Package 'nonprobsampling'

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Type Package

Title Inference for Nonprobability Samples Using Multiple Reference Surveys

Version 0.2.0

Description Provides pseudo-weighted estimates of means and prevalence for finite population inference from nonprobability samples using auxiliary information from one or multiple probability reference surveys. The package supports estimation with multiple reference surveys, allowing auxiliary information to be combined when no single survey contains all variables relevant to participation. Optional cumulative precalibration can be applied to align weighted totals of shared variables across surveys. Methods are based on the generalized estimating equations framework of Landsman et al. (2026) <doi:10.1002/sim.70403> for correcting participation bias. For a single reference survey, the package implements the raking ratio calibration method and includes the adjusted logistic propensity (ALP) weighting method of Wang, Valliant, and Li (2021) <doi:10.1002/sim.9122>, as well as the Chen-Li-Wu (CLW) method of Chen, Li, and Wu (2020) <doi:10.1080/01621459.2019.1677241>. Analytic variance estimation uses Taylor linearization and accounts for complex sampling designs in the reference surveys via integration with the 'survey' package.

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`coef.pwmean` *Extract Pseudo-Weighted Means or Category Prevalence*

Description

Extracts pseudo-weighted estimates from an object returned by `pwmean`.

Usage

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

Arguments

object	An object of class "pwmean" or "pwmean_factor" returned by pwmean.
...	Additional arguments, currently unused.

Details

Values are taken from object$estimates$adjusted_mean, in row order. For numeric outcomes, names are the domain labels, including "Overall" when no domain variable was supplied.

For categorical outcomes, values estimate category prevalence. Names combine the category and domain labels separated by " | ", including "Overall" when no domain variable was supplied. When names repeat, later occurrences get numeric suffixes such as .1, skipping suffixes that would duplicate an existing name. Objects of class "pwmean_factor" inherit this method.

Unweighted estimates remain available in object$estimates. Participation model coefficients can be extracted from the original "pw_fit" object using coef.pw_fit.

Value

A named numeric vector of pseudo-weighted means for numeric outcomes, or category prevalence estimates for categorical outcomes.

See Also

coef, pwmean, coef.pw_fit

---

coef.pw_fit *Extract Participation Model Coefficients*

Description

Extracts the participation model coefficients estimated by est_pw.

Usage

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

Arguments

object	An object of class "pw_fit" returned by est_pw.
...	Additional arguments, currently unused.

Value

A named numeric vector of participation model coefficients, in the order stored in `object$coefficients`. Returns `NULL` if the object does not contain coefficients.

See Also

`coef`, `est_pw`

`confint.pwmean` *Confidence Intervals for Pseudo-Weighted Estimates*

Description

Computes normal-approximation confidence intervals for pseudo-weighted means or category prevalence returned by `pwmean`.

Usage

```
## S3 method for class 'pwmean'
confint(object, parm, level = 0.95, ...)
```

Arguments

`object`	An object of class `"pwmean"` or `"pwmean_factor"` returned by `pwmean`.
`parm`	A character vector of estimate names, as returned by `names(coef(object))`, or a numeric vector of positive integer positions. If omitted, all estimates are included.
`level`	A single numeric confidence level strictly between 0 and 1. Defaults to `0.95`.
`...`	Additional arguments, currently unused.

Details

Intervals use the pseudo-weighted estimates and standard errors stored in `object$estimates`, with standard normal critical values. At the default confidence level, the intervals match the stored `adjusted_lower` and `adjusted_upper` columns.

Row names match `names(coef(object))`. Objects of class `"pwmean_factor"` inherit this method. Intervals for category prevalence are not truncated to the range from 0 to 1, consistent with the intervals stored by `pwmean()`.

Value

A numeric matrix with one row per requested estimate and two columns containing the lower and upper confidence limits. Column names give the corresponding tail probabilities as percentages. Selecting one estimate still returns a matrix.

See Also

`confint`, `coef.pwmean`, `pwmean`

est_pw *Estimate Pseudo-Weights for Nonprobability Samples*

Description

`est_pw()` estimates pseudo-weights for a nonprobability sample using one or multiple probability reference surveys. The function specifies the participation model, handles missing values in the participation model variables, solves the estimating equations, and stores the quantities needed for downstream point and variance estimation.

Users should harmonize variable names and coding before calling `est_pw()`. Variables used in the participation model must have consistent names and compatible definitions across the nonprobability sample and the reference survey data used for estimation.

With one reference survey, the available methods include the raking ratio calibration method described in Landsman et al. (2026), the adjusted logistic propensity (ALP) weighting method proposed by Wang, Valliant, and Li (2021), and the CLW method proposed by Chen, Li, and Wu (2020). With multiple reference surveys, pseudo-weights are estimated using the multi-reference calibration method proposed by Landsman et al. (2026).

