

Package ‘hyreg2’

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Type Package

Title Estimate Latent Classes on a Mixture of Continuous and Dichotomous Data

Version 1.1.2

Description The hybrid model likelihood as described by Ramos-Goñi et al. (2017) <[doi:10.1097/MLR.0000000000000283](https://doi.org/10.1097/MLR.0000000000000283)> is implemented and embedded in a latent class framework. The package is based on 'flexmix' and among others contains an M-step-driver as described by Leisch (2004) <[doi:10.18637/jss.v011.i08](https://doi.org/10.18637/jss.v011.i08)>. Users can, for example, estimate latent classes for EQ-5D value sets and address preference heterogeneity. Both uncensored and censored data are supported. Furthermore, heteroscedasticity can be taken into account. It is possible to control for different covariates on the continuous and dichotomous data and start values can differ between the expected latent classes.

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FLXMRhyreg	<i>M-step driver to be used in flexmix</i>
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Description

Function used in flexmix M-Step to estimate hybrid model

Usage

```
FLXMRhyreg(
  formula = . ~ .,
  family = c("hyreg"),
  type = NULL,
  type_cont = NULL,
  type_dich = NULL,
  variables_both = NULL,
  variables_cont = NULL,
  variables_dich = NULL,
  stv = NULL,
  offset = NULL,
  opt_method = "BFGS",
  optimizer = "optim",
  lower = -Inf,
  upper = Inf,
  formula_type_classic = TRUE,
  ...
)
```

Arguments

formula	model formula, automatically provided by <code>hyreg2</code> and <code>flexmix::flexmix()</code>
family	default "hyreg", needed for <code>flexmix::flexmix()</code>
type	character vector containing the indicator whether that datapoint (row) contains continuous or dichotomous data, see Details of <code>hyreg2</code>
type_cont	value of type referring to continuous data, see Details of <code>hyreg2</code>
type_dich	value of type referring to dichotomous data, see Details of <code>hyreg2</code>
variables_both	character vector; variables to be fitted on both continuous and dichotomous data. see Details of <code>hyreg2</code>
variables_cont	character vector; variables to be fitted only on continuous data. see Details of <code>hyreg2</code>
variables_dich	character vector; variables to be fitted only on dichotomous data. see Details of <code>hyreg2</code>
stv	named vector or list of named vectors containing start values for all coefficients from formula, including theta, see Details of <code>hyreg2</code>
offset	offset as in <code>flexmix::flexmix()</code> , default NULL
opt_method	character, optimization method to be used in optimizer, default "BFGS"
optimizer	character, optimizer to be used in <code>bbmle::mle2()</code> , default "optim"
lower	lower bound for censored data. If this is used, <code>opt_method</code> must be set to "L-BFGS-B", default -INF,
upper	upper bound for censored data. If this is used, <code>opt_method</code> must be set to "L-BFGS-B", default INF
formula_type_classic	logical; is the provided formula a typical R formula containing only variables or does it include variables and parameters? default TRUE
...	additional arguments for <code>flexmix::flexmix()</code> or <code>bbmle::mle2()</code>

Value

a model object, that can be used in `hyreg2` as input for parameter model in `flexmix::flexmix()`
 a model object, that can be used in `hyreg2` as input for parameter model in `flexmix::flexmix`

Author(s)

Svenja Elkenkamp and Kim Rand

Examples

```
formula <- y ~ -1 + x1 + x2 + x3
the$k <- 2
stv <- setNames(c(0.2,0,1,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
```

```

x <- model.matrix(formula,simulated_data_norm)
y <- simulated_data_norm$y
w <- 1
model <- FLXMRhyreg(formula = formula,
                    family=c("hyreg"),
                    type = simulated_data_norm$type,
                    stv = stv,
                    type_cont = "TTO",
                    type_dich = "DCE_A",
                    opt_method = "L-BFGS-B",
                    control = list(iter.max = 1000, verbose = 4),
                    offset = NULL,
                    optimizer = "optim",
                    variables_both = names(stv)[!is.element(names(stv),c("sigma","theta"))],
                    variables_cont = NULL,
                    variables_dich = NULL,
                    lower = -Inf,
                    upper = Inf,
                    )

```

FLXMRhyreg_het

M-step driver to be used in flexmix accounting for heteroscedastisity

Description

Function used in flexmix M-Step to estimate hybrid model accounting for heteroscedastisity

