

Package ‘imputeMulti’

May 8, 2026

Title Imputation Methods for Multivariate Multinomial Data

Version 0.8.4

Description Implements imputation methods using EM and Data Augmentation for multinomial data following the work of Schafer 1997 <ISBN: 978-0-412-04061-0>.

Depends R (>= 3.5),

Imports gtools (>= 3.3), methods, parallel, Rcpp (>= 0.11.4), data.table (>= 1.14.2)

License GPL-3

LazyData true

Suggests testthat, knitr, R.rsp, covr

LinkingTo Rcpp

RoxygenNote 7.1.2

Encoding UTF-8

VignetteBuilder knitr, R.rsp

Collate 'RcppExports.R' 'class_imputeMulti.R' 'data-tract2221.R'
'data_dep_prior_multi.R' 'imputeMulti-package.R'
'int-count_levels.R' 'int-impute_multinomial.R'
'int-search_z_Os_y.R' 'int-splitRows.R' 'merge_imputed.R'
'methods_imputeMulti.R' 'multinomial_data_aug.R'
'multinomial_em.R' 'multinomial_impute.R' 'multinomial_stats.R'

NeedsCompilation yes

Author Alex Whitworth [aut, cre]

Maintainer Alex Whitworth <whitworth.alex@gmail.com>

Repository CRAN

Date/Publication 2023-02-18 20:10:02 UTC

Contents

data_dep_prior_multi	2
imputeMulti-class	3

is.imputeMulti	4
is.mod_imputeMulti	4
merge_imputed	5
mod_imputeMulti-class	5
multinomial_data_aug	6
multinomial_em	8
multinomial_impute	9
multinomial_stats	10
summary,imputeMulti-method	11
summary,mod_imputeMulti-method	11
supDistC	12
tract2221	12

Index 14

data_dep_prior_multi *Data Dependent Prior for Multinomial Distribution*

Description

Creates a data dependent prior for p-dimensional multinomial distributions using a conjugate prior (eg *Dirichlet*(α)) based on 20

Usage

```
data_dep_prior_multi(dat)
```

Arguments

dat A data.frame. All variables must be factors

Value

A data.frame containing identifiers for all possible $P(Y = y)$ and the associated prior-counts, α

References

Darnieder, William Francis. Bayesian methods for data-dependent priors. Dissertation. The Ohio State University, 2011.

See Also

[expand.grid](#)

imputeMulti-class	Class "imputeMulti"
-------------------	---------------------

Description

A multivariate multinomial model imputed by EM or Data Augmentation is represented as a `mod_imputeMulti` object. A complete dataset and model is represented as an `imputeMulti` object. Inherits from `mod_imputeMulti`. Additional slots are supplied for (1) the call to `multinomial_impute`; (2) the missing and imputed data; and (3) the number of observations with missing values.

Usage

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

get_imputations(object)

## S4 method for signature 'imputeMulti'
get_imputations(object)

n_miss(object)
```

Arguments

`object` an object of class "imputeMulti"

Slots

`Gcall` the call to `multinomial_impute`
`method` the modeling method
`mle_call` the call to the estimation function
`mle_iter` the number of iterations in estimation
`mle_log_lik` the final log-likelihood
`mle_cp` the conjugate prior if any
`mle_x_y` the MLE estimate of the sufficient statistics and parameters
`data` a list of the missing and imputed data
`nmiss` the number of observations with missing data

Objects from the class

Objects are created by calls to `multinomial_impute`, `multinomial_em`, or `multinomial_data_aug`.

See Also

`multinomial_impute`, `multinomial_em`, `multinomial_data_aug`

is.imputeMulti *Check imputeMulti Class*

Description

Function that checks if the target object is a imputeMulti object.

Usage

```
is.imputeMulti(x)
```

Arguments

x any R object.

Value

Returns TRUE if its argument has class "imputeMulti" among its classes and FALSE otherwise.

is.mod_imputeMulti *Check mod_imputeMulti Class*

Description

Function that checks if the target object is a mod_imputeMulti object.

Usage

```
is.mod_imputeMulti(x)
```

Arguments

x any R object.

Value

Returns TRUE if its argument has class "mod_imputeMulti" among its classes and FALSE otherwise.

merge_imputed	<i>Merge imputed data and original dataset</i>
---------------	--

Description

Merge the imputed dataset from an `imputeMulti` object with the original dataset. Merging is done by rownames, since `imputeMulti` maintains row-order during imputation.

Usage

