Package ‘flexrsurv’

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Type Package

Title Flexible Relative Survival Analysis

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Description Package for parametric relative survival analyses. It allows to model non-linear and
non-proportional effects and both non proportional and non linear effects, using splines (B-
spline and truncated power basis), Weighted Cumulative Index of Exposure effect, with correc-
tion model for
the life table. Both non proportional and non linear effects are described in
Remontet, L. et al. (2007) <doi:10.1002/sim.2656> and

License GPL (>= 2.0)

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flexrsurv-package

Package for flexible relative survival analyses

Description

flexrsurv is a package for parametric relative survival analyses. The package implements non-linear, non-proportional effects and both non proportional and non linear effects, using splines (B-spline and truncated power basis), Weighted Cumulative Index of Exposure effect, with correction model for the life table. Both non proportional and non linear effects are described in Remontet et al. (2007) doi:10.1002/sim.2656 and Mahboubi et al. (2011) doi:10.1002/sim.4208.

Details

Package: flexrsurv
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The main function is flexrsurv()

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References


See Also
flexrsurv

flexrsurv  Fit Relative Survival Model

Description
flexrsurv is used to fit relative survival regression model. Time dependent variables, non-proportionnal (time dependent) effects, non-linear effects are implemented using Splines (B-spline and truncated power basis). Simultaneously non linear and non proportional effects are implemented using approaches developed by Remontet et al.(2007) and Mahboubi et al. (2011).

Usage
flexrsurv(formula=formula(data),
   data=parent.frame(),
   knots.Bh,
   degree.Bh=3,
   Spline=c("b-spline", "tp-spline", "tpi-spline"),
   log.Bh=FALSE,
   bhlink=c("log", "identity"),
   Min_T=0,
   Max_T=NULL,
   model=c("additive","multiplicative"),
   rate=NULL,
   weights=NULL,
   na.action=NULL,
   int_meth=c("GL", "CAV_SIM", "SIM_3_8", "BOOLE", "BANDS"),
   npoints=20,
   stept=NULL,
   bands=NULL,
   init=NULL,
   initbyglm=TRUE,
   initbands=bands,
   optim.control=list(trace=100, REPORT=1, fnscale=-1, maxit=25),
Arguments

formula a formula object, with the response on the left of a ~ operator, and the terms on the right. The response must be a survival object as returned by the Surv function.

data a data.frame in which to interpret the variables named in the formula.

knots.Bh the internal breakpoints that define the spline used to estimate the baseline hazard. Typical values are the mean or median for one knot, quantiles for more knots.

degree.Bh degree of the piecewise polynomial of the baseline hazard. Default is 3 for cubic splines.

Spline a character string specifying the type of spline basis. "b-spline" for B-spline basis, "tp-spline" for truncated power basis and "tpi-spline" for monotone (increasing) truncated power basis.

log.Bh logical value: if TRUE, an additional basis equal to log(time) is added to the spline bases of time.
bhlink logical value: if TRUE, log of baseline hazard is modelled, if FALSE, the baseline hazard is out of the log.

Min_T minimum of time period which is analysed. Default is \( \max(0, \min(bands)) \).

Max_T maximum of time period which is analysed. Default is \( \max(c(bands, timevar)) \).

model character string specifying the type of model for both non-proportional and non-linear effects. The model method="additive" assumes effects as explained in Remontet et al.(2007), the model method="multiplicative" assumes effects as explained in Mahboubi et al. (2011).
rate an optional vector of the background rate for a relevant comparative population to be used in the fitting process. Should be a numeric vector (for relative survival model). rate is evaluated in the same way as variables in formula, that is first in data and then in the environment of formula.

weights an optional vector of weights to be used in the fitting process. Should be NULL or a numeric vector. If not null, the total likelihood is the weighted sum of individual likelihood.

na.action a missing-data filter function, applied to the model.frame, after any subset argument has been used. Default is options(na.action).

int_meth character string specifying the the numerical integration method. Possible values are "GL" for Gauss-Legendre quadrature, "CAV_SIM" for Cavalieri-Simpson's rule, "SIM_3_8" for the Simpson's 3/8 rule, "BOOLE" for the Boole's rule, or "BANDS" for the midpoint rule with specified bands.

npoints number of points used in the Gauss-Legendre quadrature (when int_meth="GL").

stept scalar value of the time-step in numerical integration. It is required only when int_meth="CAV_SIM" or "SIM_3_8" or "BOOLE". If no value is supplied, Max_T/500 is used.

bands bands used to split data when int_meth="BANDS".

init starting values of the parameters.

initbyglm a logical value indicating how are found or refined init values. If TRUE, the fitting method described in Remontet et al.(2007) is used to find or refine starting values. This may speedup the fit. If FALSE, the maximisation of the likelihood starts at values given in init. If init=NULL, the starting values correspond to a constant net hazard equal to the ratio of the number of event over the total number of person-time.

initbands bands used to split data when initbyglm=TRUE.

optim.control a list of control parameters passed to the optim() function.

optim_meth method to be used to optimize the likelihood. See optim.

control.glm a list of control parameters passed to the glm() function when method="glm".

vartype character string specifying the type of variance matrix computed by flexsurv: the inverse of the hessian matrix computed at the MLE estimate (ie. the inverse of the observed information matrix) if vartype= "oim", the inverse of the outer product of the gradients if vartype= "opg". The variance is not computed when vartype= "none".

debug control the volume of intermediate output
Details

A full description of the additive and the multiplicative both non-linear and non-proportional models is given respectively in Remontet (2007) and Mahboubi (2011).

flexrsurv is the workhorse function: it is not normally called directly.

Value

flexrsurv returns an object of class "flexrsurv". An object of class "flexrsurv" is a list containing at least the following components:

- coefficients: a named vector of coefficients
- loglik: the log-likelihood
- var: estimated covariance matrix for the estimated coefficients
- informationMatrix: estimated information matrix
- bhlink: the link function of baseline hazard: if "identity" baseline = sum g0_i b_i(t); if "log" log(baseline) = sum g0_i b_i(t);
- init: vector of the starting values supplied
- converged: logical, Was the optimizer algorithm judged to have converged?
- linear.predictors: the linear fit on link scale (not including the baseline hazard term if bhlink = "identity")
- fitted.values: the estimated value of the hazard rate at each event time, obtained by transforming the linear predictors by the inverse of the link function
- cumulative.hazard: the estimated value of the cumulative hazard in the time interval
- call: the matched call
- formula: the formula supplied
- terms: the terms object used
- data: the data argument
- rate: the rate vector used
- time: the time vector used
- workingformula: the formula used by the fitter
- optim.control: the value of the optim.control argument supplied
- control.glm: the value of the control.glm argument supplied
- method: the name of the fitter function used

References


See Also
print.flexrsurv, summary.flexrsurv, logLik.flexrsurv, predict.flexrsurv, NPH, NLL, and NPHNLL.

