Package 'bclogit'

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Title Conditional Logistic Regression

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Description Performs inference for Bayesian conditional logistic regression with informative priors built from the concordant pair data. We include many options to build the priors. And we include many options during the inference step for estimation, testing and confidence set creation. For details, see Kapelner and Tennenbaum (2026) ``Improved Conditional Logistic Regression using Information in Concordant Pairs with Software" <doi:10.48550/arXiv.2602.08212>.

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License GPL-3

Encoding UTF-8

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`bclogit-package` *Bayesian Conditional Logistic Regression with Concordant Pairs*

Description

bclogit

Details

Fits a conditional logistic regression model to incidence data. Allows for use of the concordant pairs in the fitting.

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References

Jacob Tennenbaum and Adam Kapelner (2026). "Improved Conditional Logistic Regression using Information

See Also

Useful links:

- https://github.com/tennenbaumj/bclogit_package_and_paper_repo
- Report bugs at https://github.com/tennenbaumj/bclogit_package_and_paper_repo/issues

---

`bclogit.formula` *Initialize a new bclogit model*

Description

This function fits a Bayesian conditional logistic regression model, incorporating information from concordant pairs to improve estimation.

Usage

```
## S3 method for class 'formula'
bclogit(
  formula,
  data,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  concordant_method = "GLM",
  prior_type = "Naive",
  chains = 4,
  return_raw_stan_output = FALSE,
  prior_variance_treatment = 100,
  stan_refresh = 0,
  ...
)

bclogit(
  formula,
  data,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  concordant_method = "GLM",
  prior_type = "Naive",
  chains = 4,
  return_raw_stan_output = FALSE,
  prior_variance_treatment = 100,
```

```
  stan_refresh = 0,
  ...
)

## Default S3 method:
bclogit(
  formula = NULL,
  data = NULL,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  concordant_method = "GLM",
  prior_type = "Naive",
  chains = 4,
  return_raw_stan_output = FALSE,
  prior_variance_treatment = 100,
  stan_refresh = 0,
  ...,
  y = NULL,
  X = NULL,
  treatment_name = NULL,
  call = NULL
)
```

Arguments

`formula`	For the formula method, a symbolic description of the model to be fitted.
`data`	A data.frame, data.table, or model.matrix containing the variables (optional for formula method).
`treatment`	Optional vector specifying the treatment variable (required for default method, or can be specified in formula method).
`strata`	Vector specifying the strata (matched pairs).
`subset`	An optional vector specifying a subset of observations.
`na.action`	A function which indicates what should happen when the data contain NAs.
`concordant_method`	The method to use for fitting the concordant pairs and reservoir. Options are "GLM", "GEE", and "GLMM". "GLMM" requires the suggested package **glmmTMB**; if it is not available from CRAN, install it via `install.packages("glmmTMB", repos = c("https://glmmtmb.r-universe.dev", "https://cloud.r-project.org"))`.
`prior_type`	The type of prior to use for the discordant pairs. Options are "Naive", "G prior", "PMP", and "Hybrid".
`chains`	Number of chains for Stan sampling. Default is 4.
`return_raw_stan_output`	Logical; if `TRUE`, the raw Stan posterior samples (iterations x chains x parameters) are stored in the returned object. Default `FALSE`.

prior_variance_treatment
: Prior variance for the treatment coefficient in the covariance matrix Sigma_con. Default is 100.

stan_refresh
: How often Stan reports sampling progress (in iterations). Default is 0 (silent). Set to a positive integer (e.g., 1 or 100) to see progress.

...
: Additional arguments passed to rstan::sampling (e.g., iter, warmup, thin, seed, control).

y
: For the default method, a binary (0,1) vector containing the response of each subject.

X
: A data.frame, data.table, or model.matrix containing the variables.

treatment_name
: Optional string name for the treatment variable.

call
: Optional call object to store in the result.

Value

An object of class "bclogit".

