Package 'lacm'

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Priority optional

Title Latent Autoregressive Count Models

Description Perform pairwise likelihood inference in latent autoregressive count models. See Pedeli and Varin (2020) for details.

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R topics documented:

CLIC *Composite Likelihood Information Criterion*

Description

Calculates the composite likelihood information criterion for a latent autoregressive count model fitted through maximum pairwise likelihood.

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Usage

```
CLIC(object, ...)
```

Arguments

object	a fitted model object of class `"lacm"`.
...	optional arguments.

Details

Function `CLIC` computes the composite likelihood information criterion (Varin and Vidoni, 2005) for a latent autoregressive count model estimated by maximum pairwise likelihood. See Pedeli and Varin (2020) for details.

When comparing models fitted by maximum pairwise likelihood to the same data, the smaller the CLIC, the better the fit.

Value

a numeric value with the corresponding CLIC.

Author(s)

Xanthi Pedeli and Cristiano Varin.

References

Pedeli, X. and Varin, C. (2020). Pairwise likelihood estimation of latent autoregressive count models. *Statistical Methods in Medical Research*. doi: 10.1177/0962280220924068.

Varin, C. and Vidoni, P. (2005). A note on composite likelihood inference and model selection. *Biometrika*, **92**, 519–528.

See Also

`lacm`.

Examples

```
data("polio", package = "lacm")
## model components
trend <- 1:length(polio)
sin.term <- sin(2 * pi * trend / 12)
cos.term <- cos(2 * pi * trend / 12)
sin2.term <- sin(2 * pi * trend / 6)
cos2.term <- cos(2 * pi * trend / 6)
## fit model with pairwise likelihood of order 1
mod1 <- lacm(polio ~ I(trend * 10^(-3)) + sin.term + cos.term + sin2.term + cos2.term)
CLIC(mod1)
```

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lacm	*Fitting Latent Autoregressive Count Models by Maximum Pairwise Likelihood*

Description

Fits latent autoregressive count models by maximum pairwise likelihood.

Usage

```
lacm(formula, data, subset, offset, contrasts = NULL, start.theta = NULL, fixed, d = 1,
     kernel.type = c("Rectangular", "Trapezoidal"), fit = TRUE, gh.num = 20,
     reltol.opt = 1e-06, opt.method = c("BFGS", "Nelder-Mead"), maxit.opt = 1000,
     sandwich.lag = NULL, bread.method = c("Outer-product", "Hessian"), ...)
```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The details of model specification are given under 'Details'.
data	an optional data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model. If not found in data, the variables are taken from environment(formula), typically the environment from which lacm is called.
subset	an optional vector specifying a subset of observations to be used in the fitting process.
offset	this can be used to specify an *a priori* known component to be included in the linear predictor during fitting. This should be NULL or a numeric vector of length equal to the number of cases. One or more offset terms can be included in the formula instead or as well, and if more than one is specified their sum is used. See model.offset.
contrasts	an optional list. See the contrasts.arg of model.matrix.default.
start.theta	optional numeric vector with starting values for the model parameters.
fixed	optional numeric vector of the same length as the total number of parameters. If supplied, only NA entries in fixed will be varied.
d	order of the pairwise likelihood. Defaults to 1.
kernel.type	one of "Rectangular", "Trapezoidal" indicating the type of kernel weights to be used in the weighted pairwise likelihood specification. The default "Rectangular" corresponds to equal contribution from all pairs of observations that are distant apart up to lag d. Can be abbreviated.
fit	a logical value indicating whether to compute the maximum pairwise likelihood estimates or not.
gh.num	number of the Gauss-Hermite quadrature nodes. Defaults to 20.
reltol.opt	relative convergence tolerance to be passed to optim. Defaults to 1e-6.

opt.method	one of "BFGS" or "Nelder-Mead" indicating the optimization method to be passed to optim. Can be abbreviated. See optim for details.
maxit.opt	the maximum number of iterations to be passed to optim. Defaults to 1000.
sandwich.lag	the lag length used for computing the bandwith of the sandwich variance. See 'Details'.
bread.method	one of "Outer-product" or "Hessian" indicating whether the bread matrix of the sandwich variance is estimated with the outer-product of the individual gradients or with a numerical approximation of the Hessian matrix. Can be abbreviated. See 'Details'.
...	further arguments passed to or from other methods.

Details

Function lacm performs maximum pairwise likelihood estimation in latent autoressive count models, see Pedeli and Varin (2020) for details.

Evaluation of the pairwise likelihood is performed through double Gauss-Hermite quadrature with the gh.num nodes and weights calculated by gauss.quad.

Standard formula y ~ x1 + x2 indicates that the mean response is modelled as a function of covariates x1 and x2 through a log link function.

Starting values supplied by the user can be specified through start.theta. If start.theta=NULL, then starting values are obtained using the method-of-moments as discussed in Ng et al. (2011).

Sandwich standard errors that are robust to heteroschedasticity and autocorrelation (HAC-type) are computed. The "meat matrix" is estimated using a lag length equal to sandwich.lag. If sandwich.lag is NULL, then L is set equal to $10 * \log 10(n)$, where n is the time series length and d is the pairwise likelihood order. The "bread matrix" is computed with the average of outer products of the individual grandients (bread.matrix = "Outer-product") or with a numerical approximation of the Hessian (bread.method = "Hessian"). Details are given in Pedeli and Varin (2020).