The returned object is designed to be passed to `pwmean`.

Usage

```
est_pw(
  data,
  sp_order = c("size", "given"),
  precali = TRUE,
  p_formula = NULL,
  method = NULL,
  na.action = stats::na.omit,
  sc_wname = "pseudo_wts",
  control = pw_solver_control(),
  verbose = FALSE
)
```

Arguments

`data`	A list of input data objects of the form `list(sc, sp1_design, sp2_design, ...)`. The first element must be a data frame corresponding to the nonprobability sample. Each remaining element must be a valid survey design object corresponding to a probability reference survey, such as an object created by `svydesign` or `svrepdesign`.
`sp_order`	Character string controlling the order of reference surveys when multiple reference surveys are used. Supported values are `"size"` and `"given"`. `"size"` orders reference surveys by sample size, from largest to smallest. `"given"` uses the user-specified order of the reference surveys in `data`. Default is `"size"`. With one reference survey, this argument is ignored; a warning is issued if a non-default value is supplied.

precali — Logical. Used only with multiple reference surveys. If TRUE, cumulative precalibration is applied before the main multi-reference estimation step; see the **Multi-reference precalibration** section for details. Default is TRUE. With one reference survey, this argument is ignored; a warning is issued if FALSE is supplied.

p_formula — Optional participation model formula. Must always be one-sided (no response variable on the left-hand side). A two-sided formula such as y ~ x will raise an error.

With one reference survey, supply a single one-sided formula, for example ~ age + sex + income. With multiple reference surveys, supply a list of one-sided formulas with one formula per reference survey, for example list(~ age + sex, ~ age + income). If NULL, a default formula is constructed automatically from variables shared across the data sources used for estimation. Since shared variables are identified by name, their names should be harmonized across data sources before estimation.

If standardization is needed, use the same centering and scaling constants across all datasets before calling est_pw(). Avoid standardizing each dataset separately or using scale(x) directly within p_formula.

method — Character string specifying the pseudo-weighting method, or NULL (default). If NULL, "calibration" is used when data contains one reference survey, and "multi" is used when data contains more than one reference survey.

To override the default, supply one of the following values. For a one-reference method: "alp", "clw", or "calibration" (or "cali"). For the multi-reference method: "multi". The value "calibration" selects raking ratio calibration, and "multi" selects multi-reference calibration.

The argument is case-insensitive, so inputs such as "ALP", "Clw", or "CALI" are also accepted.

na.action — Function specifying how missing values should be handled for variables used in the participation model. Common choices include stats::na.omit, stats::na.exclude, and stats::na.fail. Default is stats::na.omit.

sc_wname — Character string giving the name of the pseudo-weight column added to the returned nonprobability sample. Default is "pseudo_wts". An error is raised at input validation if this name already exists as a column in sc.

control — A solver control object created by pw_solver_control. This object stores numerical settings for solving estimating equations, including the solver, convergence tolerance, maximum number of iterations, tracing behavior, and other options.

verbose — Logical. If TRUE, progress messages and diagnostics are printed during pseudo-weight estimation. Default is FALSE. Must be a single TRUE or FALSE; an error is raised otherwise.

Details

est_pw() performs pseudo-weight estimation for the nonprobability sample and stores the method-specific internal objects needed later by pwmean. It does not require an outcome variable.

The input data must be provided as a list, where the first element is the nonprobability sample and the remaining elements are reference survey design objects. Reference survey designs can be

created with svydesign for standard complex survey designs or svrepdesign for surveys with replicate weights. These objects preserve the sampling structure needed for design-consistent variance estimation.

Variable harmonization. Variables are matched by name, not by meaning. Before applying est_pw(), shared variables must be harmonized across the nonprobability sample and reference survey data. For example, if a categorical variable is named agecat in the nonprobability sample and age_group in the reference survey, the user should rename one of the variables before estimation.

Categorical variables must have compatible category definitions, identical levels in the same order, and the same contrast coding across the nonprobability sample and all reference surveys containing the variable. When treatment contrasts are used, the reference category must be the same across samples. The package checks factor levels and compares the observed categories when a variable is stored as character in both samples. Users must verify contrast coding separately, as inconsistent coding can produce incorrect estimates without an error. Harmonize factor coding before creating reference survey design objects. Changing the original data frame afterwards does not update the data stored in an existing survey design object.

Continuous variables included in the participation model should also be measured on comparable scales across datasets.