A list of class bclogit containing:

coefficients
: Estimated coefficients (posterior means).

var
: Variance-covariance matrix of coefficients.

model
: The fitted Stan model object.

posterior_samples
: Raw posterior samples as a 3D array (iterations x chains x parameters) from rstan::extract(model, permuted = FALSE). Only populated when return_raw_stan_output = TRUE; NULL otherwise.

concordant_model
: The fitted model object for the concordant pairs/reservoir (GLM/GEE/GLMM).

matched_data
: The processed matched pairs data from the premodeling step.

prior_info
: A list with elements mu (prior mean vector), Sigma (prior covariance matrix), and fallbacks (a character vector naming every robustness fallback that was triggered during prior construction, or character(0) if none were needed). Possible fallback names are: "insufficient_concordant_pairs" (too few concordant pairs; diffuse prior used), "na_in_prior_mean" (NAs in prior mean replaced with 0), "na_in_prior_covariance" (NAs in prior covariance replaced with diag(100)), "glm_fallback" (non-positive-definite GEE/GLMM covariance; re-fitted via GLM), "diffuse_prior" (non-positive-definite covariance replaced with diag(100)).

call
: The function call.

terms
: The model terms.

num_discordant
: Number of discordant pairs used.

num_concordant
: Number of concordant pairs/reservoir entries used.

A list of class "bclogit" containing:

coefficients
: Estimated coefficients (posterior means).

var	Variance-covariance matrix of the coefficients (posterior covariance).
model	The fitted Stan model object for the discordant pairs.
posterior_samples	Raw posterior samples as a 3D array (iterations x chains x parameters) from rstan::extract(model, permuted = FALSE). Only populated when return_raw_stan_output = TRUE; NULL otherwise.
concordant_model	The fitted model object for the concordant pairs (GLM, GEE, or GLMM).
matched_data	The processed matched pairs data from the C++ pre-modeling step.
prior_info	A list with elements mu (prior mean vector), Sigma (prior covariance matrix), and fallbacks (character vector of robustness fallbacks triggered; character(0) if none).
call	The function call.
terms	The model terms.
xlevels	Factor level information (always NULL for this method).
n	Total number of observations.
num_discordant	Number of discordant pairs used for fitting.
num_concordant	Number of concordant pairs used for the prior.
X_model_matrix_col_names	Column names of the covariate model matrix.
treatment_name	Name of the treatment variable.

Methods (by class)

- bclogit(formula): Formula method
- bclogit(default): Default method for matrix/data input.

Numerical Stability in GEE Pre-modeling

When concordant_method = "GEE", the function applies a layered set of safeguards to ensure the prior covariance Sigma_con passed to Stan is valid (positive definite, symmetric, and free of NA values).

Naive (model-based) covariance GEE's default covariance is the sandwich (robust) estimator, which can produce degenerate (e.g. negative) variances when the number of independent clusters is small. The code instead uses geese$vbeta.naiv, the model-based covariance that assumes the working correlation structure is exactly correct. It is less efficient asymptotically but always well-structured for small samples.

Cholesky positive-definiteness check After extracting the covariance, a Cholesky decomposition is attempted via tryCatch(chol(Sigma_con), ...). This is the canonical test for positive definiteness: it succeeds if and only if the matrix is PD. A failed decomposition sets an is_pd = FALSE flag without crashing the call.

GLM fallback for non-PD GEE or GLMM covariance If the GEE naive covariance or the GLMM fixed-effect vcov is still not positive definite (GLMM failures are common with boundary variance estimates or convergence issues), a standard `glm(..., family = binomial)` is re-fitted on the same concordant data and its Fisher-information-based vcov is used instead. That matrix is always PD for a non-degenerate design matrix, providing a graceful degradation from GEE/GLMM to GLM.