Examples

if (requireNamespace("relsurv", quietly = TRUE)) {

# data from package relsurv
data(rdata, package="relsurv")

# rate table from package relsurv
data(slopop, package="relsurv")

# get the death rate at event (or end of followup) from slopop for rdata
rdata$iage <- findInterval(rdata$age*365.24+rdata$time, attr(slopop, "cutpoints")[[1]])
rdata$iyear <- findInterval(rdata$year+rdata$time, attr(slopop, "cutpoints")[[2]])
therate <- rep(-1, dim(rdata)[1])
for (i in 1:dim(rdata)[1]){
  therate[i] <- slopop[rdata$iage[i], rdata$iyear[i], rdata$sex[i]]
}

rdata$slorate <- therate

# change sex coding
rdata$sex01 <- rdata$sex -1

# fit a relative survival model with a non linear effect of age
fit <- flexrsurv(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, Boundary.knots = c(24, 95)), rate=slorate, data=rdata,
  knots.Bh=1850, # one interior knot at 5 years
  degree.Bh=3,
  Max_T=5400,
  Spline = "b-spline",
  initbyglm=TRUE,
  initbands=seq(0, 5400, 100),
  int_meth= "BANDS",
  bands=seq(0, 5400, 50)
  )

summary(fit)

# fit a relative survival model with a non linear & non proportional effect of age
fit2 <- flexrsurv(Surv(time,cens)~sex01+NPHNLL(age, time, Knots=60, Degree=3, Knots.t = 1850, Degree.t = 3), rate=slorate, data=rdata,
  knots.Bh=1850, # one interior knot at 5 years
degree.Bh=3,
Spline = "b-spline",
initbyglm=TRUE,
int_meth= "BOOLE",
step=50
)

summary(fit2, correlation=TRUE)
}

flexrsurvclt

**Fit Relative Survival Model and Correct Life Tables**

**Description**

flexrsurvclt is used to fit relative survival regression model. transition package.

**Usage**

```r
flexrsurvclt(formula=formula(data),
formula.table=NULL,
data=parent.frame(),
Id,
baselinehazard=TRUE,
firstWCEIadditive=FALSE,
knots.Bh,
degree.Bh=3,
intercept.Bh=TRUE,
Spline=c("b-spline", "tp-spline", "tpi-spline"),
log.Bh=FALSE,
bhlink=c("log", "identity"),
Min_T=0,
Max_T=NULL,
model=c("additive","multiplicative"),
rate,
logit_start,
logit_end,
logit_start_byperiod = NULL,
logit_end_byperiod = NULL,
weights_byperiod = NULL,
Id_byperiod = NULL,
contrasts.table = NULL,
knots.table=c(-2.5,0,2.5),
degree.table=3,
Spline.table=c("restricted B-splines"),
Spline.CLT=R2bBSplineBasis(knots=c(-2.5,0,2.5), degree=3),
model_correction = c("cohort","period"))
```
weights=NULL,
na.action=NULL,
datacontrol=NULL,
Idcontrol,
ratecontrol,
logit_startcontrol,
logit_endcontrol,
logit_start_byperiodcontrol = NULL,
logit_end_byperiodcontrol = NULL,
weights_byperiodcontrol = NULL,
Id_byperiodcontrol = NULL,
weightscontrol=NULL,
int_meth=c("GL", "CAV_SIM", "SIM_3_8", "BOOLE", "GLM", "BANDS"),
bands=NULL,
npoints=20,
stept=NULL,
init=NULL,
initbyglm=TRUE,
initbands=bands,
optim.control=list(trace=100, REPORT=1, fnscale=-1, maxit=25),
optim_meth=c("BFGS", "CG", "Nelder-Mead", "L-BFGS-B", "SANN", "Brent"),
Coptim.control=list(),
lower = -Inf,
upper = Inf,
control(glm=list(epsilon=1e-8, maxit=100, trace=FALSE, epsilon(glm=.1, maxit.glm=25)),
vartype = c("oim", "opg", "none"),
varmethod = c("optim", "numDeriv.hessian", "numDeriv.jacobian"),
numDeriv.method.args=list(eps=5e-7, d=0.001,
zero.tol=sqrt(.Machine$double.eps/7e-4), r=4, v=2),
dep=FALSE
)

flexrsurveclt.ll(formula=formula(data),
formula.table=NULL,
data=parent.frame(),
Id,
baselinehazard=TRUE,
firstWCEIadditive=FALSE,
knobs.Bh,
degree.Bh=3,
Spline=c("b-spline", "tp-spline", "tpi-spline"),
log.Bh=FALSE,
bhlink=c("log", "identity"),
intercept.Bh=TRUE,
Min_T=0,
Max_T=NULL,
model=c("additive", "multiplicative"),
}
rate,
logit_start,
logit_end,
logit_start_byperiod = NULL,
logit_end_byperiod = NULL,
weights_byperiod = NULL,
Id_byperiod = NULL,
contrasts.table = NULL,
knots.table = c(-2.5, 0, 2.5),
degree.table = 3,
Spline.table = c("restricted B-splines"),
Spline.CLT = R2bBSplineBasis(knots = c(-2.5, 0, 2.5), degree = 3),
model_correction = c("cohort", "period"),
weights = NULL,
na.action = NULL,
datacontrol = NULL,
Idcontrol,
ratecontrol,
logit_startcontrol,
logit_endcontrol,
logit_start_byperiodcontrol = NULL,
logit_end_byperiodcontrol = NULL,
weights_byperiodcontrol = NULL,
Id_byperiodcontrol = NULL,
weightscontrol = NULL,
int_meth = c("GL", "CAV_SIM", "SIM_3_8", "BOOLE", "GLM", "BANDS"),
bands = NULL,
npoints = 20,
stept = NULL,
ninit = NULL,
optim.control = list(trace = 100, REPORT = 1, fnscale = -1, maxit = 25),
Coptim.control = list(),
optim_meth = c("BFGS", "CG", "Nelder-Mead", "L-BFGS-B", "SANN", "Brent"),
lower = -Inf,
upper = Inf,
vartype = c("oim", "opg", "none"),
varmethod = c("optim", "numDeriv.hessian", "numDeriv.jacobian"),
numDeriv.method.args = list(eps = 5e-7, d = 0.001,
    zero.tol = sqrt(.Machine$double.eps / 7e-4), r = 4, v = 2),
debug = FALSE
)

Arguments

formula  a formula object, with the response on the left of a ~ operator, and the terms
          on the right. The response must be a survival object as returned by the Surv
          function.
formula.table  a formula object, with empty left hand side, and the terms on the right. This is the formula of the proportional part of the correction model for the table table

data  a data.frame in which to interpret the variables named in the formulas.