Internally, est_pw() performs the following steps:

1. **Input validation**
   Validates the structure and required components of the input data.
2. **Reference survey detection**
   Determines whether the input contains a single reference survey or multiple reference surveys.
3. **Method selection**
   Selects the pseudo-weighting method based on the specified argument(s).
4. **Participation model specification**
   Constructs a default participation model formula when p_formula = NULL.
5. **Missing data handling**
   Applies missing-data handling procedures to variables used in the participation model.
6. **Model matrix construction**
   Generates model matrices from the participation model variables.
7. **Pseudo-weight estimation**
   Estimates pseudo-weights using the selected method.
8. **Output augmentation**
   Appends the estimated pseudo-weights as a new column to the nonprobability sample.
9. **Metadata storage**
   Stores information related to missing-data handling and other internal objects for later use or diagnostics.

Value

An object of class "pw_fit". This is a list containing user-facing outputs and internal objects required by pwmean.

Important components include:

`sc_updated` A data frame containing the nonprobability sample with an added pseudo-weight column named by `sc_wname`.

`pseudo_weights` The estimated pseudo-weight vector. With `stats::na.omit`, the vector contains only observations retained for pseudo-weight estimation. With `stats::na.exclude`, excluded observations receive `NA` and the vector has length `nrow(sc)`.

`coefficients` Named numeric vector of estimated participation model coefficients. Extract with `coef()`.

`solver_diagnostics` A list of solver diagnostics: `solver` (solver name), `termcd` (termination code), `message` (solver message), `iter` (number of iterations), `fmax` (maximum absolute equation residual returned by the solver at termination), and `ftol` (the equation tolerance supplied to the solver). The equation tolerance is met when `fmax <= ftol`.

`method` The pseudo-weighting method used by the function.

`internal` A list of internal objects needed for downstream estimation.

`na_summary` An object of class `"pw_na_summary"` summarizing the number of rows excluded from the nonprobability sample and each reference survey due to missing participation model variables. `NULL` if no rows were excluded.

`call` The matched function call.

One-reference method and multi-reference method

If `data` contains one reference survey design object, `est_pw()` fits a one-reference method. If `data` contains more than one reference survey design objects, `est_pw()` fits the multi-reference calibration method. In both settings, the auxiliary variables used for pseudo-weight estimation should be harmonized across all data sources before calling `est_pw()`.

Multi-reference precalibration

When `precali = TRUE`, cumulative precalibration is performed before the main multi-reference calibration step. The first reference survey supplies the initial weighted totals and sum of weights. Each subsequent survey is calibrated to the accumulated targets for variables it shares with earlier surveys, together with the initial sum of weights. Newly encountered variables contribute targets computed using that survey's calibrated weights; previously established targets are retained. Variables need not appear in every survey. If a survey has no variables shared with the accumulated targets, only its sum of weights is calibrated.

The order of the reference surveys is controlled by `sp_order`. If `sp_order = "size"`, reference surveys are ordered by sample size, from largest to smallest. If `sp_order = "given"`, the user-specified order of the reference surveys is used. The order determines which survey first supplies each target and can therefore affect the calibrated weights.

Cumulative precalibration is based only on overlapping variables that are specified in `p_formula`, rather than on all overlapping variables in the reference surveys. This choice avoids excluding observations because of missing values in variables that are not used for pseudo-weight estimation.

With `precali = TRUE`, calibrating a reference survey to totals estimated from earlier surveys can induce correlation between the estimated totals. The analytic variance estimator omits this cross-survey covariance. This also applies when replicate weights are used to estimate the variance contribution of an individual reference survey. See Landsman et al. (2026), Section 6.3.2.

Missing data handling

Missing values are handled only for variables used in the participation model. The selected `na.action` is recorded in the returned object, together with the row indices of the nonprobability sample observations retained for pseudo-weight estimation.

With `stats::na.omit`, rows with missing participation model variables are removed from `sc_updated`. With `stats::na.exclude`, the original rows are retained in `sc_updated`, but excluded rows receive `NA` in the pseudo-weight column. This can be useful when users want to preserve row alignment with the original nonprobability sample for later imputation or merging.

Numerical control

Numerical settings are supplied through the `control` argument, which should be created by `pw_solver_control`. This object controls solver choice, convergence tolerance, maximum iterations, tracing, and optional solver-specific arguments.

The top-level `ftol`, `xtol`, and `maxit` values in `pw_solver_control` are the package-level convergence controls used by pseudo-weight estimation stages. When the selected solver is `"nleqslv"`, additional arguments can be passed through `nleqslv_control`. These are forwarded to `nleqslv::nleqslv()`.