```
merge_imputed(impute_obj, y, ...)
```

Arguments

<code>impute_obj</code>	An object of class "imputeMulti".
<code>y</code>	The dataset from which the missing data was imputed.
<code>...</code>	Arguments to be passed to other methods

<code>mod_imputeMulti-class</code>	<i>Class "mod_imputeMulti"</i>
------------------------------------	--------------------------------

Description

A multivariate multinomial model imputed by EM or Data Augmentation is represented as a `mod_imputeMulti` object. A complete dataset and model is represented as an `imputeMulti` object. Slots for `mod_imputeMulti` objects include: (1) the modeling method; (2) the call to the estimation function; (3) the number of iterations in estimation; (4) the final log-likelihood; (5) the conjugate prior if any; (6) the MLE estimate of the sufficient statistics and parameters.

Usage

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

get_parameters(object)

## S4 method for signature 'mod_imputeMulti'
get_parameters(object)

get_prior(object)

## S4 method for signature 'mod_imputeMulti'
get_prior(object)

get_iterations(object)
```

```

## S4 method for signature 'mod_imputeMulti'
get_iterations(object)

get_logLik(object)

## S4 method for signature 'mod_imputeMulti'
get_logLik(object)

get_method(object)

## S4 method for signature 'mod_imputeMulti'
get_method(object)

## S4 method for signature 'imputeMulti'
n_miss(object)

```

Arguments

`object` an object of class "mod_imputeMulti"

Slots

`method` the modeling method
`mle_call` the call to the estimation function
`mle_iter` the number of iterations in estimation
`mle_log_lik` the final log-likelihood
`mle_cp` the conjugate prior if any
`mle_x_y` the MLE estimate of the sufficient statistics and parameters

Objects from the class

Objects are created by calls to [multinomial_impute](#), [multinomial_em](#), or [multinomial_data_aug](#).

See Also

[multinomial_impute](#), [multinomial_em](#), [multinomial_data_aug](#)

`multinomial_data_aug` *Data Augmentation algorithm for multinomial data*

Description

Implement the Data Augmentation algorithm for multivariate multinomial data given observed counts of complete and missing data (Y_{obs} and Y_{mis}). Allows for specification of a Dirichlet conjugate prior.

Usage

```

multinomial_data_aug(
  x_y,
  z_0s_y,
  enum_comp,
  conj_prior = c("none", "data.dep", "flat.prior", "non.informative"),
  alpha = NULL,
  burnin = 100,
  post_draws = 1000,
  verbose = FALSE
)

```

Arguments

<code>x_y</code>	A data.frame of observed counts for complete observations.
<code>z_0s_y</code>	A data.frame of observed marginal-counts for incomplete observations.
<code>enum_comp</code>	A data.frame specifying a vector of all possible observed patterns.
<code>conj_prior</code>	A string specifying the conjugate prior. One of <code>c("none", "data.dep", "flat.prior", "non.informative")</code> .
<code>alpha</code>	The vector of counts α for a $Dir(\alpha)$ prior. Must be specified if <code>conj_prior</code> is either <code>c("data.dep", "flat.prior")</code> . If <code>flat.prior</code> , specify as a scalar. If <code>data.dep</code> , specify as a vector with key matching <code>enum_comp</code> .
<code>burnin</code>	A scalar specifying the number of iterations to use as a burnin. Defaults to 100.
<code>post_draws</code>	An integer specifying the number of draws from the posterior distribution. Defaults to 1000.
<code>verbose</code>	Logical. If TRUE, provide verbose output on each iteration.

Value

An object of class `mod_imputeMulti-class`.

See Also

[multinomial_em](#), [multinomial_impute](#)

Examples

```

## Not run:
data(tract2221)
x_y <- multinomial_stats(tract2221[,1:4], output= "x_y")
z_0s_y <- multinomial_stats(tract2221[,1:4], output= "z_0s_y")
x_possible <- multinomial_stats(tract2221[,1:4], output= "possible.obs")

imputeDA_mle <- multinomial_data_aug(x_y, z_0s_y, x_possible, n_obs= nrow(tract2221),
  conj_prior= "none", verbose= TRUE)

## End(Not run)

```

multinomial_em *EM algorithm for multinomial data*

Description

Implement the EM algorithm for multivariate multinomial data given observed counts of complete and missing data (Y_{obs} and Y_{mis}). Allows for specification of a Dirichlet conjugate prior.

