

Package ‘merlin’

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Title Mixed Effects Regression for Linear, Non-Linear and User-Defined Models

Description Fits linear, non-linear, and user-defined mixed effects regression models following the framework developed by Crowther (2017) <arXiv:1710.02223>. 'merlin' can fit multivariate outcome models of any type, each of which could be repeatedly measured (longitudinal), with any number of levels, and with any number of random effects at each level. Standard distributions/models available include the Bernoulli, Gaussian, Poisson, beta, negative-binomial, and time-to-event/survival models include the exponential, Gompertz, Royston-Parmar, Weibull and general hazard model. 'merlin' provides a flexible predictor syntax, allowing the user to define variables, random effects, spline and fractional polynomial functions, functions of other outcome models, and any interaction between each of them. Non-linear and time-dependent effects are seamlessly incorporated into the predictor. 'merlin' allows multivariate normal random effects, which are integrated out using Gaussian quadrature or Monte-Carlo integration. Note, 'merlin' is based on the 'Stata' package of the same name, described in Crowther (2018) <arXiv:1806.01615>.

License GPL (>= 3)

Depends R (>= 2.10)

Imports statmod, stats, survival, randtoolbox, MASS

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URL <https://www.mjcrowther.co.uk/software/merlin>

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merlin	<i>merlin - Mixed Effects Regression for Linear, Nonlinear and User-defined models</i>
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Description

merlin fits linear, non-linear and user-defined mixed effects regression models. merlin can fit multivariate outcome models of any type, each of which could be repeatedly measured (longitudinal), with any number of levels, and with any number of random effects at each level. Standard distributions/models available include the Bernoulli, Gaussian, Poisson, beta, negative-binomial, and time-to-event/survival models include the exponential, Gompertz, Weibull, Royston-Parmar, and general hazard model. merlin provides a flexible predictor syntax, allowing the user to define variables, random effects, spline and fractional polynomial functions, functions of other outcome models, and

any interaction between each of them. Non-linear and time-dependent effects are seamlessly incorporated into the predictor. merlin allows multivariate normal random effects, which are integrated out using Gaussian quadrature or Monte-Carlo integration. Relative survival (excess hazard) models are supported. Utility functions are provided to allow user-defined models to be specified, in conjunction with the complex predictor.

Usage

```
merlin(model, from = NULL, ip = NULL, family = "gaussian",
       link = NULL, timevar = NULL, covariance = "diagonal",
       intmethod = "ghermite", data, userf = NULL, sweights = NULL,
       levels = NULL, debug = FALSE, verbose = FALSE, predict = FALSE,
       predtype = NULL, predmodel = NULL, causes = NULL)
```

Arguments

`model` specify the fixed and random elements for each model outcome. Where there are multiple outcomes, the models should be specified in a list. Each model should be specified as a formula (e.g. $y \sim x$). A number of different element types can be specified, including

- `varname` - an independent variable from the data set
- `random-effects` - a random-effect at the cluster level can be specified using `M#[cluster level]`, for example `M1[id]` would define a random intercept at the ID level. Each independent random-effect should be given a unique name, if two random-effects are given the same name they will be treated as shared random-effects.
- `rscs()` - restricted cubic spline terms, this option can be used to include a restricted cubic spline function, with the degrees of freedom (number of spline terms) specified using the `df` sub-option, with the boundary knots assumed to be at the minimum and maximum of the variable, with internal knots placed at equally spaced centiles. Other default options or `thog=TRUE`, which by default orthogonalises the splines, `log=FALSE`, which can be used to calculate splines of the log of the variable and `event=F`, which can be used to calculate the internal knots based only on observations that experienced the event of interest (for survival models).
- `srcs()` is a shorthand element, equivalent to `rscs(..., log=T, event=T)`, for use with survival models.
- `fp()` - fractional polynomials of order 1 or 2 can be specified, the sub-option `powers` is used to specify the powers of the fp model.
- `EV[depvar]` - the expected value of the response of a submodel
- `dEV[depvar]` - the first derivative with respect to time of the expected value of the response of a submodel
- `d2EV[depvar]` - the second derivative with respect to time of the expected value of the response of a submodel
- `iEV[depvar]` - the integral with respect to time of the expected value of the response of a submodel
- `XB[depvar]` - the expected value of the complex predictor of a submodel