References

Chen, Y., Li, P., and Wu, C. (2020). Doubly robust inference with nonprobability survey samples. *Journal of the American Statistical Association*, 115(532), 2011–2021. doi:10.1080/01621459.2019.1677241

Wang, L., Valliant, R., and Li, Y. (2021). Adjusted logistic propensity weighting methods for population inference using nonprobability volunteer-based epidemiologic cohorts. *Statistics in Medicine*, 40(24), 5237–5250. doi:10.1002/sim.9122

Landsman, V., Wang, L., Carrillo-Garcia, I., Mitani, A. A., Smith, P. M., Graubard, B. I., Bui, T., and Carnide, N. (2026). Correction for Participation Bias in Nonprobability Samples Using Multiple Reference Surveys. *Statistics in Medicine*, 45(3–5). doi:10.1002/sim.70403

See Also

`pw_solver_control`, `pwmean`

Examples

```
data(sc)
data(sp1)
data(sp2)

## One-reference example

ref1_design <- survey::svydesign(
  ids     = ~psu_sp1,
  strata  = ~strata_sp1,
  weights = ~wts_sp1,
  data    = sp1,
  nest    = TRUE
)
```

```
fit1 <- est_pw(
  data      = list(sc, ref1_design),
  p_formula = ~ agecat + race + education + comorbidity + BMI + diabetes,
  method    = "calibration",
  control   = pw_solver_control(ftol = 1e-6)
)

print(fit1)

summary(fit1)

## Multi-reference example

ref2_design <- survey::svydesign(
  ids     = ~psu_sp2,
  strata  = ~strata_sp2,
  weights = ~wts_sp2,
  data    = sp2,
  nest    = TRUE
)

fit2 <- est_pw(
  data = list(sc, ref1_design, ref2_design),
  p_formula = list(
    ~ agecat + race + education + psa_level + pros_enlarged + comorbidity,
    ~ agecat + race + BMI + diabetes + comorbidity
  ),
  sp_order = "size",
  precali = TRUE,
  control = pw_solver_control(ftol = 1e-6)
)

print(fit2)

summary(fit2)
```

`na.action.pwmean` *Extract NA action from a pwmean object*

Description

Returns the `na.action` component recorded during estimation, mimicking `na.action` behavior for fitted model objects.

Usage

```
## S3 method for class 'pwmean'
na.action(object, ...)
```

Arguments

object	An object of class "pwmean" returned by pwmean.
...	Additional arguments (not used).

Value

The na.action object recorded by pwmean: an integer vector of rows omitted because of missing outcome or domain values (of class "omit" or "exclude"), or NULL if no rows were omitted.

---

na.action.pw_fit *Extract NA action from a pw_fit object*

Description

Returns the na.action component recorded during the build step.

Usage

```
## S3 method for class 'pw_fit'
na.action(object, ...)
```

Arguments

object	An object of class "pw_fit" returned by est_pw.
...	Additional arguments (not used).

Value

The na.action object recorded by est_pw during the build step: an integer vector of the nonprobability-sample rows omitted because of missing participation model variables (of class "omit" or "exclude"), or NULL if no rows were omitted.

---

print.pwmean *Print method for pwmean objects*

Description

Displays the pseudo-weighted mean estimate and its uncertainty. For factor-like domain variables, prints one row per domain level.

Usage

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

Arguments

x	An object of class "pwmean", returned by pwmean.
...	Additional arguments, currently unused.

Value

Invisibly returns x.

---

print.pwmean_factor *Print method for pwmean objects with categorical outcomes*

Description

Displays pseudo-weighted prevalence estimates and their uncertainty.

Usage

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

Arguments

x	An object of class "pwmean_factor", returned by pwmean when y is a factor.
...	Additional arguments, currently unused.

Value

Invisibly returns x.

---

print.pw_fit *Print method for pw_fit objects*

Description

Compact one-screen overview of a fitted pseudo-weight object: the call, the pseudo-weighting method, the participation model size, solver convergence, and a summary of the estimated pseudo-weights. For the full coefficient table and detailed solver diagnostics, use summary.pw_fit.

Usage

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

Arguments

x	An object of class "pw_fit", returned by est_pw.
...	Additional arguments, currently unused.

Value

Invisibly returns x.

---

print.pw_na_summary *Print method for pw_na_summary*

Description

Prints a formatted table showing the original row count, rows used, and rows excluded due to missing participation model variables, for each dataset (‘sc‘ and each reference survey).

Usage

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

Arguments

x	A ‘pw_na_summary‘ object returned by ‘.report_na_exclusions()‘.
...	Further arguments passed to or from other methods (unused).

Value

Invisibly returns ‘x‘.

---

pwmean *Estimate Pseudo-Weighted Means, Prevalence, and Standard Errors*

Description

Computes pseudo-weighted means and standard errors using a fitted pseudo-weight object of class "pw_fit" returned by est_pw. The function applies second-layer missing-data handling for the outcome and optional domain variable, and then estimates overall or domain-specific means or prevalence using the pseudo-weighting method stored in object.