Usage

```

FLXMRhyreg_het(
  data,
  formula = . ~ .,
  formula_sigma = formula_sigma,
  family = c("hyreg"),
  type = NULL,
  type_cont = NULL,
  type_dich = NULL,
  variables_both = NULL,
  variables_cont = NULL,
  variables_dich = NULL,
  stv = NULL,
  stv_sigma = NULL,
  offset = NULL,
  opt_method = "BFGS",
  optimizer = "optim",
  lower = -Inf,
  upper = Inf,
  ...
)

```

Arguments

<code>data</code>	a data.frame containing the data, see Details of hyreg2_het
<code>formula</code>	linear model formula
<code>formula_sigma</code>	formula for estimation of sigma to account for heteroscedasticity, see Details hyreg2_het
<code>family</code>	default "hyreg", needed for <code>flexmix::flexmix()</code>
<code>type</code>	character vector containing the indicator whether that datapoint (row) contains continuous or dichotomous data, see Details of hyreg2_het
<code>type_cont</code>	value of type referring to continuous data, see Details of hyreg2_het
<code>type_dich</code>	value of type referring to dichotomous data, see Details of hyreg2_het
<code>variables_both</code>	character vector; variables to be fitted on both continuous and dichotomous data. see Details of hyreg2_het
<code>variables_cont</code>	character vector; variables to be fitted only on continuous data. see Details of hyreg2_het
<code>variables_dich</code>	character vector; variables to be fitted only on dichotomous data. see Details of hyreg2_het
<code>stv</code>	named vector or list of named vectors containing start values for all coefficients from formula, including theta, see Details of hyreg2_het
<code>stv_sigma</code>	named vector with start values for sigma estimation. Have to be the same variables as given in <code>formula_sigma</code> , see Details of hyreg2_het
<code>offset</code>	offset as in <code>flexmix::flexmix()</code> , default NULL
<code>opt_method</code>	character, optimization method to be used in optimizer, default "BFGS"
<code>optimizer</code>	character, optimizer to be used in <code>bbmle::mle2()</code> , default "optim"
<code>lower</code>	lower bound for censored data. If this is used, <code>opt_method</code> must be set to "L-BFGS-B", default -INF,
<code>upper</code>	upper bound for censored data. If this is used, <code>opt_method</code> must be set to "L-BFGS-B", default INF
<code>...</code>	additional arguments for <code>flexmix::flexmix()</code> or <code>bbmle::mle2()</code>

Value

a model object, that can be used in [hyreg2_het](#) as input for parameter model in `flexmix::flexmix()`

Author(s)

Svenja Elkenkamp and Kim Rand

Examples

```
formula <- y ~ -1 + x1 + x2 + x3
formula_sigma <- y ~ x1 + x2 + x3
stv <- setNames(c(0.2,0,1,1),c(colnames(simulated_data_norm)[3:5],c("theta")))
stv_sigma <- setNames(c(0.2,0.2,0.1,1),c(colnames(simulated_data_norm)[3:5],c("(Intercept)")))
```

```

x <- model.matrix(formula,simulated_data_norm)
y <- simulated_data_norm$y
w <- 1
model <- FLXMRhyreg_het( data = simulated_data_norm,
                        formula = formula,
                        formula_sigma = formula_sigma,
                        family=c("hyreg"),
                        type = simulated_data_norm$type,
                        stv = stv,
                        stv_sigma = stv_sigma,
                        type_cont = "TTO",
                        type_dich = "DCE_A",
                        opt_method = "L-BFGS-B",
                        control = list(iter.max = 1000, verbose = 4),
                        offset = NULL,
                        optimizer = "optim",
                        variables_both = names(stv)[!is.element(names(stv),c("theta"))],
                        variables_cont = NULL,
                        variables_dich = NULL,
                        lower = -Inf,
                        upper = Inf,
)

```

get_stv

extract parameter estimates as named vector

Description

function to export coefficient values and names from a model fitted by `hyreg2` or `hyreg2_het`. These values can be used as `stv` for a new model with $k > 1$.

Usage

```
get_stv(mod, comp = "Comp.1")
```

Arguments

<code>mod</code>	model output from <code>hyreg2</code> oder <code>hyreg2_het</code> . If latent was "cont" or "dich" only one element of the output list can be used.
<code>comp</code>	character, default "Comp.1". "Comp.x" indicating values from which model component (x) should be exported

Value

named vector of parameter estimates from `mod`. Can be used as `stv` for additional model estimations using `hyreg2` or `hyreg2_het`.