	<ul style="list-style-type: none"> • <code>dXB[depvar]</code> - the first derivative with respect to time of the expected value of the complex predictor of a submodel • <code>d2XB[depvar]</code> - the second derivative with respect to time of the expected value of the complex predictor of a submodel • <code>iXB[depvar]</code> - the integral with respect to time of the expected value of the complex predictor of a submodel • <code>bhazard(varname)</code> - invokes a relative survival (excess hazard) model. <code>varname</code> specifies the expected hazard rate at the event time. • <code>exposure(varname)</code> - include <code>log(varname)</code> in the linear predictor, with a coefficient of 1. For use with <code>family = "poisson"</code>. • <code>ap(#)</code> - defines the number of ancillary parameters. Used with <code>family="user"</code>.
<code>from</code>	this is an optional argument giving the initial values for the full parameter vector, for more details on how to specify the initial estimates see the vignette.
<code>ip</code>	an optional vector of integers specifying the number of integration points to be used when integrating out the random effects. A different number of <code>ip</code> can be specified for each level (from highest to lowest level). If only a single number is given then it will assume that number of integration points at all levels. Default is <code>ip = 7</code> for each level using Gauss-Hermite quadrature, or <code>ip = 100</code> for each level using Monte-Carlo integration.
<code>family</code>	<p>a vector of strings specifying the family for each outcome specified in model. The currently available models include,</p> <ul style="list-style-type: none"> • <code>gaussian</code> - Gaussian distribution • <code>bernoulli</code> - Bernoulli distribution • <code>poisson</code> - Poisson distribution • <code>beta</code> - Beta distribution • <code>negbinomial</code> - Negative binomial distribution <p>with survival models including,</p> <ul style="list-style-type: none"> • <code>exponential</code> - exponential distribution • <code>weibull</code> - Weibull distribution • <code>gompertz</code> - Gompertz distribution • <code>rp</code> - Royston-Parmar model (complex predictor on the log cumulative hazard scale) • <code>loghazard</code> - general log hazard model (complex predictor on the log hazard scale) <p>and user-defined,</p> <ul style="list-style-type: none"> • <code>user</code> - fit a user-defined model, which should be written using merlin's utility functions. The name of your user-defined function should be passed through the <code>userf</code> option. • <code>null</code> - is a convenience tool to define additional complex predictors, that do not contribute to the log likelihood. For use with <code>family="user"</code>.
<code>link</code>	string vector defining the link functions for each model. Default is <code>"identity"</code> for all models. If specified, you must define a link function for all submodels. Options include <code>"identity"</code> , <code>"log"</code> and <code>"logit"</code> .

timevar	specifies the variable which represents time, this is necessary when a function of time is used in the linear predictor of a survival model as it may interact with other elements of the model.
covariance	the structure of the variance-covariance matrix can be varied, the default is diagonal where all diagonal elements of the variance-covariance matrix are estimated uniquely, identity assumes all diagonal elements are equal and unstructured estimates all elements of the variance-covariance matrix.
intmethod	method used for numerically integrating out the random-effects in order to calculate the likelihood for a mixed effects model which includes random effects. Options include ghermite for non-adaptive Gauss-Hermite quadrature, halton for Monte-Carlo integration using Halton sequences, or sobol for Monte-Carlo integration using Sobol sequences, or mc for standard Monte-Carlo integration using normal draws. The default is ghermite. Level-specific integration techniques can be specified, for example, with a three level model, we may use Gauss-Hermite quadrature at the highest level, and Monte-Carlo integration with Halton sequences at level 2, using <code>intmethod = c("ghermite", "halton")</code> .
data	a data frame containing all variables required for fitting the model. Can be a tibble object.
userf	string vector defining the name of the user-written functions for each <code>family="user"</code> . Each function must be in memory and should return the observation level contribution to the log-likelihood.
sweights	Not documented.
levels	if the model contains random-effects then a vector giving the order of levels must be specified, from the highest level to the lowest, e.g. <code>levels=c("practice", "id")</code> .
debug	Not documented.
verbose	Not documented.
predict	Not documented.
predtype	Not documented.
predmodel	Not documented.
causes	Not documented.