Usage

```
pwmean(object, y, zcol = NULL, na.action = stats::na.omit)
```

Arguments

object	An object of class "pw_fit" returned by est_pw.
y	A character string specifying the name of the outcome variable in the nonprobability sample stored in object. The outcome must be numeric for mean estimation, including binary 0/1 outcomes for prevalence estimation, or a factor for category prevalence estimation.
zcol	Optional character string giving the name of a categorical domain variable in the nonprobability sample stored in the object. If NULL, the overall mean is estimated. If supplied, estimates are computed within domains defined by this variable. The following column types are supported: logical (must contain both TRUE and FALSE); numeric or integer containing only 0 and 1 after removing missing values; character (empty strings are treated as missing values); and factor (unused levels are dropped).
na.action	Function specifying how missing values in y and zcol should be handled. Default is stats::na.omit.

Details

Missing data handling (layer 2). After pseudo-weights are constructed by est_pw(), estimation of the mean requires complete cases for the outcome y and, if supplied, the domain variable zcol. The argument na.action controls how these missing values are handled at the outcome-estimation step. For character domain variables, leading and trailing whitespace is removed and empty strings are converted to missing values before applying na.action. These rows are omitted with stats::na.omit or stats::na.exclude, and cause an error with stats::na.fail.

Input object**.** The object argument should be an object of class "pw_fit" returned by est_pw. It stores the estimated pseudo-weights, participation model information, and design-based quantities required for point and variance estimation.

Categorical outcomes. When y is a categorical variable (defined as a factor in R), pwmean() estimates the prevalence (proportion) of each category. To do so, each category is internally converted into a 0/1 indicator variable, and the pseudo-weighted mean estimator is then computed for each indicator.

Value

An object of class "pwmean" containing unweighted and pseudo-weighted estimates, standard errors, and confidence intervals. For categorical outcomes, the estimate columns contain estimates of category prevalence.

method Character. The pseudo-weighting method used.

estimates A data frame containing the unweighted and pseudo-weighted estimates. The adjusted_ prefix in column names denotes pseudo-weighted results. Extract the pseudo-weighted means or category prevalence as a named numeric vector with coef(). Obtain normal-approximation confidence intervals at a chosen level with confint().

For numeric outcomes, the first column is domain. If zcol = NULL, domain is "Overall". If zcol is a logical variable or a numeric/integer variable containing only 0 and 1, there is one row with domain labeled "<zcol> = 1". If zcol is a factor or character variable, there is one row per zcol level, with domain labeled "<zcol> = <level>".

For categorical outcomes, the first two columns are `category` and `domain`. `category` identifies the outcome level as `"<y> = <level>"`. If `zcol = NULL`, `domain` is `"Overall"` for each outcome level. If `zcol` is supplied, the rows are formed by each outcome category within each domain, and `domain` follows the same labels described above for `zcol`.

The columns are:

`category` Category label for categorical outcomes only.

`domain` Domain label.

`unweighted_mean`, `unweighted_se` Unweighted mean of `y` and its standard error.

`unweighted_lower`, `unweighted_upper` Bounds of the 95% confidence interval for the unweighted mean, based on the normal approximation.

`adjusted_mean`, `adjusted_se` Pseudo-weighted mean of `y` and its standard error.

`adjusted_lower`, `adjusted_upper` Bounds of the 95% confidence interval for the pseudo-weighted mean, based on the normal approximation.

`na.action` Integer vector of row indices omitted at the outcome-estimation step, with class `"omit"` or `"exclude"` matching the `na.action` argument, or `NULL` if no observations were omitted. The indices refer to the nonprobability sample available to `pwmean()` after missing-data handling in `est_pw()`.

`call` The matched function call.

See Also

`est_pw`, `coef.pwmean`, `confint.pwmean`, `summary.pwmean`, `print.pwmean`

Examples

```
data(sc)
data(sp1)

ref1_design <- survey::svydesign(
  ids     = ~psu_sp1,
  strata  = ~strata_sp1,
  weights = ~wts_sp1,
  data    = sp1,
  nest    = TRUE
)

fit <- est_pw(
  data      = list(sc, ref1_design),
  p_formula = ~ agecat + race + education + comorbidity + BMI + diabetes,
  method    = "calibration",
  control   = pw_solver_control(ftol=1e-6)
)

out <- pwmean(fit, y = "psa_level", zcol = "BMI")

print(out)

summary(out)
```

```
coef(out)

confint(out)
confint(out, level = 0.90)
```

`pw_solver_control` *Control Solver Settings for Pseudo-Weight Estimation*

Description

`pw_solver_control()` creates a solver control object used by `est_pw` to manage numerical settings for pseudo-weight estimation.