Symmetrization `Sigma_con <- (Sigma_con + t(Sigma_con)) / 2` is applied after the GLM fallback re-extraction and again unconditionally before the matrix is passed to Stan. Name-indexed covariance matching can introduce tiny floating-point asymmetries; averaging with the transpose enforces exact symmetry as required by Stan's Cholesky-based samplers.

NA sanitization Aliased model terms (collinear columns in the concordant data) cause `coef()` and `vcov()` to return `NA`. These are caught before Stan sees them: `NA` entries in the prior mean vector default to `0` (a neutral prior), and any `NA` in the covariance matrix triggers replacement of the entire matrix with a wide diagonal (`diag(100, p)`), an uninformative but valid prior.

Diffuse prior fallback Multiple failure paths (too few concordant pairs, persistent non-PD matrix, `NA`-contaminated covariance) fall back to `diag(100, p)`, which is positive definite by construction and encodes a broad, independent prior that lets the discordant-pair likelihood dominate.

Treatment prior reset After extracting the concordant-model covariance, the entire first row and column (corresponding to the treatment coefficient) are zeroed and the diagonal entry is set to `prior_variance_treatment` (default 100). This decouples the treatment prior from the nuisance-covariate prior: concordant pairs inform covariate shrinkage but are not allowed to shrink the treatment coefficient, which remains independently diffuse. Zeroing the off-diagonals also eliminates any spurious prior correlation between treatment and covariates induced by the concordant-model fit.

See Also

`summary.bclogit`, `confint.bclogit`, `vcov.bclogit`, `coef.bclogit`

Examples

```
# Example usage
data("fhs")
fit <- bclogit(PREVHYP ~ TOTCHOL + CIGPDAY + BMI + HEARTRTE,
  data = fhs, treatment = PERIOD, strata = RANDID)
summary(fit)
```

---

clogit.default *Frequentist Conditional Logistic Regression*

Description

Fits a conditional logistic regression model for matched pairs using the discordant-pair GLM trick. This is a fast frequentist alternative to `bclogit`.

Usage

```
## Default S3 method:
clogit(
  formula = NULL,
  data = NULL,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  do_inference_on_var = "all",
  ...,
  y = NULL,
  X = NULL,
  treatment_name = NULL,
  call = NULL
)

## S3 method for class 'formula'
clogit(
  formula,
  data,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  do_inference_on_var = "all",
  ...
)

clogit(
  formula,
  data,
  treatment = NULL,
  strata = NULL,
  subset = NULL,
  na.action = NULL,
  do_inference_on_var = "all",
  ...
)
```

Arguments

formula	For the formula method, a symbolic description of the model.
data	A data frame containing the variables (for formula method).
treatment	Vector specifying the treatment variable.
strata	Vector specifying the strata (matched pairs).

subset	An optional vector specifying a subset of observations to be used in the fitting process.
na.action	A function which indicates what should happen when the data contain NAs.
do_inference_on_var	Which variable(s) to compute standard errors for. "all" (default) computes SEs for all coefficients. An integer j computes the SE only for the jth coefficient (1 = treatment, then covariates in order). "none" skips inference entirely.
...	Additional arguments passed to fastLogisticRegressionWrap::fast_logistic_regression (e.g., convergence tolerances).
y	For the default method, a binary (0,1) response vector.
X	A data.frame, data.table, or model.matrix containing the variables.
treatment_name	Optional string name for the treatment variable.
call	Optional call object to store in the result.

Value

A list of class "clogit_bclogit" containing:

coefficients	Estimated coefficients (posterior means).
var	Variance-covariance matrix of the coefficients (diagonal, built from standard errors). NULL when do_inference_on_var is not "all".
flr_model	The fitted fast logistic regression model object returned by fastLogisticRegressionWrap::fast_logis
call	The function call.
terms	The model terms.
n	Total number of observations.
num_discordant	Number of discordant pairs used for fitting.
num_concordant	Number of concordant pairs.
X_model_matrix_col_names	Column names of the covariate model matrix.
treatment_name	Name of the treatment variable.
se	Standard errors of the coefficients.
z	Z-statistics for each coefficient.
pval	Approximate p-values for each coefficient.
do_inference_on_var	The value of the do_inference_on_var argument.