Author(s)

Emma C. Martin, Alessandro Gasparini and Michael J. Crowther

References

- Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>
- Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>
- Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear, non-linear and user-defined models.

See Also

[predict.merlin](#)

[merlin_util_depvar](#), [merlin_util_timevar](#), [merlin_util_xzb](#), [merlin_util_xzb_mod](#), [merlin_util_xzb_deriv](#), [merlin_util_xzb_deriv_mod](#), [merlin_util_xzb_deriv2](#), [merlin_util_xzb_deriv2_mod](#), [merlin_util_xzb_integ](#), [merlin_util_xzb_integ_mod](#), [merlin_util_ev](#), [merlin_util_ev_mod](#), [merlin_util_ev_deriv](#), [merlin_util_ev_deriv_mod](#), [merlin_util_ev_deriv2](#), [merlin_util_ev_deriv2_mod](#), [merlin_util_ev_integ](#), [merlin_util_ev_integ_mod](#), [merlin_util_ap](#), [merlin_util_ap_mod](#)

Examples

```
library(merlin)
data(pbc.merlin, package = "merlin")

# Linear fixed-effects model
merlin(logb ~ year,
       family = "gaussian",
       data = pbc.merlin)

# Linear mixed-effects model with random intercept and slope at ID level
merlin(logb ~ year + M1[id] * 1 + year:M2[id] * 1,
       family = "gaussian",
       levels = "id",
       data = pbc.merlin)

# Joint longitudinal and survival model with shared random effects
merlin(model = list(logb ~ year + M1[id] * 1,
                   Surv(stime, died) ~ trt + M1[id]),
       family = c("gaussian", "weibull"),
       levels = "id",
       data = pbc.merlin)

# Joint longitudinal and survival model with expected value
merlin(model = list(logb ~ year + M1[id] * 1,
                   Surv(stime, died) ~ trt + EV[logb]),
       family = c("gaussian", "weibull"),
       levels = "id",
       timevar = c("year", "stime"),
       data = pbc.merlin)

# Gaussian distribution - implemented as a user-written family
logl_gaussian <- function(gml)
{
  y <- merlin_util_depvar(gml)
  xzb <- merlin_util_xzb(gml)
  se <- exp(merlin_util_ap(gml,1))

  mu <- (sweep(xzb,1,y,"-"))^2
  logl <- ((-0.5 * log(2*pi) - log(se)) - (mu/(2 * se^2)))
  return(logl)
}
```

```
merlin(logb ~ year + ap(1), family = "user", data = pbc.merlin,  
       userf = "logl_gaussian")  
  
# 3-level Weibull model  
merlin(Surv(stime1,dead1) ~ age + M1[id1]*1 + M2[id2]*1,  
       levels=c("id1","id2"), family="weibull", data=sim3)
```

merlin_util_ap	<i>merlin_util_ap - returns the current estimate of the ith ancillary parameter for the associated model</i>
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Description

merlin_util_ap - returns the current estimate of the ith ancillary parameter for the associated model

Usage

```
merlin_util_ap(gml, i)
```

Arguments

gml	merlin object - should not be edited
i	index for which ancillary parameter to extract