Value

An object of class "lacm" with the following components:

nobs	the number of observations.
p	the number of regressors, including the intercept.
d	the order of the pairwise likelihood.
npar	the number of parameters.
Y	the response used.
X	the model matrix used for the mean response.
offset	the offset used.
sandwich.lag	the lag length used for the bandwith of the HAC-type standard errors.
fit	logical. Was the model fitted or not?
gh.num	number of Gauss-Hermite nodes used.
call	the matched call.

terms	the [terms](#) object used.
latent	logical. Does the model include the latent part?
fixed	the numeric vector indicating which parameters are constants.
ifree	indeces of the free parameters.
kweights	the kernel weights used.
start.theta	the starting values.
objfun	function computing the logarithm of the pairwise likelihood of order d.
grad	function computing the gradient of the pairwise likelihood of order d.
gh	Gauss-Hermite nodes and weights used.
opt.method	a character string specifying the method argument passed to optim. The default optimization routine is the quasi-Newton algorithm BFGS. See [optim](#) for details.
convergence	an integer code indicating convergence of the optimizer. See link{optim} for details.
gh	a list with components the Gauss-Hermite nodes and the weights used for approximating the pairwise likelihood.
plik	the maximum pairwise likelihood value.
theta	the maximum pairwise likelihood estimate.
jacobian	the jacobian of the individual pairwise likelihood terms.
outer-product	logical. Was the bread matrix of the sandwich variance computed with the outer product of the individual scores?
H	the bread matrix.
J	the meat matrix.
vcov	the variance-covariance matrix of the maximum pairwise likelihood estimate.
CLIC	the composite likelihood information criterion.

Functions [summary.lacm](#), [coefficients](#) and [vcov.lacm](#) can be used to obtain or print a summary of the results, extract coefficients and their estimated variance-covariance matrix of the model fitted by [lacm](#).

Author(s)

Xanthi Pedeli and Cristiano Varin.

References

Ng, C., Joe, H., Karlis, D., and Liu, J. (2011). Composite likelihood for time series models with a latent autoregressive process. *Statistica Sinica*, **21**, 279–305.

Pedeli, X. and Varin, C. (2020). Pairwise likelihood estimation of latent autoregressive count models. *Statistical Methods in Medical Research*.doi: [10.1177/0962280220924068](#).

See Also

[CLIC](#).

Examples

```
data("polio", package = "lacm")
## model components
trend <- 1:length(polio)
sin.term <- sin(2 * pi * trend / 12)
cos.term <- cos(2 * pi * trend / 12)
sin2.term <- sin(2 * pi * trend / 6)
cos2.term <- cos(2 * pi * trend / 6)
## fit model with pairwise likelihood of order 1
mod1 <- lacm(polio ~ I(trend * 10^(-3)) + sin.term + cos.term + sin2.term + cos2.term)
mod1
summary(mod1)
## refit with d = 3
mod3 <- update(mod1, d = 3)
summary(mod3)
```

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polio   *Polio Time Series*

Description

Time series of Polio incidences in USA from 1970 to 1983.

Usage

```
data(polio)
```

Format

Time series of monthly Polio cases in USA from January 1970 to December 1983.

Source

Zeger, S.L. (1988). A regression model for time series of counts. *Biometrika* **75**, 822–835.

Examples

```
data(polio, package = "lacm")
```

---

summary.lacm   *Methods for* lacm *Objects*

Description

Methods for fitted latent autoregressive count model objects of class "lacm"

Usage

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

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

## S3 method for class 'lacm'
coef(object, ...)

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

## S3 method for class 'lacm'
simulate(object, nsim = 1, seed = NULL, ...)
```

Arguments

object, x	a fitted model object of class "lacm".
digits	the number of significant digits to use when printing.
nsim	number of response vectors to simulate. Defaults to 1.
seed	an object specifying if and how the random number generator should be initialized ('seeded'). See simulate.
...	additional optional arguments.

Value

The function summary.lacm returns an object of class "summary.lacm", a list of some components of the "lacm" object, plus

coefficients	a summary of the parameter estimates, standard errors, z-values and corresponding p-values.
clic	the composite likelihood information criterion.

The function simulate.lacm returns a list of simulated responses.

The function print returns the call and coefficients, coef returns the estimated coefficients and vcov the corresponding variance-covariance matrix.

Author(s)

Xanthi Pedeli and Cristiano Varin.

References

Pedeli, X. and Varin, C. (2020). Pairwise likelihood estimation of latent autoregressive count models. *Statistical Methods in Medical Research*.doi: 10.1177/0962280220924068.

See Also

CLIC.

Examples

```
data("polio", package = "lacm")
## model components
trend <- 1:length(polio)
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## fit model with pairwise likelihood of order 1
mod1 <- lacm(polio ~ I(trend * 10^(-3)) + sin.term + cos.term + sin2.term + cos2.term)
mod1
summary(mod1)
## refit with d = 3
mod3 <- update(mod1, d = 3)
summary(mod3)
```

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