Package 'ib'

July 22, 2025

Type Package

Title Bias Correction via Iterative Bootstrap

Version 0.2.0

Description An implementation of the iterative bootstrap procedure of Kuk (1995) <doi:10.1111/j.2517-6161.1995.tb02035.x> to correct the estimation bias of a fitted model object. This procedure has better bias correction properties than the bootstrap bias correction technique.

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Depends R (>= 4.0.0)

Imports betareg, lme4, Formula, MASS, Matrix, methods, Rdpack (>= 0.7), stats, utils, VGAM

Suggests testthat (>= 3.0.0), knitr, nlraa, rmarkdown

License GPL (>= 2)

Encoding UTF-8

RdMacros Rdpack

RoxygenNote 7.1.2

URL https://github.com/SMAC-Group/ib/

BugReports https://github.com/SMAC-Group/ib/issues/

Config/testthat/edition 3

NeedsCompilation no

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Repository CRAN

Date/Publication 2022-04-04 22:50:02 UTC

Contents

`bootstrap` *Parametric bootstrap*

Description

Method for generating parametric bootstrap estimates from a fitted model.

Usage

```
bootstrap(object, B = 1000, extra_param = FALSE, ...)
```

Arguments

object	an object representing a fitted model (see 'Details').
B	an integer for number of bootstrap replicates (default 1,000).
extra_param	if TRUE, bootstrap is also performed for extra parameters (see 'Details').
...	additional optional arguments to pass to ibControl.

Details

This method is a simple wrapper around the ib method where number of iterations is set to 1.

Value

A matrix p (size of parameter) times B of bootstrapped estimates.

Author(s)

Samuel Orso

See Also

ib, ibControl

---

coef,Ib-method *Method for extracting coefficients from an object in class union "Ib"*

Description

Method for extracting coefficients from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
coef(object, ...)
```

Arguments

object	an object of class union "Ib"
...	further arguments to pass to coef

See Also

Ib, coef

`effects,Ib-method` *Method for extracting effects from an object in class union "Ib"*

Description

Method for extracting effects from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
effects(object, ...)
```

Arguments

`object`	an object of class union "Ib"
`...`	further arguments to pass to `effects`

See Also

Ib, effects

`fitted,Ib-method` *Method for extracting fitted values from an object in class union "Ib"*

Description

Method for extracting fitted values from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
fitted(object, ...)
```

Arguments

`object`	an object of class union "Ib"
`...`	further arguments to pass to `fitted`

See Also

Ib, fitted.values

getEst *Accessor to the object in class union "Ib"*

Description

Method for obtaining estimates from fitted model within any object of class union Ib.

Usage

```
getEst(x)

## S4 method for signature 'Ib'
getEst(x)
```

Arguments

x	an object of class union "Ib"

Details

This methods allow to access extra parameter estimates. If `extra_param=TRUE`, it becomes equivalent to `coef`.

Value

an estimate (as in `getExtra`).

See Also

Ib

getExtra *Accessor to an extra part in class union "Ib"*

Description

Method for obtaining a extra values generated by the iterative bootstrap procedure within any object of class union Ib.

Usage

```
getExtra(x)

## S4 method for signature 'Ib'
getExtra(x)
```

Arguments

x	an object of class union "Ib"

Value

a `list` with the following components:

iteration	number of iterations (k)
of	value of the objective function $\|\|\hat{\pi} - \frac{1}{H}\sum_{h=1}^{H}\hat{\pi}_h(\hat{\theta}^k)\|\|$
estimate	value of the estimates $\hat{\theta}^k$
test_theta	value for difference of thetas: $\|\|\hat{\theta}^k - \hat{\theta}^{k-1}\|\|$
ib_warn	optional warning message
boot	`matrix` of H bootstrap estimates: $\hat{\pi}(\hat{\theta}^k)$

See Also

Ib

---

getIteration *Accessor to the object in class union "Ib"*

Description

Method for obtaining the number of iteration from fitted model within any object of class union Ib.

Usage

```
getIteration(x)