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ap_mod	<i>merlin_util_ap_mod - returns the current estimate of the ith ancillary parameter for the specified model</i>
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Description

merlin_util_ap_mod - returns the current estimate of the ith ancillary parameter for the specified model

Usage

```
merlin_util_ap_mod(gml, m, i)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
i	index for which ancillary parameter to extract

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_depvar	<i>merlin_util_depvar - returns the response variable(s)</i>
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Description

Utility function to extract the dependent variable(s) for the current model. If the model is a survival/time-to-event model, then it will contain the event times in the first column and the event indicator in the second.

Usage

```
merlin_util_depvar(gml)
```

Arguments

gml merlin object - should not be edited

Author(s)

Emma C. Martin, Alessandro Gasparini and Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev	<i>merlin_util_ev - returns the observation-level expected value of the outcome</i>
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Description

Utility function to extract the expected value of the outcome at the current parameter estimates for a particular model.

Usage

```
merlin_util_ev(gml, t = NULL)
```

Arguments

gml merlin object - should not be edited
t specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_deriv *merlin_util_ev_deriv - returns the first derivative with respect to time of the observation-level expected value of the outcome*

Description

Utility function to extract d/dt of the expected value of the outcome at the current parameter estimates for a particular model.

Usage

```
merlin_util_ev_deriv(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

Examples

```
library(merlin)
data(pbc.merlin, package = "merlin")

# Linear fixed-effects model
merlin(model = list(logb ~ year),
       family = "gaussian",
       data = pbc.merlin)
```

merlin_util_ev_deriv2 *merlin_util_ev_deriv2* - returns the second derivative with respect to time of the observation-level expected value of the outcome

Description

merlin_util_ev_deriv2 - returns the second derivative with respect to time of the observation-level expected value of the outcome

Usage

```
merlin_util_ev_deriv2(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_deriv2_mod

merlin_util_ev_deriv2_mod - returns the second derivative with respect to time of the observation-level expected value of the specified outcome

Description

merlin_util_ev_deriv2_mod - returns the second derivative with respect to time of the observation-level expected value of the specified outcome

Usage

```
merlin_util_ev_deriv2_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_deriv_mod

merlin_util_ev_deriv - returns the first derivative with respect to time of the observation-level expected value of the specified outcome

Description

Utility function to extract d/dt of the expected value of the outcome at the current parameter estimates for a specified model.

Usage

```
merlin_util_ev_deriv_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_integ *merlin_util_ev_integ* - returns the integral with respect to time of the observation-level expected value of the outcome

Description

merlin_util_ev_integ - returns the integral with respect to time of the observation-level expected value of the outcome

Usage

```
merlin_util_ev_integ(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_integ_mod

merlin_util_ev_integ_mod - returns the integral with respect to time of the observation-level expected value of the specified outcome

Description

merlin_util_ev_integ_mod - returns the integral with respect to time of the observation-level expected value of the specified outcome

Usage

```
merlin_util_ev_integ_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_ev_mod

merlin_util_ev_mod - returns the observation-level expected value of the outcome for a specified model

Description

Utility function to extract the expected value of the outcome at the current parameter estimates for a specified model.

Usage

```
merlin_util_ev_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the model
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_timevar *merlin_util_timevar - returns the time variable*

Description

Utility function to extract the time variable(s) for the current model.

Usage

```
merlin_util_timevar(gml)
```

Arguments

gml	merlin object - should not be edited
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Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_xzb	<i>merlin_util_xzb - returns the observation-level complex predictor</i>
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Description

Utility function to extract the complex predictor evaluated at the current parameter estimates for a particular model.

