) that take lists of specifications. We have similarly consolidated some of the arguments to Effect methods into the confint and fixed.predictors arguments.

For backwards compatibility, we have to the extent possible retained the older arguments. If specified, these legacy arguments take precedence over the newer list-style arguments

Details

Here is the correspondence between the old and new arguments.

For plots methods:

```
multiline=TRUE/FALSE lines=list(multiline=TRUE/FALSE)
colors={vector of colors} lines=list(col={vector of colors})
lty={vector of line types} lines=list(lty={vector of line types})
lwd={vector of line widths} lines=list(lwd={vector of line widths})
use.splines=TRUE/FALSE lines=list(splines=TRUE/FALSE)
cex={number} points=list(cex={number})
rug=TRUE/FALSE axes=list(x=list(rug=TRUE/FALSE)
xlab={"axis title"} axes=list(x=list(lab={"axis title"}))
xlim={c(min, max)} axes=list(x=list(lim={c(min, max)}))
rotx={degrees} axes=list(x=list(rot={degrees}))
ticks.x=list({tick specifications}) axes=list(x=list(ticks=list({tick specifications})))
transform.x=list(link={function}, inverse={function}) axes=list(x=list(transform=list({lists of tran
ylab={"axis title"} axes=list(y=list(lab={"axis title"}))
ylim={c(min, max)} axes=list(y=list(lim={c(min, max)}))
roty={degrees} axes=list(y=list(rot={degrees}))
ticks=list({tick specifications}) axes=list(y=list(ticks=list({tick specifications})))
alternating=TRUE/FALSE axes=list(alternating=TRUE/FALSE)
grid=TRUE/FALSE axes=list(grid=TRUE/FALSE)
ci.style="bands"/"lines"/"bars"/"none" confint=list(style="bands"/"lines"/"bars"/"none")
band.transparency={number} confint=list(alpha={number})
band.colors={vector of colors} confint=list(col={vector of colors})
```

residuals.color={color} partial.residuals=list(col={color})

residuals.pch={plotting character} partial.residuals=list(pch={plotting character})

residuals.cex={number} partial.residuals=list(cex={number})

smooth.residuals=TRUE/FALSE partial.residuals=list(smooth=TRUE/FALSE)

residuals.smooth.color={color} partial.residuals=list(smooth.col={color})

span={number} partial.residuals=list(span={number})

show.fitted=TRUE/FALSE partial.residuals=list(fitted=TRUE/FALSE)

factor.names=TRUE/FALSE lattice=list(strip=list(factor.names=TRUE/FALSE))

show.strip.values=TRUE/FALSE lattice=list(strip=list(values=TRUE/FALSE))

layout={lattice layout} lattice=list(layout={lattice layout})

key.args={lattice key args} lattice=list(key.args={lattice key args})

style="lines"/"stacked" for plot.effpoly, axes=list(y=list(style="lines"/"stacked"))

rescale.axis=TRUE/FALSE type="rescale"/"response"/"link"

For Effect methods:

confint=TRUE/FALSE **or a list** may be substituted for the se argument.

confidence.level={number} se=list(level={number})

given.values={named vector} fixed.predictors=list(given.values={named vector})

typical={function} fixed.predictors=list(typical={function})

offset={function} fixed.predictors=list(offset={function})

partial.residuals=TRUE/FALSE residuals=TRUE/FALSE

Author(s)

John Fox <jfox@mcmaster.ca>

See Also

Effect, plot.eff, plot.effpoly

---

plot.predictoreff *Draw Predictor Effect Plots*

Description

These functions call plot.eff and plot.efflist to draw predictor effect plots.