Usage

```
multinomial_em(
  x_y,
  z_0s_y,
  enum_comp,
  n_obs,
  conj_prior = c("none", "data.dep", "flat.prior", "non.informative"),
  alpha = NULL,
  tol = 5e-07,
  max_iter = 10000,
  verbose = FALSE
)
```

Arguments

<code>x_y</code>	A data.frame of observed counts for complete observations.
<code>z_0s_y</code>	A data.frame of observed marginal-counts for incomplete observations.
<code>enum_comp</code>	A data.frame specifying a vector of all possible observed patterns.
<code>n_obs</code>	An integer specifying the number of observations in the original data.
<code>conj_prior</code>	A string specifying the conjugate prior. One of <code>c("none", "data.dep", "flat.prior", "non.informative")</code> .
<code>alpha</code>	The vector of counts α for a $Dir(\alpha)$ prior. Must be specified if <code>conj_prior</code> is either <code>c("data.dep", "flat.prior")</code> . If <code>flat.prior</code> , specify as a scalar. If <code>data.dep</code> , specify as a vector with key matching <code>enum_comp</code> .
<code>tol</code>	A scalar specifying the convergence criteria. Defaults to <code>5e-7</code>
<code>max_iter</code>	An integer specifying the maximum number of allowable iterations. Defaults to <code>10000</code> .
<code>verbose</code>	Logical. If TRUE, provide verbose output on each iteration.

Value

An object of class `mod_imputeMulti-class`.

See Also

[multinomial_data_aug](#), [multinomial_impute](#)

Examples

```
## Not run:
data(tract2221)
x_y <- multinomial_stats(tract2221[,1:4], output= "x_y")
z_0s_y <- multinomial_stats(tract2221[,1:4], output= "z_0s_y")
x_possible <- multinomial_stats(tract2221[,1:4], output= "possible.obs")

imputeEM_mle <- multinomial_em(x_y, z_0s_y, x_possible, n_obs= nrow(tract2221),
                              conj_prior= "none", verbose= TRUE)

## End(Not run)
```

multinomial_impute	<i>Impute Values for missing multinomial values</i>
--------------------	---

Description

Impute values for multivariate multinomial data using either EM or Data Augmentation.

Usage

```
multinomial_impute(
  dat,
  method = c("EM", "DA"),
  conj_prior = c("none", "data.dep", "flat.prior", "non.informative"),
  alpha = NULL,
  verbose = FALSE,
  ...
)
```

Arguments

dat	A data.frame. All variables must be factors.
method	c("EM", "DA") A string specifying EM or Data Augmentation (DA)
conj_prior	A string specifying the conjugate prior. One of c("none", "data.dep", "flat.prior", "non.informative").
alpha	The vector of counts α for a $Dir(\alpha)$ prior. Must be specified if conj_prior is either c("data.dep", "flat.prior"). If flat.prior, specify as a scalar. If data.dep, specify as a vector with key matching enum_comp.
verbose	Logical. If TRUE, provide verbose output on each iteration.
...	Arguments to be passed to other methods

Value

An object of class `imputeMulti-class`

References

Schafer, Joseph L. Analysis of incomplete multivariate data. Chapter 7. CRC press, 1997.

See Also

[data_dep_prior_multi](#), [multinomial_em](#)

Examples

```
## Not run:
data(tract2221)
imputeEM <- multinomial_impute(tract2221[,1:4], method= "EM",
                              conj_prior = "none", verbose= TRUE)
imputeDA <- multinomial_impute(tract2221[,1:4], method= "DA",
                              conj_prior = "non.informative", verbose= TRUE)

## End(Not run)
```

multinomial_stats *Multinomial Sufficient Statistics*

Description

Calculate observed-data sufficient statistics, marginally-observed summary statistics or enumerate all possible observed patterns from a multivariate multinomial dataset.

Usage

```
multinomial_stats(dat, output = c("x_y", "z_0s_y", "possible.obs"))
```

Arguments

dat	A data.frame. All variables must be factors.
output	A string specifying the desired output. One of c("x_y", "z_0s_y", "possible.obs"). "x_y" indicates the observed-data sufficient statistics, "z_0s_y" indicates the marginally-observed summary statistics, and "possible.obs" indicates the possible observed patterns.

Value

A data.frame containing either sufficient statistics or possible observed patterns.