An object of class "clogit_bclogit".

An object of class "clogit_bclogit".

Methods (by class)

- clogit(default): Default method for matrix/data input.
- clogit(formula): Formula method

See Also

bclogit, summary.clogit_bclogit, coef.clogit_bclogit, vcov.clogit_bclogit

Examples

```
data("fhs")
fit <- clogit(PREVHYP ~ TOTCHOL + CIGPDAY + BMI + HEARTRTE,
  data = fhs, treatment = PERIOD, strata = RANDID)
summary(fit)
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5),
  x1 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(1:(n / 2), each = 2)
)
fit <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata)
# Inference on treatment only (faster):
fit2 <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata,
               do_inference_on_var = 1)
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5),
  x1 = rnorm(n),
  x2 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(1:(n / 2), each = 2)
)
fit <- clogit(y ~ x1 + x2, data = dat, treatment = treatment, strata = strata)
summary(fit)
coef(fit)
vcov(fit)
```

---

coef.bclogit *Extract coefficients from a bclogit model*

Description

Extract coefficients from a bclogit model

Usage

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

Arguments

object	A bclogit object.
...	Additional arguments.

Value

Named numeric vector of posterior mean coefficients.

See Also

vcov.bclogit, summary.bclogit

Examples

```
data("fhs")
fit <- bclogit(PREVHYP ~ TOTCHOL + BMI, data = fhs,
               treatment = PERIOD, strata = RANDID)
coef(fit)
```

---

coef.clogit_bclogit *Extract coefficients from a clogit_bclogit model*

Description

Extract coefficients from a clogit_bclogit model

Usage

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

Arguments

object	A clogit_bclogit object.
...	Additional arguments.

Value

Numeric vector of coefficients.

Examples

```
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5), x1 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(1:(n / 2), each = 2)
)
fit <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata)
coef(fit)
```

confint.bclogit *Credible Intervals for bclogit Parameters*

Description

Computes Bayesian credible intervals for the model parameters.

Usage

```
## S3 method for class 'bclogit'
confint(object, parm, level = 0.95, type = c("HPD_one", "CR", "HPD_many"), ...)
```

Arguments

object	A bclogit object.
parm	A specification of which parameters to be given credible intervals, either a vector of numbers or a vector of names. If missing, all parameters are considered.
level	The confidence level required (default 0.95).
type	Type of interval to compute: "HPD_one" (default unimodal HPD interval via coda), "CR" (equal-tailed credible region), "HPD_many" (multimodal HPD interval via ggdist).
...	Additional arguments.

Value

A matrix with columns lower and upper. For "HPD_many", a parameter may appear on multiple rows when the interval is disjoint. The matrix has a Probability attribute.

See Also

summary.bclogit, coef.bclogit

fhs *Framingham Heart Study Dataset*

Description

A subset of the Framingham Heart Study data.

Usage

```
fhs
```

Format

A data frame with 5944 rows and 39 variables:

RANDID Unique identification number for each participant. (This is the strata for the matched pairs).

PERIOD Examination Cycle where 0 = baseline, 1 = endpoint (the treatment variable)

SEX Participant sex (1 = Male, 2 = Female).

TOTCHOL Total serum cholesterol (mg/dL).

AGE Age at exam (years).

SYSBP Systolic blood pressure (mmHg).

DIABP Diastolic blood pressure (mmHg).

CURSMOKE Current smoking status (0 = No, 1 = Yes).

CIGPDAY Number of cigarettes smoked per day.

BMI Body Mass Index (kg/m^2).

DIABETES Diabetes status (0 = No, 1 = Yes).

BPMEDS Use of Anti-hypertensive medication (0 = No, 1 = Yes).