Usage

```
## S3 method for class 'predictoreff'
plot(x, x.var,
    main = paste(names(x$variables)[1], "predictor effect plot"), ...)

## S3 method for class 'predictorefflist'
plot(x, selection, rows, cols, ask = FALSE, graphics = TRUE,
     lattice, ...)
```

Arguments

x	An object of class predictoreff or predictorefflist.
x.var	the index (number) or quoted name of the covariate or factor to place on the horizontal axis of each panel of the effect plot. The default is the predictor with the largest number of levels or values.
main	the title for the plot, printed at the top; the default title is constructed from the name of the effect.
...	arguments to be passed to plot.eff or plot.efflist.
selection	the optional index (number) or quoted name of the effect in an effect list to be plotted; if not supplied, a menu of high-order terms is presented or all effects are plotted.
rows, cols	Number of rows and columns in the "meta-array"" of plots produced for an efflist object; if either argument is missing, then the meta-layout will be computed by the plot method.
ask	if selection is not supplied and ask is TRUE, a menu of high-order terms is presented; if ask is FALSE (the default), effects for all high-order terms are plotted in an array.
graphics	if TRUE (the default), then the menu of terms to plot is presented in a dialog box rather than as a text menu.
lattice	argument passed to plot.efflist.

Details

The plot.predictoreff calls the method plot.eff and plot.predictorefflist calls plot.efflist. Both of these functions are documented at plot.eff. Warning: By default, the functions documented here use the argument lines=list(multiline=TRUE) while direct calls to the underlying functions use lines=list(multiline = FALSE) if standard errors were computed by the call to create the object x.

Value

See the documentation for plot.eff.

Author(s)

S. Weisberg, <sandy@umn.edu>

See Also

predictorEffect, plot.eff.

Examples

```
mod <- lm(prestige ~ type*(education + income + women), Prestige)
plot(predictorEffects(mod, ~ income))
```

---

predictorEffects *Functions For Computing Predictor Effects*

Description

Alternatives to the Effect and allEffects functions that use a different paradigm for conditioning in an effects display. The user specifies one predictor, either continuous or a factor, for the horizontal axis of a plot, and the function determines the appropriate plot to display (which is drawn by plot).

Usage

```
predictorEffect(predictor, mod, xlevels, ...)

## S3 method for class 'svyglm'
predictorEffect(predictor, mod, xlevels, ...)

## Default S3 method:
predictorEffect(predictor, mod, ...)

predictorEffects(mod, predictors, ...)

## Default S3 method:
predictorEffects(mod, predictors = ~ ., ...)
```

Arguments

mod	A model object. Supported models include all those described on the help page for Effect.
predictor	quoted name of the focal predictor.
xlevels	this argument is used to set the values for any predictor in the effect that is not a factor. For a predictor effect, the default is to use 50 quantiles of the focal predictor on the x-axis between the 0.01 and 0.98 quantiles. See Effect for details and for how other defaults are set.

predictors	If the default ~ ., a predictor effecrts plot is drawn for each predictor (not regressor) in a model. Otherwise, this should be a one-sided formula listing the first-order predictors for which predictor effects plots should be drawn.
...	Additional arguments passed to Effect.

Details

Effects plots view a fitted regression function E(Y|X) in (sequences of) two-dimensional plots using conditioning and slicing. The functions describe here use a different method of determining the conditioning and slicing than Effects uses. The predictor effects a focal predictor say x1 will be the the usual effect for the generalized interaction of x1 with all the other predictors in a model. When a predictor effects object is plotted, the focal predictor is by default plotted on the horizontal axis.

For example, in the model mod with formula y ~ x1 + x2 + x3, then p1 <- predictorEffects(mod, ~ x1) is essentially equilavent to p2 <- Effect("x1", mod). When plotted, these objects may be different because plot(p1) will always put x1 on the horizontal axis while plot(p2) uses a rule to determine the horizontal axis based on the characteristics of all the predictors, preferring continuous predictors over factors.

If mod has the formula y ~ x1 + x2 + x3 + x1:x2, then p1 <- predictorEffects(mod, ~ x1) is essentially equilavent to p2 <- Effect(c("x1", "x2"), mod). As in the last example, the plotted versions of these objects may differ because of rules used to determine the horizontal axis.