Author(s)

Svenja Elkenkamp

Examples

```

formula <- y ~ -1 + x1 + x2 + x3 | id

k <- 1
stv <- setNames(c(0.2,0,1,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
control = list(iter.max = 1000, verbose = 4)
rm(counter)
mod <- hyreg2(formula = formula,
              data = simulated_data_norm,
              type = simulated_data_norm$type,
              stv = stv,
              k = k,
              type_cont = "TTO",
              type_dich = "DCE_A",
              opt_method = "L-BFGS-B",
              control = control,
              latent = "both",
              id_col = "id"
            )
new_stv <- get_stv(mod)

# these new_stv can be used in an other estimation using hyreg2 as stv

```

 give_class

decode classes by the model

Description

This function can be used to decode the classified classes by the model generated using `hyreg2` or `hyreg2_het`

Usage

```
give_class(data, model, id_col = NULL)
```

Arguments

<code>data</code>	a dataframe, which was used to estimate the model
<code>model</code>	a flexmix modelobject estimated using <code>hyreg2()</code> or <code>hyreg2_het()</code>
<code>id_col</code>	character-string, name of grouping variable, which must be a column of the provided data. the parameter must be specified, if the provided model was estimated under control for groups

Value

dataframe of two columns, first column named as provided `id_col` or "observation" if `id_col` was not given as an input. second column named "mod_comp" indicating the assigned class for this group or observation

Author(s)

Svenja Elkenkamp & John Grosser

Examples

```
# estimate a model using simulated_data_norm

### using grouping variable id ###
formula <- y ~ -1 + x1 + x2 + x3 | id
k <- 1
stv <- setNames(c(0.2,0.2,0.2,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
control <- list(iter.max = 1000, verbose = 4)

hyflex_mod <- hyreg2(formula = formula,
                     data = simulated_data_norm,
                     type = simulated_data_norm$type,
                     stv = stv,
                     k = k,
                     type_cont = "TTO",
                     type_dich = "DCE_A",
                     opt_method = "L-BFGS-B",
                     control = control,
                     latent = "both",
                     id_col = "id"
)
# use of function give_class
give_class(data = simulated_data_norm,
           model = hyflex_mod,
           id_col = "id")
```

hyreg2

Estimating hybrid models

Description

Estimation of hybrid model using continuous and dichotomous data e.g. EQ-5D data

Usage

```

hyreg2(
  formula,
  data,
  type,
  type_cont,
  type_dich,
  k = 1,
  control = NULL,
  stv = NULL,
  offset = NULL,
  opt_method = "BFGS",
  optimizer = "optim",
  lower = -Inf,
  upper = Inf,
  latent = "both",
  id_col = NULL,
  classes_only = FALSE,
  variables_both = NULL,
  variables_dich = NULL,
  variables_cont = NULL,
  formula_type_classic = TRUE,
  ...
)

```

Arguments

formula	model formula, can be linear or non-linear. For non-linear formulas, variables and parameters must be provided and <code>formula_type_classic</code> must be set to <code>FALSE</code> . Using <code> xg</code> will include a grouping variable <code>xg</code> . see Details.
data	a <code>data.frame</code> containing the data. see Details.
type	either the name of the column in <code>data</code> containing an indicator of whether an observation is continuous or dichotomous (as character), or a vector containing the indicator. see Details.
type_cont	value of type referring to continuous data. see Details.
type_dich	Value of type referring to dichotomous data. see Details.
k	numeric. Number of latent classes to be estimated via <code>flexmix::flexmix()</code> .
control	control list for <code>flexmix::flexmix()</code> .
stv	named vector or list of named vectors containing start values for all coefficients formula, including sigma and theta, see Details
offset	offset as in <code>flexmix::flexmix()</code>
opt_method	character, optimization method to be used in optimizer, default "BFGS"
optimizer	character, optimizer to be used in <code>bbmle::mle2()</code> , default "optim"
lower	numeric, lower bound for censored data, default <code>-INF</code> . If this is used, <code>opt_method</code> must be set to "L-BFGS-B",