HEARTRTE Heart rate (beats/minute).

GLUCOSE Fast blood glucose (mg/dL).

educ Education level.

PREVCHD Prevalence of Coronary Heart Disease.

PREVAP Prevalence of Angina Pectoris.

PREVMI Prevalence of Myocardial Infarction.

PREVSTRK Prevalence of Stroke.

PREVHYP Prevalence of Hypertension.

TIME Number of days since baseline exam.

HDLC High Density Lipoprotein Cholesterol.

LDLC Low Density Lipoprotein Cholesterol.

DEATH Death status.

ANGINA Angina Pectoris status.

HOSPMI Hospitalized Myocardial Infarction.

MI_FCHD Myocardial Infarction or Fatal Coronary Heart Disease.

ANYCHD Any Coronary Heart Disease event.

STROKE Stroke status.

CVD Cardiovascular Disease status.

HYPERTEN Hypertension status.

TIMEAP Time to Angina Pectoris.

TIMEMI Time to Myocardial Infarction.

TIMEMIFC Time to Myocardial Infarction or Fatal CHD.

TIMECHD Time to Any CHD.

TIMESTRK Time to Stroke.

TIMECVD Time to Cardiovascular Disease.

TIMEDTH Time to Death.

TIMEHYP Time to Hypertension.

Details

This dataset was constructed by running the following code:

```
pacman::p_load(riskCommunicator, data.table)
data("framingham")
D = data.table(framingham)
D = D[!is.na(CIGPDAY)] #we drop missing data in covariates
D = D[!is.na(BMI)]
D = D[!is.na(HEARTRTE)]
D = D[!is.na(TOTCHOL)]
Dba = D[PERIOD %in% c(1,3)] #we drop intermediate periods so we have matched pairs
Dba[PERIOD == 1, PERIOD := 0]
Dba[PERIOD == 3, PERIOD := 1]
Dba[, num_periods_per_id := .N, by = RANDID]
Dba = Dba[num_periods_per_id == 2] #we drop intermediate periods so we have matched pairs
Dba[, num_periods_per_id := NULL]
```

Source

https://biolincc.nhlbi.nih.gov/teaching/

---

formula.bclogit *Extract model formula*

Description

Extract model formula

Usage

```
## S3 method for class 'bclogit'
formula(x, ...)
```

Arguments

x	A bclogit object.
...	Additional arguments.

Value

The `formula` used in the model, or `NULL` when the model was fitted via the default (matrix) interface.

See Also

`bclogit`

Examples

```
data("fhs")
fit <- bclogit(PREVHYP ~ TOTCHOL + BMI, data = fhs,
               treatment = PERIOD, strata = RANDID)
formula(fit)
```

---

print.summary.bclogit *Print summary of a bclogit model*

Description

Print summary of a bclogit model

Usage

```
## S3 method for class 'summary.bclogit'
print(x, digits = max(3, getOption("digits") - 3), ...)
```

Arguments

`x`	A `summary.bclogit` object.
`digits`	Number of significant digits to print.
`...`	Additional arguments.

Value

Invisibly returns `x`.

See Also

`summary.bclogit`, `confint.bclogit`

Examples

```
data("fhs")
fit <- bclogit(PREVHYP ~ TOTCHOL + BMI, data = fhs,
               treatment = PERIOD, strata = RANDID)
print(summary(fit))
```

print.summary.clogit_bclogit *Print summary of a clogit_bclogit model*

Description

Print summary of a clogit_bclogit model

Usage

```
## S3 method for class 'summary.clogit_bclogit'
print(x, digits = max(3, getOption("digits") - 3), ...)
```

Arguments

x	A summary.clogit_bclogit object.
digits	Number of significant digits to print.
...	Additional arguments.

Value

Invisibly returns x.