## S4 method for signature 'Ib'
getIteration(x)
```

Arguments

x	an object of class union "Ib"

Details

This methods allow to access extra information about the number of iterations.

Value

a number of iterations (as in `getExtra`).

See Also

Ib

getObject *Accessor to the object in class union "Ib"*

Description

Method for obtaining a fitted model within any object of class union Ib.

Usage

```
getObject(x)

## S4 method for signature 'Ib'
getObject(x)
```

Arguments

x	an object of class union "Ib"

See Also

Ib

ib *Bias correction via iterative bootstrap*

Description

ib is used to correct the bias of a fitted model object with the iterative bootstrap procedure.

Usage

```
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'betareg'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'glm'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'lm'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'lmerMod'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'nls'
```

```
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)

## S4 method for signature 'vglm'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)
```

Arguments

object	an object representing a fitted model (see 'Details').
thetastart	an optional starting value for the iterative procedure. If NULL (default), the procedure starts at the estimates in object.
control	a list of parameters for controlling the iterative procedure (see ibControl).
extra_param	if TRUE, the bias of estimation of extra parameters is performed (see 'Details').
...	additional optional arguments (see 'Details').

Details

The iterative bootstrap procedure is described in Kuk (1995) and further studied by Guerrier et al. (2019) and Guerrier et al. (2020). The *k*th iteration of this algorithm is

$$\hat{\theta}^k = \hat{\theta}^{k-1} + \hat{\pi} - \frac{1}{H}\sum_{h=1}^{H} \hat{\pi}_h(\hat{\theta}^{k-1})$$

for $k = 1, 2, \ldots$ and where the sum is over $h = 1, \ldots, H$. The estimate $\hat{\pi}$ is provided by the object. The value $\hat{\pi}_h(\hat{\theta})$ is a parametric bootstrap estimate where the bootstrap sample is generated from $\hat{\theta}$ and a fixed seed (see ibControl). The greater the parameter value H generally the better bias correction but the more computation it requires (see ibControl). If thetastart=NULL, the initial value of the procedure is $\hat{\theta}^0 = \hat{\pi}$. The number of iterations are controlled by maxit parameter of ibControl.

By default, the method correct coefficients only. For extra parameters, it depends on the model. These extra parameters may have some constraints (e.g. positivity). If constraint=TRUE (see ibControl), then a transformation from the constraint space to the real is used for the update.

For betareg, extra_param is not available as by default mean and precision parameters are corrected. Currently the 'identity' link function is not supported for precision parameters.

For glm, if extra_param=TRUE: the shape parameter for the Gamma, the variance of the residuals in lm or the overdispersion parameter of the negative binomial regression in glm.nb, are also corrected. Note that the quasi families are not supported for the moment as they have no simulation method (see simulate). Bias correction for extra parameters of the inverse.gaussian is not yet implemented.

For lm, if extra_param=TRUE: the variance of the residuals is also corrected. Note that using the ib is not useful as coefficients are already unbiased, unless one considers different data generating mechanism such as censoring, missing values and outliers (see ibControl).

For lmer, by default, only the fixed effects are corrected. If extra_param=TRUE: all the random effects (variances and correlations) and the variance of the residuals are also corrected. Note that using the ib is certainly not useful with the argument REML=TRUE in lmer as the bias of variance components is already addressed, unless one considers different data generating mechanism such as censoring, missing values and outliers (see ibControl).

For nls, if extra_param=TRUE: the variance of the residuals is also corrected.

For vglm, extra_param is currently not used. Indeed, the philosophy of a vector generalized linear model is to potentially model all parameters of a distribution with a linear predictor. Hence, what would be considered as an extra parameter in glm for instance, may already be captured by the default coefficients. However, correcting the bias of a coefficients does not imply that the bias of the parameter of the distribution is corrected (by Jensen's inequality), so we may use this feature in a future version of the package. Note that we currently only support distributions with a simslot (see simulate.vlm).

Value

A fitted model object of class Ib.

Author(s)

Samuel Orso

References

Guerrier S, Dupuis-Lozeron E, Ma Y, Victoria-Feser M (2019). "Simulation-Based Bias Correction Methods for Complex Models." *Journal of the American Statistical Association*, **114**(525), 146-157. doi: 10.1080/01621459.2017.1380031, https://doi.org/10.1080/01621459.2017.1380031.

Guerrier S, Karemera M, Orso S, Victoria-Feser M, Zhang Y (2020). "A General Approach for Simulation-based Bias Correction in High Dimensional Settings." https://arxiv.org/pdf/2010.13687.pdf. Version 2: 13 Nov 2020, 2010.13687, https://arxiv.org/pdf/2010.13687.pdf.

Kuk AYC (1995). "Asymptotically Unbiased Estimation in Generalized Linear Models with Random Effects." *Journal of the Royal Statistical Society: Series B (Methodological)*, **57**(2), 395-407. doi: 10.1111/j.25176161.1995.tb02035.x, https://rss.onlinelibrary.wiley.com/doi/pdf/10.1111/j.2517-6161.1995.tb02035.x, https://rss.onlinelibrary.wiley.com/doi/abs/10.1111/j.2517-6161.1995.tb02035.x.

See Also

betareg

glm, glm.nb

lm

lmer

nls

vglm

Examples