upper	numeric, upper bound for censored data, default INF. If this is used, <code>opt_method</code> must be set to "L-BFGS-B",
latent	character, data type to use in component identification, must be one of "both", "cont" or "dich", default "both", see Details
id_col	character, name of the grouping variable, only needed if <code>latent != "both"</code> , see Details
classes_only	logical, default FALSE, indicates whether the function should perform only classification, rather than both classification and model estimation, only possible for <code>latent != "both"</code> , see Details
variables_both	character vector; variables to be fitted on both continuous and dichotomous data. If not specified, all variables from formula are used. If provided and not all variables from formula are included, <code>variables_cont</code> and <code>variables_dich</code> must be provided as well, while one of them can be NULL, see Details.
variables_dich	character vector; variables to be fitted only on dichotomous data, if provided, <code>variables_both</code> and <code>variables_cont</code> must be provided as well.
variables_cont	character vector; variables to be fitted only on continuous data. If provided, <code>variables_both</code> and <code>variables_dich</code> must be provided as well.
formula_type_classic	logical; is the provided formula a classic R formula containing only variables (TRUE) or does it include both variables and parameters (FALSE)? default TRUE, see Details
...	additional arguments for <code>flexmix::flexmix()</code> or <code>bbmle::mle2()</code>

Details

see details of different inputs listed below.

Value

model object of type `flexmix` or list of model objects of type `flexmix`. Please note, that the estimates for `sigma` and `theta` are on a log-scale and have to be transformed using `exp()` to get the correct estimated values.

formula

a classic R formula containing only variables (e.g. $y \sim x_1 + x_2 + \dots$) can be provided as well as a formula including variables and parameters (non-classic) e.g. $y \sim x_1 * \beta_1 + x_2 * \beta_2$ or $y \sim 1/\exp(x_1 * \beta_1 + x_2 * \beta_2)$, where `beta` are the parameters to be estimated and `thex` are column names from the dataset. Non-linear models and the 8-parameter model for EQ-5D data can only be estimated using a non-classic formula. If the provided formula is non-classic, `formula_type_classic` must be set to FALSE. When estimating an intercept, the formula must explicitly include a parameter named "INTERCEPT" (without a corresponding variable from the dataset). Additionally, it is possible to include a grouping variable for repeated measures by using "`| xg`" where `xg` is the column containing the group-memberships. The resulting formula will look like this: $y \sim x_1 + x_2 + \dots | xg$. In `flexmix`, this is called the concomitant variable specification: the model is fit conditional on grouping, so that all observations with the same group are treated as belonging together when computing likelihood contributions. One possible grouping variable

can be an id number to identify answers by the same participants. We highly recommend using a grouping variable, since otherwise the algorithm for $k = 2$ tends to classify all continuous data into one estimated class and all dichotomous data into the other.

data

a dataframe having the following columns: all independent variables (x) and the dependent variable y used in formula, one column for the grouping variable xg if grouping should be used, e.g. id numbers of participants with repeated measurements, one column indicating if the observations belongs to continuous or dichotomous data with the entries `type_cont` and `type_dich` (e.g., for a column called "type" with the entries "TTO" for continuous datapoints and "DCE" for dichotomous datapoints, `type_cont` will be "TTO" and `type_dich` will be "DCE"). One row should match one observation (one datapoint).

start values (stv)

if the same start values `stv` are to be used for all latent classes, the given start values must be a named vector. Otherwise (if different start values are assumed for each latent class), a list of named vectors should be used. In this case, there must be one entry in the list for each latent class. Each start value vector must include start values for sigma and theta. Currently, it is necessary to use the names "sigma" and "theta" for these values. If users are unsure for which variables start values must be provided (in the linear formula case), this can be checked by calling `colnames(model.matrix(formula,data))`. In this call, the formula should not include the grouping variable.

latent, id_col, classes_only

in some situations, it can be useful to identify the latent classes on only one type of data while estimating the model parameters on both types of data. In such cases, the input variable `latent` can be used to specify on which type of data the classification should be done. If "cont" or "dich" is used, `formula` must contain a grouping variable and additionally the input parameter `id_col` must be specified and gives the name, i.e. a character string, of the grouping variable for classification. Some groups may be removed from the data, since they have only continuous or only dichotomous observations. Then in a first step, a model is estimated only on the continuous/dichotomous data and the achieved classification is stored. In a next step, model parameters are estimated separately for each identified class on both types of data using this classification. The output object of `hyreg2` in this case is a list of k models. Additionally, at position $k+1$ of the list, a data frame containing the corresponding classifications from the first step is returned. Each element k in the list contains the estimated parameters for one of the latent classes. When setting the input variable `classes_only` to `TRUE`, the second step is left out and the estimated classes from step one are given as output.

variables_both, variables_cont, variables_dich

It is possible to specify partial coefficients, which are used only on continuous or dichotomous data.