Examples

```
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5), x1 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(1:(n / 2), each = 2)
)
fit <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata)
print(summary(fit))
```

summary.bclogit *Summarize a bclogit model*

Description

Summarize a bclogit model

Usage

```
## S3 method for class 'bclogit'
summary(object, level = 0.95, inference_method = "HPD_one", ...)
```

Arguments

object	A bclogit object.
level	Confidence level for credible intervals (default 0.95).
inference_method	Method used for both the displayed confidence set bounds and the p-value (computed via bisection over alpha). Options are: "HPD_one" (default) uses unimodal HPD intervals (C++) with 20 bisection iterations, "HPD_many" uses ggdist::hdi which supports disjoint (multimodal) HPD regions, with 50 bisection iterations (requires the **ggdist** package). Confidence set bounds are shown when the HPD is a single interval; if disjoint, they are set to NA (use confint.bclogit with type = "HPD_many" to see all intervals), "CR" uses equal-tailed credible intervals (quantile-based, C++) with 20 bisection iterations.
...	Additional arguments (not used).

Value

A list of class "summary.bclogit" containing:

call	The original function call.
coefficients	A matrix with one row per parameter and columns for the posterior mean estimate, posterior median estimate, standard error, lower and upper credible interval bounds, optionally Rhat and n_eff convergence diagnostics (when available from Stan), and Pr(tx!=0) (the Bayesian p-value).
num_discordant	Number of discordant pairs used for fitting.
num_concordant	Number of concordant pairs used for the prior.
level	The credible interval level used.
inference_method	The inference method used for interval and p-value computation.
prior_info	A list with elements mu and Sigma describing the prior derived from the concordant pairs model.
treatment_name	Name of the treatment variable.

See Also

print.summary.bclogit, confint.bclogit, coef.bclogit, vcov.bclogit

---

summary.clogit_bclogit

Summarize a clogit_bclogit model

Description

Summarize a clogit_bclogit model

Usage

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

Arguments

object	A clogit_bclogit object.
...	Additional arguments (not used).

Value

A list of class "summary.clogit_bclogit" containing:

call	The original function call.
coefficients	A matrix with one row per parameter and columns Estimate, Std. Error, z value, and Pr(>|z|).
num_discordant	Number of discordant pairs used for fitting.
num_concordant	Number of concordant pairs.
n	Total number of observations.
treatment_name	Name of the treatment variable.
do_inference_on_var	The value of the do_inference_on_var argument.

See Also

clogit, print.summary.clogit_bclogit, coef.clogit_bclogit, vcov.clogit_bclogit

Examples

```
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5),
  x1 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(seq_len(n / 2), each = 2)
)
fit <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata)
summary(fit)
```

vcov.bclogit *Extract variance-covariance matrix from a bclogit model*

Description

Extract variance-covariance matrix from a bclogit model

Usage

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

Arguments

object	A bclogit object.
...	Additional arguments.

Value

A square matrix of the posterior covariance of the coefficients, derived from the MCMC samples.

See Also

coef.bclogit, summary.bclogit

Examples

```
data("fhs")
fit <- bclogit(PREVHYP ~ TOTCHOL + BMI, data = fhs,
               treatment = PERIOD, strata = RANDID)
vcov(fit)
```

vcov.clogit_bclogit *Extract variance-covariance matrix from a clogit_bclogit model*

Description

Extract variance-covariance matrix from a clogit_bclogit model

Usage

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

Arguments

object	A clogit_bclogit object.
...	Additional arguments.

Value

A diagonal matrix of the estimated coefficient variances (squared standard errors), or NULL when do_inference_on_var is not "all".

See Also

coef.clogit_bclogit, summary.clogit_bclogit

Examples

```
n <- 200
dat <- data.frame(
  y = rbinom(n, 1, 0.5),
  x1 = rnorm(n),
  treatment = rep(c(0, 1), n / 2),
  strata = rep(seq_len(n / 2), each = 2)
)
fit <- clogit(y ~ x1, data = dat, treatment = treatment, strata = strata)
vcov(fit)
```

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