Id  vector whose unique values defines the Ids of the subjects.

baselinehazard  if FALSE, no baseline hazard in the model

firstWCEIadditive  if TRUE, the first WCEI term in the formula is considered as the baseline

knots.Bh  the internal breakpoints that define the spline used to estimate the baseline hazard. Typical values are the mean or median for one knot, quantiles for more knots.

degree.Bh  degree of the piecewise polynomial of the baseline hazard. Default is 3 for cubic splines.

intercept.Bh  TRUE if the first bases is included in the baseline hazard. Default is TRUE.

Spline  a character string specifying the type of spline basis. "b-spline" for B-spline basis, "tp-spline" for truncated power basis and "tpi-spline" for monotone (increasing) truncated power basis.

log.Bh  logical value: if TRUE, an additional basis equal to log(time) is added to the spline bases of time.

bhlink  character string specifying the link function of the baseline hazard: Default is bhlink="log" for including the baseline in the exponential; if bhlink="identity", the baseline hazard is out of the exponential.

Min_T  minimum of time period which is analysed. Default is max(0.0, min(bands))

Max_T  maximum of time period which is analysed. Default is max(c(bands, timevar))

model  character string specifying the type of model for both non-proportional and non linear effects. The model method="additive" assumes effects as explained in Remontet et al.(2007), the model method="multiplicative" assumes effects as explained in Mahboubi et al. (2011).

rate  a vector of the background rate for a relevant comparative population to be used in the fitting process. Should be a numeric vector (for relative survival model). rate is evaluated in the same way as variables in formula, that is first in data and then in the environment of formula.

logit_start  a vector of the logit of the cumulative hazard at the start of the interval in the life table. logit_start is evaluated in the same way as variables in formula, that is first in data and then in the environment of formula.

logit_end  a vector of the logit of the cumulative hazard at the end of the interval in the life table. logit_end is evaluated in the same way as variables in formula, that is first in data and then in the environment of formula.

logit_start_byperiod, logit_end_byperiod, weights_byperiod, Id_byperiod  A REMPLIR

knots.table  the internal breakpoints on the logit scale that define the knots of the spline used to estimate the correction model of the life table.

degree.table  degree of the piecewise polynomial of the spline used to estimate the correction model of the life table. Default is 3 for cubic splines.
contrasts.table
an optional list. See the contrasts.arg of model.matrix().

Spline.table
a character string specifying the type of spline basis of the correction model of the life table. In this version, only "restricted B-splines" is available. "restricted B-splines" are B-spline basis with linear extrapolation + 2nd derivative at boundaries == 0.

Spline.CLT
a S4 object with method deriv() and evaluate(). The spline basis of the correction of the life table can be specified either by the parameters (knots.table, degree.table) or an S4 object that can be used for this purpose. IMPORTANT: the coef of the first basis is constraints to one and evaluate(deriv(spline_B), left_boundary_knots) == 1

model_correction
character string specifying A COMPLETER. method_correction="cohort" when the provided logit are those of the survival of individuals; method_correction="period" when the provided logit are those of the survival function of age distribution by period.

weights
an optional vector of weights to be used in the fitting process. Should be NULL or a numeric vector. If not null, the total likelihood is the weighted sum of individual likelihood.

na.action
a missing-data filter function, applied to the model.frame. If NULL, default is options()$na.action.

datacontrol
a data.frame in which to interpret the variables named in the formula for the control group.

Idcontrol, ratecontrol, logit_startcontrol, logit_endcontrol, weightscontrol
Id, rate, logit of the cumulative hazard at the start and the end of the interval in the life table, and weights for the control group.

logit_start_byperiodcontrol, logit_end_byperiodcontrol, weights_byperiodcontrol, Id_byperiodcontrol
A REMPLIR

int_meth
character string specifying the numerical integration method. Possible values are "GL" for Gauss-Legendre method, "CAV_SIM" for Cavalieri-Simpson's rule, "SIM_3_8" for the Simpson's 3/8 rule, "BOOLE" for the Boole's rule, or "BANDS" for the midpoint rule with specified bands.

bands
bands used to split data in the numerical integration when int_meth="BANDS".

npoints
number of points used in the numerical integration when int_meth="GL".

stept
scalar value of the time-step in numerical integration. It is required only when int_meth="CAV_SIM" or "SIM_3_8" or "BOOLE". If no value is supplied, Max_T/500 is used.

init
starting values of the parameters.

initbyglm
a logical value indicating indicating how are found or refined init values. If TRUE, the fitting method described in Remontet et al.(2007) is used to find or refine starting values. This may speedup the fit. If FALSE, the maximisation of the likelihood starts at values given in init. If init=NULL, the starting values correspond to a constant net hazard equal to the ratio of the number of event over the total number of person-time.

initbands
bands used to split data when initbyglm=TRUE.
optim.control a list of control parameters passed to the \texttt{optim()} function.

\texttt{optim.meth} method to be used to optimize the likelihood. See \texttt{optim}.

\texttt{Coptim.control} a list of control parameters passed to the \texttt{constrOptim()} function See \texttt{constrOptim}.

\texttt{lower, upper} Bounds on the variables for the "L-BFGS-B" method, or bounds in which to search for method "Brent". See \texttt{optim}.

\texttt{control.glm} a list of control parameters passed to the \texttt{glm()} function when \texttt{method="glm"}.

\texttt{vartype} character string specifying the type of variance matrix computed by \texttt{flexrsurv}: the inverse of the hessian matrix computed at the MLE estimate (ie. the inverse of the observed information matrix) if \texttt{vartype="oim"}, the inverse of the outer product of the gradients if \texttt{vartype="opg"}. The variance is not computed when \texttt{vartype="none"}.

\texttt{varmethod} character string specifying the method to compute the hessian matrix when \texttt{vartype="oim"}. If \texttt{varmethod="oim"}, the hessian matrix is computed by \texttt{optim}. If \texttt{varmethod="numDeriv.hessian"}, the hessian matrix is computed by \texttt{numDeriv:hessian} with \texttt{method="Richardson"}. If \texttt{varmethod="numDeriv.jacobian"}, the hessian matrix is computed by \texttt{numDeriv:jacobian} with \texttt{method="Richardson"}.