- Example: Suppose different models should be specified for continuous and dichotomous data:
- Model continuous data: $y \sim x_1 + x_3$
- Model dichotomous data: $y \sim x_1 + x_2$

- The formula input to `hyreg2` must then include all parameters that occur in either model: $y \sim x_1 + x_2 + x_3$
- The assignment of parameters to data types is then achieved via the input arguments `variables_both`, `variables_cont`, and `variables_dich`:
- `variables_both = "x1"`,
- `variables_cont = "x3"` and
- `variables_dich = "x2"`.
- Every variable included in the provided formula (except the grouping variable) must appear in exactly one of these vectors. One of the `variables_` vectors can also be `NULL`, if no variables should be used only on this type of the data.

Author(s)

Svenja Elkenkamp, Kim Rand and John Grosser

Examples

```
formula <- y ~ -1 + x1 + x2 + x3 | id

k <- 2
stv <- setNames(c(0.2,0,1,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
control = list(iter.max = 1000, verbose = 4)
rm(counter)
mod <- hyreg2(formula = formula,
              data = simulated_data_norm,
              type = simulated_data_norm$type, # also "type" would work
              stv = stv,
              k = k,
              type_cont = "TTO",
              type_dich = "DCE_A",
              opt_method = "L-BFGS-B",
              control = control,
              latent = "cont",
              id_col = "id"
            )
summary_hyreg2(mod)
```

hyreg2_het

Estimating hybrid models accounting for heteroscedasticity in continuous data

Description

Estimation of hybrid model using continuous and dichotomous data e.g. EQ-5D data

Usage

```

hyreg2_het(
  formula,
  formula_sigma = NULL,
  data,
  type,
  type_cont,
  type_dich,
  k = 1,
  control = NULL,
  stv = NULL,
  stv_sigma = NULL,
  offset = NULL,
  opt_method = "BFGS",
  optimizer = "optim",
  lower = -Inf,
  upper = Inf,
  latent = "both",
  id_col = NULL,
  classes_only = FALSE,
  variables_both = NULL,
  variables_dich = NULL,
  variables_cont = NULL,
  ...
)

```

Arguments

formula	linear model formula. Using xg will include a grouping variable xg. see Details.
formula_sigma	linear formula linear formula for sigma estimation. If formula_sigma is not provided, formula (excluding any grouping variables) is used by default, see Details
data	a data.frame containing the data. see Details.
type	either the name of the column in data containing an indicator of whether an observation is continuous or dichotomous (as character), or a vector containing the indicator. see Details.
type_cont	value of type referring to continuous data. see Details.
type_dich	Value of type referring to dichotomous data. see Details.
k	numeric. Number of latent classes to be estimated via <code>flexmix::flexmix()</code> .
control	control list for <code>flexmix::flexmix()</code> .
stv	named vector or list of named vectors containing start values for all coefficients formula, including sigma and theta, see Details
stv_sigma	named vector with start values for sigma estimation. Names must correspond to the variables as given in formula_sigma, see Details
offset	offset as in <code>flexmix::flexmix()</code>

opt_method	character, optimization method to be used in optimizer, default "BFGS"
optimizer	character, optimizer to be used in <code>bbmle::mle2()</code> , default "optim"
lower	numeric, lower bound for censored data, default -INF. If this is used, opt_method must be set to "L-BFGS-B",
upper	numeric, upper bound for censored data, default INF. If this is used, opt_method must be set to "L-BFGS-B",
latent	character, data type to use in component identification, must be one of "both", "cont" or "dich", default "both", see Details
id_col	character, name of the grouping variable, only needed if latent != "both", see Details
classes_only	logical, default FALSE, indicates whether the function should perform only classification, rather than both classification and model estimation, only possible for latent != "both", see Details
variables_both	character vector; variables to be fitted on both continuous and dichotomous data. If not specified, all variables from formula are used. If provided and not all variables from formula are included, variables_cont and variables_dich must be provided as well, while one of them can be NULL, see Details.
variables_dich	character vector; variables to be fitted only on dichotomous data, if provided, variables_both and variables_cont must be provided as well.
variables_cont	character vector; variables to be fitted only on continuous data. If provided, variables_both and variables_dich must be provided as well.
...	additional arguments for <code>flexmix::flexmix()</code> or <code>bbmle::mle2()</code>