If mod has the formula y ~ x1 + x2 + x3 + x1:x2 + x1:x3, then p1 <- predictorEffects(mod, ~ x1) is essentially equilavent to p2 <- Effect(c("x1", "x2", "x3"), mod). The plotted versions of these objects may differ because of rules used to determine the horizontal axis.

Value

predictorEffect returns an object of class c(predictoreff, eff). The components of the object are described under the detalis at Effect. predictorEffects returns an object of class predictorefflist, which is a list whose elements are of class c(predictoreff, eff)

Author(s)

S. Weisberg, <sandy@umn.edu>

References

See Effect.

See Also

Effect, plot.predictoreff

Examples

```
mod <- lm(prestige ~ type*(education + income + women), Prestige)
plot(predictorEffect("income", mod))
plot(predictorEffects(mod, ~ education + income + women))
```

```
# svyglm() example (adapting an example from the survey package)

if (require(survey)){
  data(api)
  dstrat<-svydesign(id=~1, strata=~stype, weights=~pw,
    data=apistrat, fpc=~fpc)
  mod <- svyglm(sch.wide ~ ell + meals + mobility, design=dstrat,
    family=quasibinomial())
  plot(predictorEffects(mod),
    axes=list(y=list(lim=log(c(0.4, 0.99)/c(0.6, 0.01)),
      ticks=list(at=c(0.4, 0.75, 0.9, 0.95, 0.99)))))
}
```

---

summary.eff *Summarizing, Printing, and Plotting Effects*

Description

summary, print, plot, and [methods for eff, effpoly, efflist, and mlm.efflist objects. The plot arguments were substantially changed in mid-2017.

Usage

```
## S3 method for class 'eff'
print(x, type=c("response", "link"), ...)
## S3 method for class 'effpoly'
print(x, type=c("probability", "logits"), ...)
## S3 method for class 'efflatent'
print(x, ...)
## S3 method for class 'efflist'
print(x, ...)
## S3 method for class 'mlm.efflist'
print(x, ...)
## S3 method for class 'summary.eff'
print(x, ...)
## S3 method for class 'eff'
summary(object, type=c("response", "link"), ...)
## S3 method for class 'effpoly'
summary(object, type=c("probability", "logits"), ...)
## S3 method for class 'efflatent'
summary(object, ...)
## S3 method for class 'efflist'
summary(object, ...)
## S3 method for class 'mlm.efflist'
summary(object, ...)
## S3 method for class 'eff'
plot(x, x.var, z.var=which.min(levels),
```

```
    main=paste(effect, "effect plot"),
    symbols=TRUE, lines=TRUE, axes, confint,
    partial.residuals, id, lattice, ...,
    # legacy arguments:
    multiline, rug, xlab, ylab, colors, cex, lty, lwd,
    ylim, xlim, factor.names, ci.style,
    band.transparency, band.colors, type, ticks,
    alternating, rotx, roty, grid, layout,
    rescale.axis, transform.x, ticks.x, show.strip.values,
    key.args, use.splines,
    residuals.color, residuals.pch, residuals.cex, smooth.residuals,
    residuals.smooth.color, show.fitted, span)
## S3 method for class 'effpoly'
plot(x, x.var=which.max(levels),
    main=paste(effect, "effect plot"),
    symbols=TRUE, lines=TRUE, axes, confint, lattice, ...,
    # legacy arguments:
    type, multiline, rug, xlab, ylab, colors, cex, lty, lwd,
    factor.names, show.strip.values,
    ci.style, band.colors, band.transparency, style,
    transform.x, ticks.x, xlim,
    ticks, ylim, rotx, roty, alternating, grid,
    layout, key.args, use.splines)
## S3 method for class 'efflist'
plot(x, selection, rows, cols, ask=FALSE, graphics=TRUE, lattice, ...)
## S3 method for class 'mlm.efflist'
plot(x, ...)
```