```
## beta regression
library(betareg)
data("GasolineYield", package = "betareg")
## currently link.phi = "identity" is not supported
```

```
## fit_beta <- betareg(yield ~ batch + temp, data = GasolineYield)
fit_beta <- betareg(yield ~ batch + temp, link.phi = "log", data = GasolineYield)
fit_ib <- ib(fit_beta)

# precision parameter can also depend on covariates
fit_beta <- betareg(yield ~ batch + temp | temp, data = GasolineYield)
fit_ib <- ib(fit_beta)
## poisson regression
counts <- c(18,17,15,20,10,20,25,13,12)
outcome <- gl(3,1,9)
treatment <- gl(3,3)
pois_fit <- glm(counts ~ outcome + treatment, family = poisson())
fit_ib <- ib(pois_fit)
summary(fit_ib)
## Set H = 1000
## Not run:
fit_ib <- ib(pois_fit, control=list(H=1000))
summary(fit_ib)

## End(Not run)

## gamma regression
clotting <- data.frame(
  u = c(5,10,15,20,30,40,60,80,100),
  lot1 = c(118,58,42,35,27,25,21,19,18),
  lot2 = c(69,35,26,21,18,16,13,12,12))
fit_gamma <- glm(lot2 ~ log(u), data = clotting, family = Gamma(link = "inverse"))
fit_ib <- ib(fit_gamma)
## summary(fit_ib)
## correct for shape parameter and show iterations
## Not run:
fit_ib <- ib(fit_gamma, control=list(verbose=TRUE), extra_param = TRUE)
summary(fit_ib)

## End(Not run)

## negative binomial regression
library(MASS)
fit_nb <- glm.nb(Days ~ Sex/(Age + Eth*Lrn), data = quine)
fit_ib <- ib(fit_nb)
## summary(fit_ib)
## correct for overdispersion with H=100
## Not run:
fit_ib <- ib(fit_nb, control=list(H=100), extra_param = TRUE)
summary(fit_ib)

## End(Not run)

## linear regression
fit_lm <- lm(disp ~ cyl + hp + wt, data = mtcars)
fit_ib <- ib(fit_lm)
summary(fit_ib)
## correct for variance of residuals
```

```
fit_ib <- ib(fit_lm, extra_param = TRUE)
summary(fit_ib)

## linear mixed-effects regression
library(lme4)
fit_lmm <- lmer(Reaction ~ Days + (Days | Subject), data = sleepstudy, REML = FALSE)
fit_ib <- ib(fit_lmm)
summary(fit_ib)
## correct for variances and correlation
## Not run:
fit_ib <- ib(fit_lmm, extra_param = TRUE)
summary(fit_ib)

## End(Not run)

## nonlinear regression
DNase1 <- subset(DNase, Run == 1)
fit_nls <- nls(density ~ SSlogis(log(conc), Asym, xmid, scal), data = DNase1)
fit_ib <- ib(fit_nls)
summary(fit_ib)