Usage

```
merlin_util_xzb(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Emma C. Martin, Alessandro Gasparini and Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

Examples

```
library(merlin)
data(pbc.merlin, package = "merlin")

# Linear fixed-effects model
merlin(model = list(logb ~ year),
       family = "gaussian",
       data = pbc.merlin)
```

merlin_util_xzb_deriv *merlin_util_xzb_deriv* - returns the first derivative with respect to time of the observation-level complex predictor

Description

Utility function to extract d/dt of the complex predictor evaluated at the current parameter estimates for a particular model.

Usage

```
merlin_util_xzb_deriv(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

Examples

```
library(merlin)
data(pbc.merlin, package = "merlin")

# Linear fixed-effects model
merlin(model = list(logb ~ year),
       family = "gaussian",
       data = pbc.merlin)
```

merlin_util_xzb_deriv2

merlin_util_xzb_deriv2 - returns the second derivative with respect to time of the observation-level complex predictor

Description

merlin_util_xzb_deriv2 - returns the second derivative with respect to time of the observation-level complex predictor

Usage

```
merlin_util_xzb_deriv2(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_xzb_deriv2_mod

merlin_util_xzb_deriv2_mod - returns the second derivative with respect to time of the observation-level complex predictor of the specified model

Description

merlin_util_xzb_deriv2_mod - returns the second derivative with respect to time of the observation-level complex predictor of the specified model

Usage

```
merlin_util_xzb_deriv2_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

Crowther MJ. Extended multivariate generalised linear and non-linear mixed effects models. <https://arxiv.org/abs/1710.02223>

Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear and non-linear models.

merlin_util_xzb_deriv_mod

merlin_util_xzb_deriv_mod - returns the first derivative with respect to time of the observation-level complex predictor of a specified model

Description

merlin_util_xzb_deriv_mod - returns the first derivative with respect to time of the observation-level complex predictor of a specified model

Usage

```
merlin_util_xzb_deriv_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

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merlin_util_xzb_integ *merlin_util_xzb_integ* - returns the integral with respect to time of the observation-level complex predictor

Description

merlin_util_xzb_integ - returns the integral with respect to time of the observation-level complex predictor

Usage

```
merlin_util_xzb_integ(gml, t = NULL)
```

Arguments

gml	merlin object - should not be edited
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

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```
merlin_util_xzb_integ_mod
    merlin_util_xzb_integ_mod - returns the integral with respect to time
    of the observation-level complex predictor of the specified model
```

Description

merlin_util_xzb_integ_mod - returns the integral with respect to time of the observation-level complex predictor of the specified model

Usage

```
merlin_util_xzb_integ_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

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```
merlin_util_xzb_mod    merlin_util_xzb_mod - returns the observation-level complex predic-
    tor of the specified model
```

Description

Utility function to extract the complex predictor evaluated at the current parameter estimates for a particular model.

Usage

```
merlin_util_xzb_mod(gml, m, t = NULL)
```

Arguments

gml	merlin object - should not be edited
m	specifies the merlin submodel
t	specifies the variable which represents time

Author(s)

Michael J. Crowther

References

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pbc

Mayo Clinic primary biliary cirrhosis data

Description

This data is from the Mayo Clinic trial in primary biliary cirrhosis (PBC) of the liver conducted between 1974 and 1984. A total of 424 PBC patients, referred to Mayo Clinic during that ten-year interval met eligibility criteria for the randomized placebo controlled trial of the drug D-penicillamine, but only the first 312 cases in the data set participated in the randomized trial. Therefore, the data here are for the 312 patients with largely complete data.

Usage

```
data(pbc)
```

```
data(pbc.merlin)
```

Format

A data frame with 1945 observations on the following 20 variables:

id patients identifier; in total there are 312 patients.

years number of years between registration and the earlier of death, transplantation, or study analysis time.

status a factor with levels alive, transplanted and dead.

drug a factor with levels placebo and D-penicil.

age at registration in years.

sex a factor with levels male and female.

year number of years between enrollment and this visit date, remaining values on the line of data refer to this visit.

ascites a factor with levels No and Yes.

hepatomegaly a factor with levels No and Yes.

spiders a factor with levels No and Yes.

edema a factor with levels No edema (i.e. no edema and no diuretic therapy for edema), edema no diuretics (i.e. edema present without diuretics, or edema resolved by diuretics), and edema despite diuretics (i.e. edema despite diuretic therapy).

serBilir serum bilirubin in mg/dl.

serChol serum cholesterol in mg/dl.

albumin albumin in mg/dl.

alkaline alkaline phosphatase in U/liter.