Arguments

x	an object of class "eff", "effpoly", "efflist", "mlm.efflist", or "summary.eff", as appropriate.
object	an object of class "eff", "effpoly", "efflist", or "mlm.efflist", as appropriate.
type	for printing or summarizing linear and generalized linear models, if "response" (the default), effects are printed on the scale of the response variable; if "link", effects are printed on the scale of the linear predictor. For polytomous logit models, this argument takes either "probability" or "logit", with the former as the default. The type argument is also a legacy argument for plot methods.
x.var	the index (number) or quoted name of the covariate or factor to place on the horizontal axis of each panel of the effect plot. The default is the predictor with the largest number of levels or values.
z.var	for linear, generalized linear or mixed models, the index (number) or quoted name of the covariate or factor for which individual lines are to be drawn in each panel of the effect plot. The default is the predictor with the smallest number of levels or values. This argument is only used for multipline plots — see the lines argument.

`main` the title for the plot, printed at the top; the default title is constructed from the name of the effect.

`symbols` TRUE, FALSE, or an optional list of specifications for plotting symbols; if not given, symbol properties are taken from `superpose.symbol` in the lattice theme. See Detailed Argument Descriptions under Details for more information.

`lines` TRUE, FALSE, or an optional list of specifications for plotting lines (and possibly areas); if not given, line properties are taken from `superpose.line` in the lattice theme. See Detailed Argument Descriptions under Details for more information.

`axes` an optional list of specifications for the x and y axes; if not given, axis properties take generally reasonable default values. See Details for more information.

`confint` an optional list of specifications for plotting confidence regions and intervals; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information.

`partial.residuals` an optional list of specifications for plotting partial residuals for linear and generalized linear models; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information.

`id` an optional list of specifications for identifying points when partial residuals are plotted; if not specified, no points are labelled. See Detailed Argument Descriptions under Details for more information.

`lattice` an optional list of specifications for various lattice properties, such as legend placement; if not given, generally reasonable default values are used. See Detailed Argument Descriptions under Details for more information.

`selection` the optional index (number) or quoted name of the effect in an effect list to be plotted; if not supplied, a menu of high-order terms is presented or all effects are plotted.

`rows, cols` Number of rows and columns in the "meta-array" of plots produced for an `efflist` object; if either argument is missing, then the meta-layout will be computed by the `plot` method.

`ask` if `selection` is not supplied and `ask` is TRUE, a menu of high-order terms is presented; if `ask` is FALSE (the default), effects for all high-order terms are plotted in an array.

`graphics` if TRUE (the default), then the menu of terms to plot is presented in a dialog box rather than as a text menu.

`...` arguments to be passed down.

`multiline, rug, xlab, ylab, colors, cex, lty, lwd, ylim, xlim, factor.names, ci.style, band.transpa` legacy arguments retained for backwards compatibility; if specified, these will take precedence over the newer list-style arguments described above. See `LegacyArguments` for details.

Details

In a generalized linear model, by default, the `print` and `summary` methods for `eff` objects print the computed effects on the scale of the response variable using the inverse of the link function. In a logit model, for example, this means that the effects are expressed on the probability scale.

By default, effects in a GLM are plotted on the scale of the linear predictor, but the vertical axis is labelled on the response scale. This preserves the linear structure of the model while permitting interpretation on what is usually a more familiar scale. This approach may also be used with linear models, for example to display effects on the scale of the response even if the data are analyzed on a transformed scale, such as log or square-root.

When a factor is on the x-axis, the `plot` method for `eff` objects connects the points representing the effect by line segments, creating a response "profile." If you wish to suppress these lines, add `lty=0` to the `lines` argument to the call to `plot` (see below and the examples).

In a polytomous (multinomial or proportional-odds) logit model, by default effects are plotted on the probability scale; they may alternatively be plotted on the scale of the individual-level logits.

Detailed Argument Descriptions

Maximizing the flexibility of these plot commands requires inclusion of a myriad of options. In an attempt to simplify the use of these options, they have been organized into just a few arguments that each accept a list of specifications as an argument. In a few cases the named entries in the list are themselves lists.

Each of the following arguments takes an optional list of specifications; any specification absent from the list assumes its default value. Some of the list elements are themselves lists, so in complex cases, the argument can take the form of nested lists. All of these arguments can also be used on objects created with `predictorEffects`.