## student regression
library(VGAM)
tdata <- data.frame(x = runif(nn <- 1000))
tdata <- transform(tdata,
                   y = rt(nn, df = exp(exp(0.5 - x))))
fit_vglm <- vglm(y ~ x, studentt3, data = tdata)
fit_ib <- ib(fit_vglm)
summary(fit_ib)
```

`ib,negbin-method` *ib method for* `negbin` *object from* `glm.nb` *function of* **MASS** *package.*

Description

`ib` method for `negbin` object from `glm.nb` function of **MASS** package.

Usage

```
## S4 method for signature 'negbin'
ib(object, thetastart = NULL, control = list(...), extra_param = FALSE, ...)
```

Arguments

`object`	an `object` representing a fitted model (see 'Details').
`thetastart`	an optional starting value for the iterative procedure. If `NULL` (default), the procedure starts at the estimates in `object`.
`control`	a `list` of parameters for controlling the iterative procedure (see `ibControl`).
`extra_param`	if `TRUE`, the bias of estimation of extra parameters is performed (see 'Details').
`...`	additional optional arguments (see 'Details').

IbBetareg-class *An S4 class union for* ib

Description

Members of the union are IbBetareg, IbGlm, IbLm, IbLmer, IbNegbin, IbNls, IbVglm

Details

The 'Functions' section describes members of the class union.

Value

Each member of the union has a slot with the initial object corrected by the ib (see getObject) and a second slot with extra meta data from ib (see getExtra).

Functions

- IbBetareg-class: fitted model by betareg from **betareg**
- IbGlm-class: fitted model by glm from **stats**
- IbLm-class: fitted model by lm from **stats**
- IbLmer-class: fitted model by lmer from **lme4**
- IbNegbin-class: fitted model by glm.nb from **MASS**
- IbNls-class: fitted model by nls from **stats**
- IbVglm-class: fitted model by vglm from **VGAM**

Author(s)

Samuel Orso

See Also

getExtra, getObject

ibControl *Auxiliary for controlling IB*

Description

Auxiliary function for ib bias correction.

Usage

```
ibControl(
  tol = 1e-05,
  maxit = 25,
  verbose = FALSE,
  seed = 123L,
  H = 1L,
  constraint = TRUE,
  early_stop = FALSE,
  cens = FALSE,
  right = NULL,
  left = NULL,
  mis = FALSE,
  prop = NULL,
  out = FALSE,
  eps = NULL,
  G = NULL,
  func = function(x) rowMeans(x, na.rm = T),
  sim = NULL
)
```

Arguments

tol	positive convergence tolerance ϵ. The ib procedure converges when $\|\|\hat{\theta}^{k+1} - \hat{\theta}^{k}\|\|_2/p < \epsilon$, where p is the dimension of θ.
maxit	integer representing the maximal number of iterations.
verbose	if TRUE, it prints some output in the console at each iteration.
seed	integer to set the seed (see Random).
H	integer representing the number of bootstrap estimates (see ib).
constraint	if TRUE (default), constraint for extra_param is used in the iterative procedure (see 'Details' of ib).
early_stop	if TRUE (default is FALSE), the iterative procedure stops as soon as there is no improvment in the minimization of the objective function (see 'Details' of ib).
cens	if TRUE the simulated responses are censored according to left and right values.
right	double for right-censoring (only used if cens=TRUE).

left	double for left-censoring (only used if cens=TRUE).
mis	if TRUE the simulated responses have missing data at random.
prop	double between 0 and 1 representing the proportion of missing data (only used if mis=TRUE).
out	if TRUE the simulated responses are also generated with a contamination mechanism.
eps	double between 0 and 1 representing the proportion of outliers in the data (only used if out=TRUE).
G	a function to generate outliers. It takes only a sample size as argument.
func	a function to reduce the H bootstrap estimates (rowwise). By default, the average is computed. The user can supply a function. One could imagine using other function such as the median or a trimmed mean.
sim	a user-defined function for simulating responses (see 'Details')

Details

sim allows the user to provide its own function for generating responses. Currently it is only supported for generalized linear models with the prototype 'fun(object, control, extra_param, ...)' (see ib).

Value

a list with components named as the arguments.

See Also

ib, the iterative procedure for bias correction.

---

plot,Ib,ANY-method *Method for plotting an object in class union "Ib"*

Description

Method for plotting an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib,ANY'
plot(x, y = NULL, ...)
```