SGOT SGOT in U/ml.

platelets platelets per cubic ml/1000.

prothrombin prothrombin time in seconds.

histologic histologic stage of disease.

status2 a numeric vector with the value 1 denoting if the patient was dead, and 0 if the patient was alive or transplanted.

Note

pbc.merlin is a version of the pbc dataset in merlin format.

Source

[pbc2](#) and [pbc](#).

References

Fleming T, Harrington D. *Counting Processes and Survival Analysis*. 1991; New York: Wiley.

Therneau T, Grambsch P. *Modeling Survival Data: Extending the Cox Model*. 2000; New York: Springer-Verlag.

predict.merlin *predict.merlin - post-estimation tools for merlin*

Description

predictions following the fit of a merlin model

Usage

```
## S3 method for class 'merlin'
predict(object, stat = "eta", type = "fixedonly",
        predmodel = 1, causes = NULL, ...)
```

Arguments

object	merlin model object
stat	specifies which prediction, which can be one of: <ul style="list-style-type: none"> • eta the expected value of the complex predictor • mu the expected value of the response variable • hazard the hazard function • chazard the cumulative hazard function • logchazard the log cumulative hazard function • survival the survival function • cif the cumulative incidence function • rmst calculates the restricted mean survival time, which is the integral of the survival function within the interval (0,t], where t is the time at which predictions are made. If multiple survival models have been specified in your merlin model, then it will assume all of them are cause-specific competing risks models, and include them in the calculation. If this is not the case, you can override which models are included by using the causes option. <code>rmst = t - totaltimelost</code>. • timelost calculates the time lost due to a particular event occurring, within the interval (0,t]. In a single event survival model, this is the integral of the cif between (0,t]. If multiple survival models are specified in the merlin model then by default all are assumed to be cause-specific event time models contributing to the calculation. This can be overridden using the causes option. • totaltimelost total time lost due to all competing events, within (0,t]. If multiple survival models are specified in the merlin model then by default all are assumed to be cause-specific event time models contributing to the calculation. This can be overridden using the causes option. <code>totaltimelost</code> is the sum of the <code>timelost</code> due to all causes.
type	the type of prediction, either: <ul style="list-style-type: none"> • fixedonly prediction calculated based only on the fixed effects; the default.

- marginal prediction calculated marginally with respect to the latent variables. the stat is calculated by integrating the prediction function with respect to all the latent variables over their entire support.

predmodel	specifies which model to obtain predictions from; default is predmodel=1
causes	is for use when calculating predictions from a competing risks merlin model. By default, cif, rmst, timelost and totaltimelost assume that all survival models included in the merlin model are cause-specific hazard models contributing to the calculation. If this is not the case, then you can specify which models (indexed using the order they appear in your merlin model by using the causes option, e.g. causes=c(1,2).
...	other options

Author(s)

Emma C. Martin, Alessandro Gasparini and Michael J. Crowther

References

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Crowther MJ. merlin - a unified framework for data analysis and methods development in Stata. <https://arxiv.org/abs/1806.01615>

Martin EC, Gasparini A, Crowther MJ. merlin - an R package for mixed effects regression of linear, non-linear and user-defined models.

See Also

[merlin](#)

Examples

```
library(merlin)
data(pbc.merlin, package = "merlin")

# Linear fixed-effects model
mod <-merlin(model = list(logb ~ year),
            family = "gaussian",
            data = pbc.merlin)
predict(mod, stat="eta", type="fixedonly")
```

`sim3`*Simulated 3-level survival data*

Description

Simulated 3-level survival data

Usage

```
data(sim3)
```

Format

A data frame...

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