

Package ‘imputeMulti’

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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)

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VignetteBuilder knitr, R.rsp

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'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'

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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	<i>Class "imputeMulti"</i>
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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>
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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>
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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	<i>EM algorithm for multinomial data</i>
----------------	--

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 *Impute Values for missing multinomial values*

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.

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