\texttt{numDeriv.method.args} arguments passed to \texttt{numDeriv:hessian} or \texttt{numDeriv:jacobian} when \texttt{varmethod="numDeriv.hessian"} or \texttt{varmethod="numDeriv.jacobian"}. Arguments not specified remain with their default values as specified in details. See \texttt{numDeriv:grad} for details about these parameters.

\texttt{debug} control the volume of intermediate output

\textbf{Details}

A full description of the additive and the multiplicative both non-linear and non-proportional models is given respectively in Remontet (2007) and Mahboubi (2011).

\texttt{flexrsurv.ll} is the workhorse function: it is not normally called directly.

\textbf{Value}

\texttt{flexrsurv} returns an object of class "\texttt{flexrsurv}". An object of class "\texttt{flexrsurv}" is a list containing at least the following components:

\begin{itemize}
  \item \texttt{coefficients} a named vector of coefficients
  \item \texttt{loglik} the log-likelihood
  \item \texttt{var} estimated covariance matrix for the estimated coefficients
  \item \texttt{informationMatrix} estimated information matrix
  \item \texttt{bhlink} the link of baseline hazard: if "identity" baseline = \texttt{sum} \texttt{g0_i b_i(t)}; if "log" \texttt{log(baseline)} = \texttt{sum} \texttt{g0_i b_i(t)};
  \item \texttt{init} vector of the starting values supplied
  \item \texttt{converged} logical, Was the optimlizer algorithm judged to have converged?
\end{itemize}
linear.predictors
the linear fit on link scale (not including the baseline hazard term if bhlink = "identity")

fitted.values
the estimated value of the hazard rate at each event time, obtained by transforming the linear predictors by the inverse of the link function

cumulative.hazard
the estimated value of the cumulative hazard in the time interval

call
the matched call

formula
the formula supplied

terms
the terms object used

data
the data argument

rate
the rate vector used

time
the time vector used

workingformula
the formula used by the fitter

optim.control
the value of the optim.control argument supplied

control.glm
the value of the control.glm argument supplied

method
the name of the fitter function used

References


See Also

print.flexrsurv, summary.flexrsurv, logLik.flexrsurv, predict.flexrsurv, NPH, NLL, and NPHNLL.

Examples

if (requireNamespace("relsurv", quietly = TRUE) & requireNamespace("date", quietly = TRUE)) {

library(date)
# data from package relsurv
data(rdata, package="relsurv")

# rate table from package relsurv
data(slopop, package="relsurv")

# get the death rate at event (or end of followup) from slopop for rdata
rdata$start <- findInterval(rdata$age*365.24+rdata$time, attr(slopop, "cutpoints"))[1]
rdata$iyear <- findInterval(rdata$year + rdata$time, attr(slopop, "cutpoints")[2])
therate <- rep(-1, dim(rdata)[1])
for( i in 1:dim(rdata)[1]) {
  therate[i] <- slopop[rdata$iage[i], rdata$iyear[i], rdata$sex[i]]
}

rdata$slorate <- therate

# get the logit_start and logit_end
# logit start at age 18

tmpsurv <- Surv(rep(0, length(rdata$time)), rdata$time, rdata$cens)

HH <- getHazardFromTable(tmpsurv, startdate=rdata$year,
                         startage=rdata$age*365.25 , matchdata=rdata, ratetable=slopop,
                         age="age", year="year",
                         rmap=list(sex=sex),
                         agemin=18,
                         ratename = "poprate", cumrateendname ="cumrateend", cumrateentername ="cumrateenter"
)

rdata$slorate <- HH$poprate
rdata$logit_start <- log(exp(HH$cumrateenter)-1)
rdata$logit_end <- log(exp(HH$cumrateend)-1)

rdata$Id <- 1:dim(rdata)[1]

# change sex coding
rdata$sex01 <- rdata$sex -1

# fit a relative survival model with a non linear effect of age
# without correction of life table
# partial likelihood
fit00 <- flexrsurvc1t(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3,
                                  Boundary.knots = c(24, 95)),
                               rate=slorate,
                               data=rdata,
                               knots.Bh=1850, # one interior knot at 5 years
degree.Bh=3,
                      Max_T=5400,
Spline = "b-spline",
initbyglm=TRUE,
initbands=seq(0, 5400, 100),
int_meth = "BANDS",
bands=seq(0, 5400, 50)
)
summary(fit00)
# fit a relative survival model with a non linear effect of age
# without correction of life table
# full likelihood
fit0 <- flexrsurvclt(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, Boundary.knots = c(24, 95)),
    rate=slorate,
    logit_start=logit_start,
    logit_end=logit_end,
    data=rdata,
    Id=Id,
    knots.Bh=1850,  # one interior knot at 5 years
    degree.Bh=3,
    Max_T=5400,
    Spline = "b-spline",
    initbyglm=TRUE,
    initbands=seq(0, 5400, 100),
    int_meth= "BANDS",
    bands=seq(0, 5400, 50)
    )
summary(fit0)

# fit a relative survival model with a non linear effect of age
# with correction of life table
# full likelihood
fit1 <- flexrsurvclt(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, Boundary.knots = c(24, 95)),
    rate=slorate,
    logit_start=logit_start,
    logit_end=logit_end,
    data=rdata,
    Id=Id,
    knots.Bh=1850,  # one interior knot at 5 years
    degree.Bh=3,
    Max_T=5400,
    Spline = "b-spline",
    Spline.CLT=flexrsurv:::R2bBSplineBasis(knots=c(-2.5,0,2.5), degree=3),
    initbyglm=TRUE,
    initbands=seq(0, 5400, 100),
    int_meth= "BANDS",
    bands=seq(0, 5400, 50)
    )
summary(fit1)

print(coef(fit1))

# fit a relative survival model with a non linear effect of age
# with correction of life table, strabified by sex
# full likelihood
fit2 <- flexrsurvclt(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, Boundary.knots = c(24, 95)),
    formula.table= ~sex,
    rate=slorate,
    logit_start=logit_start,
getBrassHazardFromTable

Compute expected hazards with respect to a corrected reference life table

Description
returns the cumulative hazard and the hazard rate of subjects in a reference life table

Usage
getBrassPseudoHazardFromTable(Y, startdate, startage, matchdata = NULL,
ratetable = survival::survexp.us,
age = 1, year = 2, rmap,
agejen = 16, scale = 365.25,
ratename = "rateend",
cumrateendname = "cumrateend",
cumrateentername = "cumrateenter",
idname = "Id_byperiod",
origin = "01/01/1970", format="%d/%m/%Y",
left.open = FALSE,
SplineBrass=R2bBSplineBasis(knots=c(-2.5,0,2.5), degree=3)*c(1, 0, 1),
verbose=FALSE)