Usage

```
pw_solver_control(
  solver = "nleqslv",
  maxit = NULL,
  trace = FALSE,
  method = c("Newton", "Broyden"),
  global = c("dbldog", "cline", "pwldog", "qline", "gline", "hook", "none"),
  xscalm = c("fixed", "auto"),
  ftol = 1e-08,
  xtol = 1e-08,
  nleqslv_control = list()
)
```

Arguments

`solver`	Character string specifying the numerical solver used for solving the estimating equations. Currently, only `"nleqslv"` is supported. Default is `"nleqslv"`.
`maxit`	Positive finite numeric value passed to `nleqslv::nleqslv()` as the maximum number of solver iterations. The value is converted to an integer before being stored in the returned control object. Default is `150` when a global strategy is specified (i.e., `global != "none"`), and `20` when no global strategy is used (`global = "none"`), matching `nleqslv`'s own defaults. Since the default global strategy is `"dbldog"`, the effective default is `150` unless `global = "none"` is explicitly specified.
`trace`	Logical. If `TRUE`, tracing or solver progress information may be requested from the underlying numerical routine when supported. Default is `FALSE`.
`method`	Character string specifying the numerical method passed to `nleqslv::nleqslv()`. Supported values are `"Newton"` and `"Broyden"`. Default is `"Newton"`.
`global`	Character string specifying the global strategy passed to `nleqslv::nleqslv()`. Supported values are `"dbldog"`, `"cline"`, `"pwldog"`, `"qline"`, `"gline"`, `"hook"`, and `"none"`. Default is `"dbldog"`.

`xscalm` Character string specifying the scaling method passed to `nleqslv::nleqslv()`. Supported values are `"fixed"` and `"auto"`. Default is `"fixed"`.

`ftol` Positive finite numeric value passed to `nleqslv::nleqslv()` as the function-value convergence tolerance. This controls convergence based on the size of the estimating function. Default is `1e-8`.

`xtol` Positive finite numeric value passed to `nleqslv::nleqslv()` as the parameter-step convergence tolerance. This controls convergence based on changes in the parameter vector. Default is `1e-8`.

`nleqslv_control`
A list of additional control options passed to `nleqslv::nleqslv()`. This can include less commonly used control options, such as `btol`, `cndtol`, `sigma`, and `scalex`. See `nleqslv` for details.

Details

The control object stores solver settings used by pseudo-weight estimation step. It is passed to `est_pw` through the `control` argument.

Currently, only `solver = "nleqslv"` is supported. The arguments `method`, `global`, `xscalm`, `ftol`, `xtol`, and `maxit` correspond to options used by `nleqslv::nleqslv()`. They are collected internally and passed to `nleqslv::nleqslv()` at the pseudo-weight estimation step.

The argument `ftol` is the function-value convergence tolerance. It controls convergence based on the size of the estimating function. The argument `xtol` is the parameter-step convergence tolerance. It controls convergence based on changes in the parameter vector. The argument `maxit` controls the maximum number of solver iterations.

Additional, less commonly used `nleqslv` control options can be supplied through `nleqslv_control`. To avoid ambiguity, do not supply `ftol`, `xtol`, `maxit`, or `trace` inside `nleqslv_control`; use the main arguments instead.

Value

A flat list containing all solver control settings for pseudo-weight estimation:

`solver` The selected numerical solver.

`method` The nleqslv numerical method.

`global` The nleqslv global strategy.

`xscalm` The nleqslv scaling method.

`ftol` The function-value convergence tolerance.

`xtol` The parameter-step convergence tolerance.

`maxit` The maximum number of solver iterations, stored as an integer. `150` if a global strategy is used; `20` if `global = "none"`. Since the default global strategy is `"dbldog"`, the effective default is `150` unless `global = "none"` is explicitly specified.

`trace` Logical value indicating whether tracing information is requested.

`nleqslv_control` A list of additional options passed to `nleqslv::nleqslv()`.

See Also

est_pw

Examples

```
## Default solver control settings
ctrl <- pw_solver_control()

## Custom nleqslv solver settings
ctrl <- pw_solver_control(
  maxit  = 20,
  trace  = FALSE,
  method = "Newton",
  global = "cline",
  xscalm = "auto",
  ftol   = 1e-8,
  xtol   = 1e-10
)

## Additional nleqslv control options
ctrl <- pw_solver_control(
  method = "Newton",
  global = "dbldog",
  nleqslv_control = list(
    btol = 1e-3
  )
)
```

---

sc *Nonprobability Sample (sc)*

Description

This dataset represents a synthetic nonprobability sample generated via Poisson sampling from a finite population constructed from the National Health and Nutrition Examination Survey (NHANES) cycles 1999–2010. It is intended to illustrate the pseudo-weighting methods implemented in the nonprobsampling package.