Details

see details of different inputs listed below

Value

model object of type `flexmix`, coefficients named `..._h` are coefficients for heteroscedasticity

formula

a classic R formula of the form $y \sim x_1 + x_2 + \dots$ should be provided. Additionally, it is possible to include a grouping variable for repeated measures by using "`| xg`" where `xg` is the column containing the group-memberships. The resulting formula will look like this: $y \sim x_1 + x_2 + \dots | xg$. In `flexmix`, this is called the concomitant variable specification: the model is fit conditional on grouping, so that all observations with the same group are treated as belonging together when computing likelihood contributions. One possible grouping variable can be an id number to identify answers by the same participants. We highly recommend using a grouping variable, since otherwise the algorithm for $k = 2$ tends to classify all continuous data into one estimated class and all dichotomous data into the other.

data

a dataframe having the following columns: all independent variables (x) and the dependent variable y used in formula, one column for the grouping variable xg if grouping should be used, e.g. id numbers of participants with repeated measurements, one column indicating if the observations belongs to continuous or dichotomous data with the entries `type_cont` and `type_dich` (e.g., for a column called "type" with the entries "TTO" for continuous datapoints and "DCE" for dichotomous datapoints, `type_cont` will be "TTO" and `type_dich` will be "DCE"). One row should match one observation (one datapoint).

start values (stv)

if the same start values `stv` are to be used for all latent classes, the given start values must be a named vector. Otherwise (if different start values are assumed for each latent class), a list of named vectors should be used. In this case, there must be one entry in the list for each latent class. Each start value vector must include start values for `sigma` and `theta`. Currently, it is necessary to use the names "sigma" and "theta" for these values. If users are unsure for which variables start values must be provided, this can be checked by calling `colnames(model.matrix(formula, data))`. In this call, the formula should not include the grouping variable.

formula_sigma, stv_sigma

To account for heteroscedasticity in the data, an additional formula `formula_sigma` and an additional vector of starting values for this formula (`stv_sigma`) can be specified. The provided `formula_sigma` must be linear and the vector `stv_sigma` must contain start values for all parameters used in the formula. If neither `formula_sigma` nor `stv_sigma` are provided, the same inputs as for `formula` (without controlling for groups) and `stv` (without `sigma`) are used. The estimates for `sigma` can be identified in the model output by the ending "_h". It is important to note that, when using `hyreg2_het`, neither `stv` nor `stv_sigma` are allowed to include `sigma`, because `sigma` is estimated with its own formula (in contrast to `hyreg2`, where `sigma` must always be specified in `stv`).

latent, id_col, classes_only

in some situations, it can be useful to identify the latent classes on only one type of data while estimating the model parameters on both types of data. In such cases, the input variable `latent` can be used to specify on which type of data the classification should be done. If "cont" or "dich" is used, the input parameter `id_col` must be specified and gives the name, i.e. a character string, of the grouping variable for classification. Some groups may be removed from the data, since they have only continuous or only dichotomous observations. Then in a first step, a model is estimated only on the continuous/dichotomous data and the achieved classification is stored. In a next step, model parameters are estimated separately for each identified class on both types of data using this classification. The output object of `hyreg2` in this case is a list of k models. Additionally, at position $k+1$ of the list, a data frame containing the corresponding classifications from the first step is returned. Each element k in the list contains the estimated parameters for one of the latent classes. When setting the input variable `classes_only` to `TRUE`, the second step is left out and the estimated classes from step one are given as output.

variables_both, variables_cont, variables_dich

It is possible to specify partial coefficients, which are used only on continuous or dichotomous data.

- Example: Suppose different models should be specified for continuous and dichotomous data:
- Model continuous data: $y \sim x_1 + x_3$
- Model dichotomous data: $y \sim x_1 + x_2$
- The formula input to `hyreg2` must then include all parameters that occur in either model: $y \sim x_1 + x_2 + x_3$
- The assignment of parameters to data types is then achieved via the input arguments `variables_both`, `variables_cont`, and `variables_dich`:
- `variables_both = "x1"`,
- `variables_cont = "x3"` and
- `variables_dich = "x2"`.
- Every variable included in the provided formula (except the grouping variable) must appear in exactly one of these vectors. One of the `variables_` vectors can also be `NULL`, if no variables should be used only on this type of the data.