Arguments
Y An object with interval data. It can be an object of class Surv with arguments time, time2 and event or a two-column matrix with starting time in the first column and ending time in the second column.
getBrassHazardFromTable

startdate a numeric vector such that as.Date(startdate) is interpreted as the date of
the start (when Y[,]==0).

startage a numeric vector of age in days the start (when Y[,]==0).

matchdata an optional data.frame in which to interpret the additional variables to be mapped
to the ratetable variables.

ratetable an object of class ratetable, ie a table of event rates.
age, year character values of the names of the age and period variables in the rate table.
rmap an optional list that maps data set names to the ratetable names. See survexp an
eexample bellow.

agemin numeric value of the age at which the cumulative hazard starts.
scale numeric value to scale agemin.
ratename, curnrateendname, cumrateentername, idname
names of the returned variables

origin, format passed to as.Date
left.open logical, passed to findInterval
SplineBrass Spline basis used to transform the rates
verbose logical, if true the progression of the computation is output.

Details

The cumulative rates are computed using survexp.

Value

A data.frame with 3 columns with the rate at the ending time, the cumulative rate from agemin up
to the starting time and upt to the ending time.

See Also

gethazardFromTable for the cumulative hazard and the hazard rate of subjects in a reference life
table. survexp

Examples

if (requireNamespace("relsurv", quietly = TRUE) & requireNamespace("date", quietly = TRUE)) {

library(date)
# data from package relsurv
data(rdata, package="relsurv")

# rate table from package relsurv
data(slopop, package="relsurv")

tmpsurr <- Surv(rep(0, length(rdata$time)), rdata$time, rdata$cens)
getHazardFromTable

getHazardFromTable(Y, startdate, startage, matchdata = NULL, ratetable = survival::survexp.us, age = 1, year = 2, rmap, agemin = 16, scale = 365.25, ratename = "rateend", cumrateendname = "cumrateend", cumrateentername = "cumrateenter", origin = "01/01/1970", format = "%d/%m/%Y", left.open = FALSE, verbose=FALSE)

Arguments

Y An object with interval data. It can be an object of class Surv with arguments time, time2 and event or a two-column matrix with starting time in the first column and ending time in the second column.

startdate a numeric vector such that as.Date(startdate) is interpreted as the date of the start (when Y[,]==0).

startage a numeric vector of age in days the start (when Y[,]==0).

matchdata an optional data.frame in which to interpret the additional variables to be mapped to the ratetable variables.

ratetable an object of class ratetable, ie a table of event rates.

age, year character values of the names of the age and period variables in the rate table.

rmap an optional list that maps data set names to the ratetable names. See survexp an example bellow.
getHazardFromTable

agemin numeric value of the age at which the cumulative hazard starts.
scale numeric value to scale agemin.
ratename, cumrateendname, cumrateentername names of the returned variables
origin, format arguments passed \texttt{as.Date}
left.open logical, passed to \texttt{findInterval}
verbose logical, if true the progression of the computation is output.

Details

The cumulative rates are computed using \texttt{survexp}.

Value

A \texttt{data.frame} with 3 columns with the rate at the ending time, the cumulative rate from agemin up to the starting time and up to the ending time.

See Also

\texttt{getPseudoHazardFromTable} for the cumulative hazard in each period of a reference life table. \texttt{getBrassHazardFromTable} for the cumulative hazard in a corrected reference life table. \texttt{survexp}

Examples

```r
if (requireNamespace("relsurv", quietly = TRUE) & requireNamespace("date", quietly = TRUE)) {

library(date)
# data from package relsurv
data(rdata, package="relsurv")

# rate table from package relsurv
data(slopop, package="relsurv")

tmpsurv <- Surv(rep(0, length(rdata$time)), rdata$time, rdata$cens)

HH <- getHazardFromTable tmpsurv, startdate=rdata$year, startage=rdata$age*365.24 , matchdata=rdata, ratetable=slopop, age="age", year="year", rmap=list(sex=sex), agemin=18, scale=365.24, ratename = "poprate", cumrateendname ="cumrateend", cumrateentername ="cumrateenter"
)

summary(HH)
}
```
getPseudoHazardFromTable

Computes expected hazards with respect to a reference life table

Description

return the cumulative pseudo hazard and the hazard rate of subjects in a reference life table

Usage

g getPseudoHazardFromTable(Y, startdate, startage, matchdata = NULL, 
    ratetable = survival::survexp.us, 
    age = 1, year = 2, rmap, 
    agemin = 16, scale = 365.25, 
    ratename = "rateend", 
    cumrateendname = "cumrateend", 
    cumrateentername = "cumrateenter", 
    idname = "Id_byperiod", 
    origin = "01/01/1970", format="%d/%m/%Y", 
    left.open = FALSE, verbose=FALSE)

Arguments

Y An object with interval data. It can be an object of class Surv with arguments time, time2 and event or a two-column matrix with starting time in the first column and ending time in the second column.
startdate a numeric vector such that as.Date(startdate) is interpreted as the date of the start (when Y[,]==0).
startage a numeric vector of age in days the start (when Y[,]==0).
matchdata an optional data.frame in which to interpret the additional variables to be mapped to the ratetable variables.
ratetable an object of class ratetable, ie a table of event rates.
age, year character values of the names of the age and period variables in the rate table.
rmap an optional list that maps data set names to the ratetable names. See survexp an example bellow.
agemin numeric value of the age at which the cumulative hazard starts.
scale numeric value to scale agemin.
ratename, cumrateendname, cumrateentername, idname names of the returned variables
origin, format passed to as.Date
left.open logical, passed to findInterval
verbose logical, if true the progression of the computation is output.
Details

The cumulative rates are computed using `survexp`.

Value

A `data.frame` with 3 columns with the rate at the ending time, the cumulative rate from `agemin` up to the starting time and up to the ending time.