Arguments

x	an object of class union "Ib"
y	not used
...	further arguments to pass to plot

See Also

Ib, plot.lm

`predict,Ib-method` *Method for making predictions from an object in class union "Ib"*

Description

Method for making predictions from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
predict(object, ...)
```

Arguments

`object`	an object of class union "Ib"
`...`	further arguments to pass to `predict`

See Also

Ib, predict

`residuals,Ib-method` *Method for extracting residuals from an object in class union "Ib"*

Description

Method for extracting residuals from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
residuals(object, ...)
```

Arguments

`object`	an object of class union "Ib"
`...`	further arguments to pass to `residuals`

See Also

Ib, residuals

---

show,Ib-method *Method for printing object in class union "Ib"*

Description

Method for printing object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
show(object)
```

Arguments

object	an object of class union "Ib"

See Also

Ib

---

show,SummaryIb-method *Summarizing a fitted model corrected by the ib procedure*

Description

Method for printing a summary of class union SummaryIb.

Usage

```
## S4 method for signature 'SummaryIb'
show(object)
```

Arguments

object	a summary object of member of SummaryIb

See Also

SummaryIb

simulation *Generic for simulating from the object*

Description

Method for simulating responses from an object.

Usage

```
simulation(object, control = list(...), ...)

## S4 method for signature 'Ib'
simulation(object, control = list(...), ...)
```

Arguments

object	an object of class union "Ib"
control	a control list
...	further argument to pass

Value

simulated responses.

Examples

```
## bootstrap poisson regression
counts <- c(18,17,15,20,10,20,25,13,12)
outcome <- gl(3,1,9)
treatment <- gl(3,3)
pois_fit <- glm(counts ~ outcome + treatment, family = poisson())

## make 100 paramtric bootstrap replicates
boot_dist <- simulate(pois_fit, nsim = 100)
```

simulation,betareg-method *Simulation for a beta regression*

Description

simulation method for class IbBetareg

Usage

```
## S4 method for signature 'betareg'
simulation(object, control = list(...), extra = NULL, ...)
```

Arguments

object	an object of class IbBetareg
control	a list of parameters for controlling the iterative procedure (see ibControl).
extra	NULL by default; extra parameters to pass to simulation.
...	further arguments

---

simulation,glm-method *Simulation for a Generalized Linear Model regression*

Description

simulation method for class IbGlm

Usage

```
## S4 method for signature 'glm'
simulation(object, control = list(...), extra = NULL, ...)
```

Arguments

object	an object of class IbGlm
control	a list of parameters for controlling the iterative procedure (see ibControl).
extra	NULL by default; extra parameters to pass to simulation.
...	further arguments

---

simulation,lm-method *Simulation for linear regression*

Description

simulation method for class IbLm

Usage

```
## S4 method for signature 'lm'
simulation(object, control = list(...), std = NULL, ...)
```

Arguments

object	an object of class IbLm
control	a list of parameters for controlling the iterative procedure (see ibControl).
std	NULL by default; standard deviation to pass to simulation.
...	further arguments

---

simulation,lmerMod-method

Simulation for linear mixed model regression

Description

simulation method for class IbLmer

Usage

```
## S4 method for signature 'lmerMod'
simulation(object, control = list(...), ...)
```

Arguments

object	an object of class IbLmer
control	a list of parameters for controlling the iterative procedure (see ibControl).
...	further arguments.

---

simulation,negbin-method

Simulation for a negative binomial regression

Description

simulation method for class IbNegbin

Usage

```
## S4 method for signature 'negbin'
simulation(object, control = list(...), extra = NULL, ...)
```

Arguments

object	an object of class IbNegbin
control	a list of parameters for controlling the iterative procedure (see ibControl).
extra	NULL by default; extra parameters to pass to simulation.
...	further arguments

`simulation,nls-method` *Simulation for nonlinear regression*

Description

simulation method for class IbNls

Usage

```
## S4 method for signature 'nls'
simulation(object, control = list(...), std = NULL, ...)
```

Arguments

`object`	an object of class IbNls
`control`	a `list` of parameters for controlling the iterative procedure (see `ibControl`).
`std`	`NULL` by default; standard deviation to pass to simulation.
`...`	further arguments

`simulation,vglm-method`
Simulation for vector generalized linear model regression

Description

simulation method for class IbVglm

Usage