Usage

```
data(sc)
```

Format

A data frame with 2404 observations and 8 variables:

psa_level Outcome variable: serum prostate-specific antigen level (numeric)

BMI Body mass index category (factor with 4 levels: "Normal", "Overweight", "Obese", "Morbidly Obese")

race Race category (factor with 4 levels: 1 = White, 2 = Black, 3 = Hispanic, 4 = Other)

agecat Age category (factor with 4 levels: 1 = 55–59, 2 = 60–64, 3 = 65–69, 4 = 70+)

education Education level (factor with 5 levels: 1 = Less Than 8 Years, 2 = 8–11 Years, 3 = 12 Years Or Completed High School, 4 = College Graduate, 5 = Postgraduate)

pros_enlarged Prostate enlargement indicator (factor with 2 levels: 0 = No, 1 = Yes)

comorbidity General comorbidity indicator (factor with 2 levels: 0 = No, 1 = Yes)

diabetes Diabetes diagnosis indicator (factor with 2 levels: 0 = No, 1 = Yes)

Details

The dataset has 2,404 complete-case observations, with `psa_level` serving as the outcome variable. Auxiliary variables shared with the probability reference surveys `sp1` and `sp2` are used to construct pseudo-weights aimed at correcting for participation bias.

Source

Synthetic data generated by the package authors. The underlying finite population was constructed from the National Health and Nutrition Examination Survey (NHANES), 1999–2010 cycles, conducted by the U.S. National Center for Health Statistics (NCHS).

Examples

```
data(sc)
str(sc)
summary(sc)
```

---

sp1 *Probability Reference Survey 1 (sp1)*

Description

This dataset represents a probability sample derived from the 1999–2010 cycles of the National Health and Nutrition Examination Survey (NHANES). It is used as a probability reference survey to support the pseudo-weighting methods implemented in the `nonprobsampling` package.

Usage

```
data(sp1)
```

Format

A data frame with 3494 observations and 14 variables:

agecat Age category (factor with 4 levels: 1 = 55–59, 2 = 60–64, 3 = 65–69, 4 = 70+)

marital Marital status (factor with 4 levels: 1 = Married Or Living As Married, 2 = Widowed, 3 = Divorced or Separated, 4 = Never Married)

race Race category (factor with 4 levels: 1 = White, 2 = Black, 3 = Hispanic, 4 = Other)

education Education level (factor with 5 levels: 1 = Less Than 8 Years, 2 = 8–11 Years, 3 = 12 Years Or Completed High School, 4 = College Graduate, 5 = Postgraduate)

employment Employment status (factor with 2 levels: 0 = Not Working, 1 = Working)

smoking Smoking status (factor with 3 levels: 1 = Never Smoker, 2 = Former Smoker, 3 = Current Smoker)

comorbidity General comorbidity indicator (factor with 2 levels: 0 = No, 1 = Yes)

psa_level Serum prostate-specific antigen level (numeric)

BMI Body mass index category (factor with 4 levels: "Normal", "Overweight", "Obese", "Morbidly Obese")

diabetes Diabetes diagnosis indicator (factor with 2 levels: 0 = No, 1 = Yes)

pros_enlarged Prostate enlargement indicator (factor with 2 levels: 0 = No, 1 = Yes)

strata_sp1 Stratum identifier for complex survey design (numeric)

psu_sp1 Primary sampling unit identifier for complex survey design (numeric)

wts_sp1 10-year interview sampling weights (numeric)

Details

The dataset includes auxiliary variables shared with the nonprobability sample `sc`, enabling the construction of pseudo-weights to adjust for participation bias. Survey design variables and sampling weights are provided to support design-consistent estimation.

The `sp1` dataset contains the outcome variable `psa_level`, which is also observed in `sc`, allowing for the evaluation of pseudo-weighted estimators against estimates based on the reference survey sampling weights. It may also be incorporated into the participation model, potentially enhancing bias reduction when participation depends on the outcome.

Source

Derived from the National Health and Nutrition Examination Survey (NHANES), 1999–2010 cycles, conducted by the U.S. National Center for Health Statistics (NCHS).

Examples

```
data(sp1)
str(sp1)
summary(sp1)
```

sp1_bootstrap *Probability Reference Survey 1 with Bootstrap Replicate Weights (sp1_bootstrap)*

Description

A replicate-weight version of sp1, including the main survey weight and 500 bootstrap replicate weights. It is provided to illustrate estimation of the reference survey contribution to the variance with svrepdesign. The original primary sampling unit and stratum identifiers are not included.