See Also

`getHazardFromTable` for the cumulative hazard and the hazard rate of subjects in a reference life table. `survexp`

Examples

```R
if (requireNamespace("relsurv", quietly = TRUE) & requireNamespace("date", quietly = TRUE)) {
  library(date)
  # data from package relsurv
  data(rdata, package="relsurv")
  # rate table from package relsurv
  data(slopop, package="relsurv")
  tmprs <- Surv(rep(0, length(rdata$time)), rdata$time, rdata$cens)
  HH <- getPseudoHazardFromTable(tmprs, startdate=rdata$year, startage=rdata$age*365.24, matchdata=rdata, ratetable=slopop, age="age", year="year", rmap=list(sex=sex), agemin=18, scale=365.24, ratename = "poprate", cumrateendname = "cumrateend", cumrateentername = "cumrateenter", idname="Id_byperiod" )
  summary(HH)
}
```

---

logLik.flexrsurv  

**Log-Likelihood and the number of observations for a flexrsurv fit.**

Description

Function to extract Log-Likelihood and the number of observations from a `flexrsurv` or `flexrsuvclt` fit.
NLL

Usage

```r
## S3 method for class 'flexrsurv'
logLik(object, ...)

## S3 method for class 'flexrsurv'
nobs(object, ...)
```

Arguments

- `object`: any object of class `flexrsurv` results of a `flexrsurv` fit.
- `...`: not used

Value

- `logLik`: returns a standard `logLik` object (see `logLik`)
- `nobs`: returns a single number, normally an integer.

See Also

- `logLik`, `nobs`

---

**NLL**

Non Log-Linear effect

Description

Generate the spline basis matrix for non log-linear effect.

Usage

```r
NLL(x,
   Spline = c("b-spline", "tp-spline", "tpi-spline"),
   Knots = NULL,
   Degree = 3,
   Intercept = FALSE,
   Boundary.knots = range(x),
   Keep.duplicates = TRUE,
   outer.ok = TRUE,
   ...)```
Arguments

- **x**: the predictor variable.
- **Spline**: a character string specifying the type of spline basis. "b-spline" for B-spline basis, "tp-spline" for truncated power basis and "tpi-spline" for monotone (increasing) truncated power basis.
- **Knots**: the internal breakpoints that define the spline used to estimate the NLL effect. By default there are none.
- **Degree**: degree of splines which are considered.
- **Intercept**: a logical value indicating whether intercept/first basis of spline should be considered.
- **Boundary.knots**: range of variable which is analysed.
- **Keep.duplicates**: Should duplicate interior knots be kept or removed. Defaults is FALSE, which removes duplicate knots with a warning if duplicate interior knots are found.
- **outer.ok**: logical indicating how are managed x values outside the knots. If FALSE, return NA, if TRUE, return 0 for the corresponding x values.
- **...**: not used

Details

NLL is based on package orthogonalsplinebasis

See Also

NPH and NPHNLL.

Description

Generate the design matrix of spline basis for non proportional effect.

Usage

NPH(x, timevar, Spline = c("b-spline", "tp-spline", "tpi-spline"), Knots.t = NULL, Degree.t = 3, Intercept.t = TRUE, Boundary.knots.t = c(0, max(timevar)), Keep.duplicates.t = TRUE, outer.ok = TRUE, ...)
Arguments

\texttt{x} \quad \text{the predictor variable.}
\texttt{timevar} \quad \text{the time variable.}
\texttt{Spline} \quad \text{a character string specifying the type of spline basis. \"b-spline\" for B-spline basis, \"tp-spline\" for truncated power basis and \"tpi-spline\" for monotone (increasing) truncated power basis.}
\texttt{Knots.t} \quad \text{the internal breakpoints that define the spline used to estimate the NPH effect. By default there are none.}
\texttt{Degree.t} \quad \text{degree of splines which are considered.}
\texttt{Intercept.t} \quad \text{a logical value indicating whether intercept/first basis of spline should be considered.}
\texttt{Boundary.knots.t} \quad \text{range of time period which is analysed. By default it is c(0, max(timevar)).}
\texttt{Keep.duplicates.t} \quad \text{Should duplicate interior knots be kept or removed. Defaults is FALSE, which removes duplicate knots with a warning if duplicate interior knots are found.}
\texttt{outer.ok} \quad \text{logical indicating how are managed \texttt{timevar} values outside the knots. If FALSE, return NA, if TRUE, return 0 for the corresponding \texttt{timevar} values.}
\texttt{...} \quad \text{not used}

Details

NPH is based on package \texttt{orthogonalsplinebasis}

See Also

\texttt{NLL}, and \texttt{NPHNLL}.

---

\texttt{NPHNLL} \quad \textit{Non Proportional Hazard and Non Log-Linear effect}

Description

Generate the design matrix of spline basis for both non log-linear and non proportional effect.

Usage

\begin{verbatim}
NPHNLL(x, 
  timevar, 
  model = c("additive", "multiplicative"), 
  Spline = c("b-spline", "tp-spline", "tpi-spline"), 
  Knots = NULL, 
  Degree = 3, 
  Intercept = FALSE,
\end{verbatim}
Boundary.knots = range(x),
Knots.t = NULL,
Degree.t = 3,
Intercept.t = (model == "multiplicative"),
Boundary.knots.t = c(0, max(timevar)),
outer.ok = TRUE,
Keep.duplicates = TRUE,
xdimnames = "XxXxXXxXxX",
tdimnames = "TtTtTTtTtT")

Arguments

x the predictor variable.
timevar the time variable.
model character string specifying the type of model for both non-proportionnal and non
linear effects. The model method="additive" assumes effects as explained in
Remontet et al.(2007), the model method="multiplicative" assumes effects
as explained in Mahboubi et al. (2011).
Spline a character string specifying the type of spline basis. "b-spline" for B-spline
basis, "tp-spline" for truncated power basis and "tpi-spline" for monotone (in-
creasing) truncated power basis.
Knots the internal breakpoints that define the spline used to estimate the NLL part of
effect. By default there are none.
Degree degree of splines of variable which are considered.
Intercept a logical value indicating whether intercept/first basis of spline should be con-
sidered.
Boundary.knots range of variable which is analysed.
Knots.t the internal breakpoints that define the spline used to estimate the NPH part of
effect. By default there are none.
Degree.t degree of splines of time variable which are considered.
Intercept.t a logical value indicating whether intercept/first basis of spline should be con-
sidered.
Boundary.knots.t range of time period which is analysed.
Keep.duplicates Should duplicate interior knots be kept or removed. Defaults is FALSE, which
removes duplicate knots with a warning if duplicate interior knots are found.
outer.ok logical indicating how are managed timevar or x values outside the knots. If
FALSE, return NA, if TRUE, return 0 for the corresponding timevar or x values.
xdimnames string to build dimnames of x bases
tdimnames string to build dimnames of timevar bases

Details

NPHNLL is based on package orthogonalsplinebasis
References


See Also

NPH and NLL.

predict.flexrsurv  Predictions for a relative survival model

Description

Predict linear predictors, hazard and cumulative hazard for a model fitted by flexrsurv

Usage

## S3 method for class 'flexrsurv'
predict(object, newdata= NULL,
   type = c("lp", "link", "risk", "hazard", "hazardrate",
   "rate", "loghazard", "log", "lograte",
   "cumulative.r"ate", "cumulative.hazard", "cumulative", "cum",
   "survival", "surv", "netsurv"),
   se.fit=FALSE, na.action=na.pass, ...)

Arguments

object  the results of a flexrsurv fit.
newdata Optional new data at which to do predictions. If absent predictions are for the
data frame used in the original fit.
type  the type of predicted value. Choices are the linear predictor ("lp", "log",
"loghazard","lograte"), the hazard ("rate", "hazard", "hazardrate", "risk")
or the cumulative hazard ("cum", "cumulative.hazard", "cumulative").
se.fit  if TRUE, pointwise standard errors are produced for the predictions (not avail-
able for cumulative hazard).
na.action  function determining what should be done with missing values in newdata. The
default is to predict NA.
...  For future methods

Details

For cumulative hazard, the cumulative hazard is computed from 0 until the given end time. The
cumulative hazard is computed using the same numerical integration method as the one used to fit
the model.
Value

a vector or a list containing the predictions (element "fit") and their standard errors (element "se.fit") if the se.fit option is TRUE.

Note

To work correctly, arguments Boundary.knots and Boundary.knots.t must be included in the call to NPH(), NLL() and NPHNLL() in the formula of flexrsurv.

See Also

predict.flexrsurv, flexrsurvclt

Examples

if (requireNamespace("relsurv", quietly = TRUE)) {

  # data from package relsurv
  data(rdata, package="relsurv")

  # rate table from package relsurv
  data(slopop, package="relsurv")

  # get the death rate at event (or end of followup) from slopop for rdata
  rdata$iage <- findInterval(rdata$age*365.24+rdata$time, attr(slopop, "cutpoints")[[1]])
  rdata$iyear <- findInterval(rdata$year+rdata$time, attr(slopop, "cutpoints")[[2]])
  therate <- rep(-1, dim(rdata)[1])
  for( i in 1:dim(rdata)[1]){
    therate[i] <- slopop[rdata$iage[i], rdata$iyear[i], rdata$sex[i]]
  }
  rdata$slorate <- therate

  # change sex coding
  rdata$sex01 <- rdata$sex -1

  # centering age
  rdata$agec <- rdata$age - 60

  # fit a relative survival model with a non linear effect of age
  fit <- flexrsurv(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, Boundary.knots = c(24, 95)),
                   rate=slorate, data=rdata,
                   knots.Bh=1850, # one interior knot at 5 years
                   degree.Bh=3,
                   Spline = "b-spline",
                   initbyglm=TRUE,
                   int_meth = "BOOLE",
                   step=50)
predictCLT

Predictions for relational life table model

Description

Predict the relational model for a life table correction model fitted by flexrsuvclt or for specified knots, degree and coefficients

Usage

predictCLT ( ... )
## S3 method for class 'flexrsurvclt'
predictCLT(object, newdata= NULL, 
  type = c("clt", "correction"), 
  se.fit=FALSE, na.action=na.pass, newcoef = NULL, ...)

## Default S3 method:
predictCLT(knots, degree, newdata, newcoef, ...)

### Arguments

- **object**: the results of a flexrsurvclt fit.
- **newdata**: Optional new vector of logarithm of the cumulative distribution odds (LCDO) at which to do predictions. If absent predictions are for values of the LCDO used in the original fit (logit_end parameter in the call to flexrsurvclt).
- **newcoef**: Optional new coefficients for which to do predictions. If absent predictions are for the coefficients of the fitted model in object.
- **type**: the type of predicted value. Choices are "clt" or "correction" to compute the corrected logarithm of the cumulative distribution odds.
- **se.fit**: if TRUE, pointwise standard errors are produced for the predictions (not yet implemented).
- **knots, degree**: knots and degree of the relational model.
- **na.action**: function determining what should be done with missing values in newdata. The default is to predict NA.
- **...**: For future methods

### Details

predictCLT with knots and degree arguments computes corrected values of \( \log(C) \).

### Value

a vector or a list containing the predicted relational model (element "fit") and their standard errors (element "se.fit") if the se.fit option is TRUE.

### See Also

predict.flexrsurvclt, flexrsurv, flexrsurvclt

### Examples