Examples

```
## Not run:
data(tract2221)
obs_suff_stats <- multinomial_stats(tract2221, output= "x_y")
marg_obs_suff_stats <- multinomial_stats(tract2221, output= "z_0s_y")

## End(Not run)
```

summary,imputeMulti-method

Summarizing imputeMulti objects

Description

summary method for class "imputeMulti"

Usage

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

Arguments

object an object of class "imputeMulti"
 ... further arguments passed to or from other methods.

summary,mod_imputeMulti-method

Summarizing mod_imputeMulti objects

Description

summary method for class "mod_imputeMulti"

Usage

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

Arguments

object an object of class "mod_imputeMulti"
 ... further arguments passed to or from other methods.

supDistC	<i>Calculate the sup of L1 distance between x and y</i>
----------	---

Description

sup of L1 distance between x and y

Usage

supDistC(x, y)

Arguments

x	A numeric vector
y	A numeric vector

Value

a numeric scalar.

tract2221	<i>Observational data on individuals living in census tract 2221</i>
-----------	--

Description

A dataset containing attributes of 3974 individuals living in census tract 2221 in Los Angeles County, CA. Data comes from the 5-year American Community Survey with end year 2014. Missing values have been inserted.

Usage

tract2221

Format

A data.frame with 3974 rows and 10 variables. All variables are of class factor:

age The individual's age coded in roughly 5 year age buckets.

gender The individuals gender – Male, Female

marital_status The individuals marital status. Takes one of 5 levels: never_mar never married; married married; mar_apart married but living apart; divorced divorced; and widowed widowed

- edu_attain** The individual's educational attainment. Takes one of 7 levels: 1t_hs less than high school; some_hs completed some high school but did not graduate; hs_grad high school graduate; some_col completed some college but did not graduate; assoc_dec completed an associates degree; ba_deg obtained a bachelors degree; grad_deg obtained a graduate or professional degree
- emp_status** The individuals employment status. Takes one of 3 levels: employed individual is in the labor force and employed; unemployed individual is in the labor force and unemployed; not_in_labor_force individual is not in the labor force
- nativity** The individual's nativity status. Takes one of 4 values: born_state_residence born in the state of residence; born_other_state born in another US state; born_out_us a US citizen born outside the US; foreigner foreign born
- pov_status** The individual's poverty status in the past year. Takes one of 2 levels: below_pov_level below the poverty level; at_above_pov_level at or above the poverty level
- geog_mobility** The individual's geographic mobility in the last year. Takes one of 5 values: same house lived in the same house; same county moved within the same county; same state moved within the same state; same state moved from a different county within the same state; diff state moved from a different state; moved from abroad moved from another country
- ind_income** The individual's annual income. Takes one of 9 levels: no_income no income; 1_1t10k income <\$10,000; 10k_1t15k \$10000-\$14999; 15k_1t25k \$15000-\$24999; 25k_1t35k \$25000-\$34999; 35k_1t50k \$35000-\$49999; 50k_1t65k \$50000-\$64999; 65k_1t75k \$65000-\$74999; gt75k \$75000+
- race** The individual's ethnicity.

Index

- * **datasets**
 - tract2221, [12](#)
- data_dep_prior_multi, [2](#), [10](#)
- expand.grid, [2](#)
- get_imputations (imputeMulti-class), [3](#)
- get_imputations, imputeMulti-method (imputeMulti-class), [3](#)
- get_iterations (mod_imputeMulti-class), [5](#)
- get_iterations, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)
- get_logLik (mod_imputeMulti-class), [5](#)
- get_logLik, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)
- get_method (mod_imputeMulti-class), [5](#)
- get_method, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)
- get_parameters (mod_imputeMulti-class), [5](#)
- get_parameters, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)
- get_prior (mod_imputeMulti-class), [5](#)
- get_prior, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)

- imputeMulti, [3](#), [5](#)
- imputeMulti-class, [3](#)
- is.imputeMulti, [4](#)
- is.mod_imputeMulti, [4](#)

- merge_imputed, [5](#)
- mod_imputeMulti, [3](#), [5](#)
- mod_imputeMulti-class, [5](#)
- multinomial_data_aug, [3](#), [6](#), [6](#), [8](#)
- multinomial_em, [3](#), [6](#), [7](#), [8](#), [10](#)
- multinomial_impute, [3](#), [6–8](#), [9](#)
- multinomial_stats, [10](#)

- n_miss (imputeMulti-class), [3](#)
- n_miss, imputeMulti-method (mod_imputeMulti-class), [5](#)

- show, imputeMulti-method (imputeMulti-class), [3](#)
- show, mod_imputeMulti-method (mod_imputeMulti-class), [5](#)
- show-imputeMulti (imputeMulti-class), [3](#)
- show-mod_imputeMulti (mod_imputeMulti-class), [5](#)
- summary, imputeMulti-method, [11](#)
- summary, mod_imputeMulti-method, [11](#)
- supDistC, [12](#)

- tract2221, [12](#)