`symbols` `TRUE`, `FALSE`, or a list of options that controls the plotting symbols and their sizes for use with factors; if `FALSE` symbols are suppressed; if `TRUE` default values are used:

- `pch` ploting symbols, a vector of plotting characters, with the default taken from `trellis.par.get("superpose.symb`
  typically a vector of 1s (circles).
- `cex` plotting character sizes, a vector of values, with the default taken from `trellis.par.get("superpose.symbol")`
  typically a vector of 0.8s.

`lines` `TRUE`, `FALSE`, or a list that controls the chacteristics of lines drawn on a plot, and also whether or not multiple lines should be drawn in the same panel in the plot; if `FALSE` lines are suppressed; if `TRUE` default values are used:

- `multiline` display a multiline plot in each panel; the default is `TRUE` if there are no standard errors in the `"eff"` object, `FALSE` otherwise. For an `"effpoly"` object `multline=TRUE` causes all of the response levels to be shown in the same panel rather than in separate panels.
- `lty` vector of line types, with the default taken from `trellis.par.get("superpose.line")$lty`, typically a vector of 1s (solid lines).
- `lwd` vector of line widths, with the default taken from `trellis.par.get("superpose.line")$lwd`, typically a vector with 2 in the first position followed by 1s.
- `col` a vector of line colors, with the default taken from from `trellis.par.get("superpose.line")$col`, used both for lines and for areas in stacked area plots for `"effpoly"` objects; in the latter case, the default colors for an ordered response are instead generated by `sequential_hcl` in the **colorspace** package.
- `splines` use splines to smooth plotted effect lines; the default is `TRUE`.

`axes` a list with elements `x`, `y`, `alternating`, and `grid` that control axis limits, ticks, and labels. The `x` and `y` elements may themselves be lists.

The `x` entry is a list with elements named for predictors, with each predictor element itself a list with the following elements:

lab axis label, defaults to the name of the predictor.

lim a two-element vector giving the axis limits, with the default determined from the data.

ticks a list with either element at, a vector specifying locations for the ticks marks, or n, the number of tick marks.

transform transformations to be applied to the horizontal axis of a numeric predictor, in the form of a list of two functions, with element names trans and inverse. The trans function is applied to the values of the predictor, and inverse is used for computing proper axis tick labels. The default is not to transform the predictor axis.

Two additional elements may appear in the x list, and apply to all predictors:

rotate angle in degrees to rotate tick labels; the default is 0.

rug display a rug plot showing the marginal distribution of a numeric predictor; the default is TRUE.

The y list contains lab, lim, ticks, and rotate elements (similar to those specified for individual predictors in the x list), along with the additional type and style elements:

type for plotting linear or generalized linear models, "rescale" (the default) plots the vertical axis on the link scale (e.g., the logit scale for a logit model) but labels the axis on the response scale (e.g., the probability scale for a logit model); "response" plots and labels the vertical axis on the scale of the response (e.g., the probability scale for a logit model); and "link" plots and labels the vertical axis on the scale of the link (e.g., the logit scale for a logit model). For polytomous logit models, this element is either "probability" or "logit", with the former as the default.

style for polytomous logit models, this element can take on the value "lines" (the default) or "stacked" for line plots or stacked-area plots, respectively.

Other elements:

alternating if TRUE (the default), the tick labels alternate by panels in multi-panel displays from left to right and top to bottom; if FALSE, tick labels appear at the bottom and on the left.

grid if TRUE (the default is FALSE), add grid lines to the plot.

confint specifications to add/remove confidence intervals or regions from a plot, and to set the nominal confidence level.

style one of "auto", "bars", "lines", "bands", and "none"; the default is "bars" for factors, "bands" for numeric predictors, and "none" for multiline plots; "auto" also produces "bars" for factors and "bands" for numeric predictors, even in multiline plots.

alpha transparency of confidence bands; the default is 0.15.