```r
if (requireNamespace("relsurv", quietly = TRUE) & requireNamespace("date", quietly = TRUE)) {
  library(date)
  # data from package relsurv
```
predictCLT

```r
data(rdata, package="relsurv")

class(rdata$year)<="integer"

# rate table from package relsurv
data(slopop, package="relsurv")

# get the death rate at event (or end of followup) from slopop for rdata
rdata$iage <- findInterval(rdata$age*365.24+rdata$time, attr(slopop, "cutpoints")[[1]])
rdata$iyear <- findInterval(rdata$year+rdata$time, attr(slopop, "cutpoints")[[2]])
therate <- rep(-1, dim(rdata)[1])
for( i in 1:dim(rdata)[1]){
  therate[i] <- slopop[rdata$iage[i], rdata$iyear[i], rdata$sex[i]]
}

rdata$slorate <- therate

# get the logit_start and logit_end
# logit start at age 18

tmpsurv <- Surv(rep(0, length(rdata$time)), rdata$time, rdata$cens)

HH <- getHazardFromTable(tmpsurv, startdate=rdata$year, 
  startage=rdata$age*365.25 , matchdata=rdata, ratetable=slopop, 
  age="age", year="year", 
  rmap=list(sex=sex), 
  agemin=18,
  ratename = "poprate", cumrateendname ="cumrateend", cumrateentername ="cumrateenter"
)

rdata$slorate <- HH$poprate
rdata$logit_start <- log(exp(HH$cumrateenter)-1)
rdata$logit_end <- log(exp(HH$cumrateend)-1)

rdata$Id <- 1:dim(rdata)[1]