Author(s)

Svenja Elkenkamp, Kim Rand and John Grosser

Examples

```
formula <- y ~ -1 + x1 + x2 + x3
formula_sigma <- y ~ x1 + x2 + x3

k <- 1
stv <- setNames(c(0.2,0,1,1),c(colnames(simulated_data_norm)[3:5],c("theta")))
stv_sigma <- setNames(c(0.2,0,1,1),c(colnames(simulated_data_norm)[3:5],c("(Intercept)")))
control = list(iter.max = 1000, verbose = 4)
rm(counter)
mod <- hyreg2_het(formula = formula,
                  formula_sigma = formula_sigma,
                  data = simulated_data_norm,
                  type = simulated_data_norm$type, # or "type"
                  stv = stv,
                  stv_sigma = stv_sigma,
                  k = k,
                  type_cont = "TTO",
                  type_dich = "DCE_A",
                  opt_method = "L-BFGS-B",
                  control = control,
                  latent = "both",
                  id_col = "id"
                )
summary_hyreg2(mod)
```

plot_hyreg2	<i>plot function for hyreg2</i>
-------------	---------------------------------

Description

Function to visualize model results by hyreg2 or hygre2_het

Usage

```
plot_hyreg2(
  data,
  x,
  y,
  id_col,
  class_df_model,
  type_to_plot = NULL,
  colors = NULL
)
```

Arguments

data	a dataframe, which was used to estimate the model using hyreg2() or hyreg2_het()
x	character string, column of data to be plotted on x-axis
y	character string, column of data to be plotted on y-axis
id_col	character sting, grouping variable, same as was given in model. if model was estimated without grouping, see Details
class_df_model	dataframe of two columns indicating which group belongs to which class, first column named as input id_col, second column named "mod_comp". this input can be generated using the give_class() function, see Details.
type_to_plot	list of two character elements. First: columnname of column containing indicator for type of data, Second: value of column type, that should be used for the plot, see details of hyreg2() inputs type and type_cont,type_dich
colors	character vector, colors to be used in ggplot, default NULL - than colors are choosen automatically

Details

id_col must be provided anyway, even if the model was estimated without grouping variable. Since there might be no grouping varibale in the data, we recommend to create a new column called "observation" in data using the rownames/observationnumbers as character values and use this column as input for id_col in plot_hyreg2, additionally you can use class_df_model = give_class(data,model,"observation"), see example

Value

ggplot object visualizing x against y by classes

Author(s)

Svenja Elkenkamp & John Grosser

Examples

```
# estimate a model using simulated_data_rnorm

formula <- y ~ -1 + x1 + x2 + x3 | id
k <- 2
stv <- setNames(c(0.2,0.2,0.2,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
control <- list(iter.max = 1000, verbose = 4)

hyflex_mod <- hyreg2(formula = formula,
                     data = simulated_data_norm,
                     type = simulated_data_norm$type,
                     stv = stv,
                     k = k,
                     type_cont = "TTO",
                     type_dich = "DCE_A",
                     opt_method = "L-BFGS-B",
                     control = control,
                     latent = "cont",
                     id_col = "id"
)
# plotting the variables id against y
plot_hyreg2(data = simulated_data_norm,
            x = "id",
            y = "y",
            id_col = "id",
            class_df_model = give_class(data = simulated_data_norm,
                                       model = hyflex_mod,
                                       id = "id"))
```

simulated_data

simulated_data

Description

simulated_data

Usage

simulated_data

Format

simulated_data:

A simulated data frame with 480 rows and 25 columns, following a combination of normal and binomial distribution

type type of data, "TTO" indicates normal distribution, "DCE_A" indicates binomial distribution

y result of the formula $y \sim -1 + mo2 + mo3 + \dots + ad4 + ad5$

mo2, mo3, mo4, mo5, sc2, sc3, sc4, sc5, ua2, ua3, ua4, ua5, pd2, pd3, pd4, pd5, ad2, ad3, ad4, ad5,
dummy variables for EQ5D data simulation

class original class of the data point

id id number of observations to simulated different persons

y_cens column y censored at 2 (upper boundary) ...