```
## S4 method for signature 'vglm'
simulation(object, control = list(...), extra_param = NULL, ...)
```

Arguments

`object`	an object of class IbVglm
`control`	a `list` of parameters for controlling the iterative procedure (see `ibControl`).
`extra_param`	`NULL` by default; extra parameters to pass to simulation.
`...`	further arguments

summary,IbBetareg-method *Summarizing a beta regression fit corrected by the iterative bootstrap*

Description

summary method for class IbBetareg

Usage

```
## S4 method for signature 'IbBetareg'
summary(object, ...)
```

Arguments

object	an object of class IbBetareg
...	further arguments passed to summary.betareg

See Also

summary.betareg

summary,IbGlm-method *Summarizing a Generalized Linear Model regression fit corrected by the iterative bootstrap*

Description

summary method for class IbGlm

Usage

```
## S4 method for signature 'IbGlm'
summary(object, ...)
```

Arguments

object	an object of class IbGlm
...	further arguments passed to summary.glm

See Also

summary.glm

summary,IbLm-method *Summarizing a linear regression fit corrected by the iterative bootstrap*

Description

summary method for class IbLm

Usage

```
## S4 method for signature 'IbLm'
summary(object, ...)
```

Arguments

object	an object of class IbLm
...	further arguments passed to summary.lm

See Also

summary.lm

summary,IbLmer-method *Summarizing a linear mixed model regression fit corrected by the iterative bootstrap*

Description

summary method for class IbLmer

Usage

```
## S4 method for signature 'IbLmer'
summary(object, ...)
```

Arguments

object	an object of class IbLmer
...	further arguments passed to summary.merMod of **lme4**

summary,IbNegbin-method *Summarizing a negative binomial regression fits corrected by the iterative bootstrap*

Description

summary method for class IbNegbin

Usage

```
## S4 method for signature 'IbNegbin'
summary(object, ...)
```

Arguments

object	an object of class IbNegbin
...	further arguments passed to summary.negbin

See Also

summary.negbin

summary,IbNls-method *Summarizing a nonlinear regression fit corrected by the iterative bootstrap*

Description

summary method for class IbNls

Usage

```
## S4 method for signature 'IbNls'
summary(object, ...)
```

Arguments

object	an object of class IbNls
...	further arguments passed to summary.nls of **stats**

`summary,IbVglm-method` *Summarizing a vector generalized linear model regression fit corrected by the iterative bootstrap*

Description

summary method for class IbVglm

Usage

```
## S4 method for signature 'IbVglm'
summary(object, ...)
```

Arguments

`object`	an object of class IbVglm
`...`	further arguments passed to `summary.merMod` of **VGAM**

`SummaryIbBetareg-class`
An S4 class union for `summary`

Description

Members of the union are SummaryIbBetareg, SummaryIbGlm, SummaryIbLm, SummaryIbLmer, SummaryIbNegbin, SummaryIbNls, SummaryIbVglm iterative bootstrap procedure

Details

The 'Functions' section describes members of the class union.

Functions

- `SummaryIbBetareg-class`: summary of class `summary.betareg` from **betareg**
- `SummaryIbGlm-class`: summary of class `summary.glm` from **stats**
- `SummaryIbLm-class`: summary of class `summary.lm` from **stats**
- `SummaryIbLmer-class`: summary of class `summary.merMod` from **lme4**
- `SummaryIbNegbin-class`: summary of class `summary.negbin` from **MASS**
- `SummaryIbNls-class`: summary of class `summary.nls` from **stats**
- `SummaryIbVglm-class`: summary of class `summary.vglm` from **VGAM**

Author(s)

Samuel Orso

`vcov,Ib-method` *Method for calculating covariance matrix from an object in class union "Ib"*

Description

Method for calculating covariance matrix from an object in class union "Ib"

Usage

```
## S4 method for signature 'Ib'
vcov(object, ...)
```

Arguments

`object`	an object of class union "Ib"
`...`	further arguments to pass to `vcov`

See Also

Ib, vcov

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