# change sex coding
rdata$sex01 <- rdata$sex -1

# fit a relative survival model with a non linear effect of age
# with correction of life table
# full likelihood
fit1 <- flexrsurvclt(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3, 
  Boundary.knots = c(24, 95)), 
  rate=slorate, 
  logit_start=logit_start, 
  logit_end=logit_end, 
  data=rdata, 
  Id=Id, 
  knots.Bh=1850, # one interior knot at 5 years
```

predictSpline

Generic method for prediction of spline function

Description

Predict a spline function by specifying its type, knots, degree and coefficients

Usage

predictSpline (object, x, ...)

## Default S3 method:
predictSpline(object=c("b-spline", "tp-spline"),
x, knots, degree, keep.duplicates = FALSE, coef=1, ... )

Arguments

object the type of spline to be predicted ("b-spline", the default, or "tp-spline")
x Vector of values at which to predict the spline function.
knots, degree knots and degree of the relational model.
keep.duplicates

Should duplicate interior knots be kept or removed. Defaults is FALSE, which removes duplicate knots with a warning if duplicate interior knots are found.

deco

vector of coefficient of the spline function.

Details

predictSpline.

Value

A vector the evaluated spline function with same length as x.

See Also

predict.flexrsurvclt, flexrsurv, flexrsurvclt

Examples

predspline <- predictSpline("b-spline",
x= seq(from=-3, to = 3, by=.1),
coef = .5 * 1:5,
knots=c(-3,0,3), degree=3)
plot(seq(from=-3, to = 3, by=.1), predspline)

print.flexrsurv

Print a Short Summary of a Relative Survival Model

Description

Print number of observations, number of events, the formula, the estimated coefficients and the log likelihood.

Usage

## S3 method for class 'flexrsurv'
print(x,
digits = max(3, getOption("digits") - 3), ...)
Summary methods for class `flexrsurv`. Produces and prints summaries of the results of a fitted Relative Survival Model.

**Description**

The default method `print.default`, and help for the function `flexrsurv, flexrsurvclt`.

**Usage**

```r
## S3 method for class 'flexrsurv'
summary(object, correlation = FALSE, symbolic.cor = FALSE, ...)

## S3 method for class 'summary.flexrsurv'
print(x, digits = max(3L, getOption("digits") - 3L),
      symbolic.cor = x$symbolic.cor,
      signif.stars = getOption("show.signif.stars"), ...)```

**Arguments**

- **object**: an object of class "flexrsurv", usually, a result of a call to `flexrsurv`.
- **x**: an object of class "summary.flexrsurv", usually, a result of a call to `summary.flexrsurv`.
- **correlation**: logical; if TRUE, the correlation matrix of the estimated parameters is returned and printed.
- **symbolic.cor**: logical. If TRUE, print the correlations in a symbolic form (see `symnum`) rather than as numbers.
- **digits**: the number of significant digits to use when printing.
- **signif.stars**: logical. If TRUE, 'significance stars' are printed for each coefficient.
- **...**: further arguments passed to or from other methods.
Summary.flexrsurv

Details

print.summary.glm tries to be smart about formatting the coefficients, standard errors, etc. and additionally gives 'significance stars' if signif.stars is TRUE.

Correlations are printed to two decimal places (or symbolically): to see the actual correlations print summary(object)$correlation directly.

The dispersion of a GLM is not used in the fitting process, but it is needed to find standard errors. If dispersion is not supplied or NULL, the dispersion is taken as 1 for the binomial and Poisson families, and otherwise estimated by the residual Chi-squared statistic (calculated from cases with non-zero weights) divided by the residual degrees of freedom.

Value

The function summary.flexrsurv computes and returns a list of summary statistics of the fitted flexible relative survival model given in object. The returned value is an object of class "summary.flexrsurv", which a list with components:

call the "call" component from object.
terms the "terms" component from object.
coefficients the matrix of coefficients, standard errors, z-values and p-values.
cov the estimated covariance matrix of the estimated coefficients.
correlation (only if correlation is true.) the estimated correlations of the estimated coefficients.
symbolic.cor (only if correlation is true.) the value of the argument symbolic.cor.
loglik the "loglik" component from object.
df.residual the "df.residual" component from object.

See Also

summary, flexrsurv, flexrsurvclt.

Examples

if (requireNamespace("relsurv", quietly = TRUE)) {
  # data from package relsurv
  data(rdata, package="relsurv")
  # rate table from package relsurv
  data(slopop, package="relsurv")
  # get the death rate at event (or end of followup) from slopop for rdata
  rdata$iage <- findInterval(rdata$age*365.24+rdata$time, attr(slopop, "cutpoints"))[1]
  rdata$iyear <- findInterval(rdata$year+rdata$time, attr(slopop, "cutpoints"))[2]
  therate <- rep(-1, dim(rdata)[1])
  for( i in 1:dim(rdata)[1])
    therate[i] <- slopop[rdata$iage[i], rdata$iyear[i], rdata$sex[i]]
}

rdata$slorate <- therate

# change sex coding
rdata$sex01 <- rdata$sex -1

# fit a relative survival model with a non linear effect of age
fit <- flexrsurv(Surv(time,cens)~sex01+NLL(age, Knots=60, Degree=3),
                 rate=slorate, data=rdata,
                 knots.Bh=1850, # one interior knot at 5 years
                 degree.Bh=3,
                 Spline = "b-spline",
                 initbyglm=TRUE,
                 initbands=seq(from=0, to=5400, by=200),
                 int_meth= "CAV_SIM",
                 step=50)

summary(fit)
}

---

**WCEI**

**Weighted cumulative exposure index**

**Description**

Generate the spline basis matrix for Weighted cumulative exposure index.

**Usage**

```r
WCEI(x,
     timevar,
     fromT=0,
     Spline.WCEI=NULL,
     Spline = c("m-spline", "b-spline", "tp-spline", "tpi-spline"),
     Knots.t = NULL,
     Degree.t = 3,
     Intercept.t = TRUE,
     Boundary.knots.t = range(c(timevar, fromT)),
     Keep.duplicates.t = TRUE,
     outer.ok = TRUE,
     ...)```
**Arguments**

- `x` the exposure variable.
- `timevar` the time variable.
- `fromT` Time at which starts exposure
- `Spline.WCEI` a S4 object with method `deriv()`, `evaluate()` and `predict()`.
- `Spline` a character string specifying the type of spline basis. "b-spline" for B-spline basis, "tp-spline" for truncated power basis and "tpi-spline" for monotone (increasing) truncated power basis.
- `Knots.t` the internal breakpoints that define the spline used to estimate the WCEI effect. By default there are none.
- `Degree.t` degree of splines which are considered.
- `Intercept.t` a logical value indicating whether intercept/first basis of spline should be considered.
- `Boundary.knots.t` range of variable which is analysed.
- `Keep.duplicates.t` Should duplicate interior knots be kept or removed. Defaults is FALSE, which removes duplicate knots with a warning if duplicate interior knots are found.
- `outer.ok` logical indicating how are managed x values outside the knots. If FALSE, return NA, if TRUE, return 0 for the corresponding x values.
- `...` not used

**Details**

WCEI is based on package `orthogonalsplinebasis`

**See Also**

`NLL`, `NPH` and `NPHNLL`. 
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