Source

simulated with true parameter values: Class 1: $\sigma = 0.02$, $\theta = 2$ and $c(mo2, mo3, mo4, mo5) = c(0.001, 0.05, 0.08, 0.1)$, $c(sc2, sc3, sc4, sc5) = c(0.01, 0.2, 0.36, 0.5)$, $c(ua2, ua3, ua4, ua5) = c(0.015, 0.25, 0.5, 0.8)$, $c(pd2, pd3, pd4, pd5) = c(0.1, 0.3, 0.4, 0.6)$, $c(ad2, ad3, ad4, ad5) = c(0.09, 0.19, 0.6, 0.7)$

Class 2: $\sigma = 0.1$, $\theta = 3$ and $c(mo2, mo3, mo4, mo5) = c(0.2, 0.4, 0.6, 0.8)$, $c(sc2, sc3, sc4, sc5) = c(0.1, 0.3, 0.4, 0.5)$, $c(ua2, ua3, ua4, ua5) = c(0.2, 0.25, 0.6, 0.7)$, $c(pd2, pd3, pd4, pd5) = c(0.05, 0.2, 0.27, 0.8)$, $c(ad2, ad3, ad4, ad5) = c(0.15, 0.35, 0.4, 0.65)$

simulated_data_mo	<i>simulated_data_mo</i>
-------------------	--------------------------

Description

simulated_data_mo

Usage

simulated_data_mo

Format

simulated_data_mo:

A simulated data frame with 480 rows and 9 columns, following a combination of normal and binomial distribution

type type of data, "TTO" indicates normal distribution, "DCE_A" indicates binomial distribution

y result of the formula $y \sim -1 + mo2 + mo3 + mo4 + mo5$

mo2, mo3, mo4, mo5 dummy variables

class original class of the data point

id id number of observations to simulated different persons

y_cens column y censored at 0 (lower boundary) ...

Source

simulated with true parameter values: Class 1: $\sigma = 0.001$, $\theta = 0.2$ and $c(\text{mo2}, \text{mo3}, \text{mo4}, \text{mo5}) = c(0.005, 0.01, 0.08, 0.1)$ Class 2: $\sigma = 0.1$, $\theta = 2$ and $c(\text{mo2}, \text{mo3}, \text{mo4}, \text{mo5}) = c(0.2, 0.4, 0.6, 0.8)$

`simulated_data_norm` *simulated_data_norm*

Description

`simulated_data_norm`

Usage

`simulated_data_norm`

Format

`simulated_data_norm`:

A simulated data frame with 600 rows and 9 columns, following a combination of normal and binomial distribution

type type of data, "TTO" indicates normal distribution, "DCE_A" indicates binomial distribution

y result of the formula $y \sim x1 + x2 + x3$

x1, x2, x3 random numbers from `rnorm`

class original class of the data point

id id number of observations to simulated different persons

y_non result of the formula $y \sim (x1 \text{ \textasciitilde beta1} + x2 \text{ \textasciitilde beta3}) \text{ \textasciitilde} (x1 \text{ \textasciitilde beta1} + x3 \text{ \textasciitilde beta3})$

y_cens column y censored at 3 ...

Source

simulated with true parameter values: Class 1: $\sigma = 1.0$, $\theta = 5$ and $c(x1, x2, x3) = c(0.5, -0.3, 0.8)$ Class 2: $\sigma = 0.5$, $\theta = 2$ and $c(x1, x2, x3) = c(1.4, 2.3, -0.2)$

summary_hyreg2 *model summary for hyreg2 objects*

Description

get model parameters of model generated by `hyreg2` or `hyreg2_het`

Usage

```
summary_hyreg2(object)
```

Arguments

`object` modelobject generated with `hyreg2()` or `hyreg2_het()`

Value

summary object of `bbmle::mle2()` model, Please note that the outputs for `sigma` and `theta` are on a log-scale and have to be transformed using `exp()` to get the correct estimated values.

Author(s)

Svenja Elkenkamp

Examples

```
formula <- y ~ -1 + x1 + x2 + x3 | id
k <- 1
stv <- setNames(c(0.2,0,1,1,1),c(colnames(simulated_data_norm)[3:5],c("sigma","theta")))
control = list(iter.max = 1000, verbose = 4)
rm(counter)
mod <- hyreg2(formula = formula,
              data = simulated_data_norm,
              type = simulated_data_norm$type,
              stv = stv,
              k = k,
              type_cont = "TTO",
              type_dich = "DCE_A",
              opt_method = "L-BFGS-B",
              control = control,
              latent = "both",
              id_col = "id"
            )
summary_hyreg2(mod)
```

the *creating environment for package internal objects*

Description

creating environment for package internal objects

Usage

the

Format

An object of class environment of length 1.

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