col colors; the default is taken from the line colors.

partial.residuals specifications concerning the addition of partial residuals to the plot.

plot display the partial residuals; the default is TRUE if residuals are present in the "eff" object, FALSE otherwise.

fitted show fitted values as well as residuals; the default is FALSE.

col color for partial residuals; the default is the second line color.

pch plotting symbols for partial residuals; the default is 1, a circle.

cex size of symbols for partial residuals; the default is 1.

smooth draw a loess smooth of the partial residuals; the default is TRUE.

span span for the loess smooth; the default is 2/3.

smooth.col color for the loess smooth; the default is the second line color.

lty line type for the loess smooth; the default is the first line type, normally 1 (a solid line).

lwd line width for the loess smooth; the default is the first line width, normally 2.

id specifications for optional point identification when partial residuals are plotted.

n number of points to identify; default is 2 if id=TRUE and 0 if id=FALSE. Points are selected based on the Mahalanobis distances of the pairs of x-values and partial residuals from their centroid.

col color for the point labels; default is the same as the color of the partial residuals.

cex relative size of text for point labels; default is 0.75.

labels vector of point labels; the default is the names of the residual vector, which is typically the row names of the data frame to which the model is fit.

lattice the plots are drawn with the **lattice** package, generally by the xyplot function. These specifications are passed as arguments to the functions that actually draw the plots.

layout the layout argument to the **lattice** function xyplot (or, in some cases densityplot), which is used to draw the effect display; if not specified, the plot will be formatted so that it appears on a single page.

key.args a key, or legend, is added to the plot if multiline=TRUE. This argument is a list with components that determine the the placement and other characteristics of the key. The default if not set by the user is key.args = list(space="top", columns=2, border=FALSE, fontfamily= If there are more than 6 groups in the plot, columns is set to 3. For stacked-area plots, the default is a one-column key.

space determines the placement of the key outside the plotting area, with default space="above" for above the plot and below its title. Setting space="right" uses space to the right of the plot for the key.

x, y, corner used to put the key on the graph itself. For example, x=.05, y=.95, corner=c(0,1) will locate the upper-left corner of the key at (.05, .95), thinking of the graph as a unit square.

columns number of columns in the key. If space="top", columns should be 2, 3 or 4; if space="right", set columns=1.

border if TRUE draw a border around the key; omit the border if FALSE.

fontfamily the default is "sans" for the sans-serif font used in the rest of the plot; the alternative is "serif" for a serif font.

cex, cex.title the default relative size of the font for labels and the title, respectively. To save space set these to be smaller than 1.

strip a list with two elements: factor.names, which if TRUE, the default, shows conditioning variable names in the panel headers; and values, which if TRUE, the default unless partial residuals are plotted, displays conditioning variable values in the panel headers.

array a list with elements row, col, nrow, ncol, and more, used to graph an effect as part of an array of plots; row, col, nrow, and ncol are used to compose the split argument and more the more argument to print.trellis. The array argument is automatically by plot.efflist and will be ignored if used with that function.

Value

The summary method for "eff" objects returns a "summary.eff" object with the following components (those pertaining to confidence limits need not be present):

header	a character string to label the effect.
effect	an array containing the estimated effect.
lower.header	a character string to label the lower confidence limits.
lower	an array containing the lower confidence limits.
upper.header	a character string to label the upper confidence limits.
upper	an array containing the upper confidence limits.

The plot method for "eff" objects returns a "plot.eff" object (an enhanced "trellis" object); the provided print method plots the object.

The [method for "efflist" objects is used to subset an "efflist" object and returns an object of the same class.