Usage

```
data(sp1_bootstrap)
```

Format

A data frame with 3494 rows and 512 columns. The first 12 columns are the substantive survey variables from sp1 (agecat, marital, race, education, employment, smoking, comorbidity, psa_level, BMI, diabetes, pros_enlarged, wts_sp1). The remaining 500 columns are bootstrap replicate weights named bw1 through bw500 (numeric).

Details

The bootstrap replicate weights were constructed from the original stratified cluster design of sp1, using the Rao-Wu rescaling bootstrap method. A total of R = 500 replicates were produced with seed = 2026.

The bootstrap replicate weights are used to estimate the reference survey contribution to the variance; the package does not bootstrap the entire estimation procedure.

The variables psu_sp1 and strata_sp1 are not included in this dataset because they are not needed when using replicate weights for variance estimation. The main survey weight wts_sp1 and the replicate weight columns bw1–bw500 are sufficient for constructing a replicate-weight survey design object via survey::svrepdesign(). These columns already include the main survey weight, so use combined.weights = TRUE to avoid multiplying by it again.

Source

Derived from sp1 (National Health and Nutrition Examination Survey, NHANES, 1999–2010 cycles), with bootstrap replicate weights added by the package authors using the Rao-Wu rescaling bootstrap.

Examples

```
data(sp1_bootstrap)

# Example: create replicate-weight survey design object
des_boot <- survey::svrepdesign(
  data    = sp1_bootstrap,
```

```
  weights = ~wts_sp1,
  repweights = "bw[0-9]+",
  type    = "bootstrap",
  combined.weights = TRUE
)

summary(des_boot)
```

---

sp2 *Probability Reference Survey 2 (sp2)*

Description

This dataset represents a probability sample derived from the 1997–2008 cycles of the National Health Interview Survey (NHIS). It is used as a probability reference survey alongside `sc` and `sp1` to illustrate the multi-reference calibration method implemented in the `nonprobsampling` package.

Usage

```
data(sp2)
```

Format

A data frame with 35525 observations and 11 variables:

agecat Age category (factor with 4 levels: 1 = 55–59, 2 = 60–64, 3 = 65–69, 4 = 70+)

marital Marital status (factor with 4 levels: 1 = Married Or Living As Married, 2 = Widowed, 3 = Divorced or Separated, 4 = Never Married)

race Race category (factor with 4 levels: 1 = White, 2 = Black, 3 = Hispanic, 4 = Other)

employment Employment status (factor with 2 levels: 0 = Not Working, 1 = Working)

diabetes Diabetes diagnosis indicator (factor with 2 levels: 0 = No, 1 = Yes)

BMI Body mass index category (factor with 4 levels: "Normal", "Overweight", "Obese", "Morbidly Obese")

smoking Smoking status (factor with 3 levels: 1 = Never Smoker, 2 = Former Smoker, 3 = Current Smoker)

comorbidity General comorbidity indicator (factor with 2 levels: 0 = No, 1 = Yes)

wts_sp2 Sampling weights (numeric)

strata_sp2 Stratum identifier for complex survey design (numeric)

psu_sp2 Primary sampling unit identifier for complex survey design (numeric)

Details

The dataset includes auxiliary variables shared with the nonprobability sample `sc`, enabling the construction of pseudo-weights to adjust for participation bias. Survey design variables and sampling weights are provided to support design-consistent estimation.

Source

Derived from the National Health Interview Survey (NHIS), 1997–2008 cycles, conducted by the U.S. National Center for Health Statistics (NCHS).

Examples

```
data(sp2)
str(sp2)
summary(sp2)
```

---

summary.pwmean *Summary method for pwmean objects*

Description

Provides console output for objects of class `"pwmean"`, including unweighted and pseudo-weighted mean estimates, standard errors, confidence intervals, and optional domain-level summaries.

Usage

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

Arguments

`object`	An object of class `"pwmean"`, returned by `pwmean`.
`...`	Additional arguments, currently unused.

Value

Invisibly returns `object`.

---

summary.pwmean_factor *Summary method for pwmean objects with categorical outcomes*

Description

Provides console output for objects of class `"pwmean_factor"`, including unweighted and pseudo-weighted prevalence estimates, standard errors, and confidence intervals.

Usage

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

Arguments

object	An object of class "pwmean_factor", returned by pwmean when y is a factor.
...	Additional arguments, currently unused.

Value

Invisibly returns object.

---

summary.pw_fit *Summarize a Pseudo-Weight Fit*

Description

Summarize a Pseudo-Weight Fit

Usage

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

Arguments

object	An object of class "pw_fit", returned by est_pw.
...	Additional arguments, currently unused.

Value

Invisibly returns object.

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