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See Also

LegacyArguments, effect, allEffects, effectsTheme, xyplot, densityplot, print.trellis, loess, sequential_hcl

Examples

```
# also see examples in ?effect

mod.cowles <- glm(volunteer ~ sex + neuroticism*extraversion,
                  data=Cowles, family=binomial)
eff.cowles <- allEffects(mod.cowles, xlevels=list(extraversion=seq(0, 24, 6)))
eff.cowles
as.data.frame(eff.cowles[[2]]) # neuroticism*extraversion interaction

plot(eff.cowles, 'sex', axes=list(y=list(lab="Prob(Volunteer)"),
                                  x=list(rotate=90)),
     lines=list(lty=0), grid=TRUE)

plot(eff.cowles, 'neuroticism:extraversion',
     axes=list(y=list(lab="Prob(Volunteer)",
        ticks=list(at=c(.1,.25,.5,.75,.9)))))

plot(Effect(c("neuroticism", "extraversion"), mod.cowles,
            se=list(type="Scheffe"),
            xlevels=list(extraversion=seq(0, 24, 6))),
     axes=list(y=list(lab="Prob(Volunteer)",
        ticks=list(at=c(.1,.25,.5,.75,.9)))))
```

```
    # change color of the confidence bands to 'black' with .15 transparency
plot(eff.cowles, 'neuroticism:extraversion',
     axes=list(y=list(lab="Prob(Volunteer)",
                      ticks=list(at=c(.1,.25,.5,.75,.9)))),
     confint=list(col="red", alpha=.3))

plot(eff.cowles, 'neuroticism:extraversion',
     lines=list(multiline=TRUE),
     axes=list(y=list(lab="Prob(Volunteer)")),
     lattice=list(key.args = list(x = 0.65, y = 0.99, corner = c(0, 1))))

# use probability scale in place of logit scale, all lines are black.
plot(eff.cowles, 'neuroticism:extraversion',
     lines=list(multiline=TRUE, lty=1:8, col="black"),
     axes=list(y=list(type="response", lab="Prob(Volunteer)")),
     lattice=list(key.args = list(x = 0.65, y = 0.99, corner = c(0, 1))),
     confint=list(style="bands"))

plot(effect('sex:neuroticism:extraversion', mod.cowles,
            xlevels=list(extraversion=seq(0, 24, 6))),
     lines=list(multiline=TRUE))

plot(effect('sex:neuroticism:extraversion', mod.cowles,
            xlevels=list(extraversion=seq(0, 24, 6))),
     lines=list(multiline=TRUE),
     axes=list(y=list(type="response")),
     confint=list(style="bands"),
     lattice=list(key.args = list(x=0.75, y=0.75, corner=c(0, 0))))


if (require(nnet)){
    mod.beps <- multinom(vote ~ age + gender + economic.cond.national +
                             economic.cond.household + Blair + Hague + Kennedy +
                             Europe*political.knowledge, data=BEPS)

    plot(effect("Europe*political.knowledge", mod.beps,
                xlevels=list(political.knowledge=0:3)))


    plot(effect("Europe*political.knowledge", mod.beps,
                xlevels=list(political.knowledge=0:3),
                fixed.predictors=list(given.values=c(gendermale=0.5))),
         axes=list(y=list(style="stacked"), x=list(rug=FALSE), grid=TRUE),
         lines=list(col=c("blue", "red", "orange")))
}

if (require(MASS)){
    mod.wvs <- polr(poverty ~ gender + religion + degree + country*poly(age,3),
                    data=WVS)
    plot(effect("country*poly(age, 3)", mod.wvs))
```

```
    plot(effect("country*poly(age, 3)", mod.wvs), lines=list(multiline=TRUE))
    plot(effect("country*poly(age, 3)", mod.wvs),
         axes=list(y=list(style="stacked")),
         lines=list(col=c("gray75", "gray50", "gray25")))

    plot(effect("country*poly(age, 3)", latent=TRUE, mod.wvs))

}

mod.pres <- lm(prestige ~ log(income, 10) + poly(education, 3) + poly(women, 2),
               data=Prestige)
eff.pres <- allEffects(mod.pres)

plot(eff.pres)
plot(eff.pres[1:2])

plot(eff.pres[1],
     axes=list(x=list(income=list(transform=list(
         trans=log10, inverse=function(x) 10^x),
         ticks=list(at=c(1000, 2000, 5000, 10000, 20000))))))
```

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