Package ‘aftgee’

September 28, 2023

Title  Accelerated Failure Time Model with Generalized Estimating Equations

Version  1.2.0

Description  A collection of methods for both the rank-based estimates and least-square estimates to the Accelerated Failure Time (AFT) model. For rank-based estimation, it provides approaches that include the computationally efficient Gehan's weight and the general's weight such as the logrank weight. Details of the rank-based estimation can be found in Chiou et al. (2014) <doi:10.1007/s11222-013-9388-2> and Chiou et al. (2015) <doi:10.1002/sim.6415>. For the least-square estimation, the estimating equation is solved with generalized estimating equations (GEE). Moreover, in multivariate cases, the dependence working correlation structure can be specified in GEE's setting. Details on the least-squares estimation can be found in Chiou et al. (2014) <doi:10.1007/s10985-014-9292-x>.

Depends  R (>= 3.4.0)

License  GPL (>= 3)

URL  https://github.com/stc04003/aftgee

BugReports  https://github.com/stc04003/aftgee/issues

Encoding  UTF-8

LazyLoad  yes

Imports  methods, parallel, geepack, survival, BB, MASS, Rcpp

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LinkingTo  Rcpp, RcppArmadillo

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Description

A package that uses Generalized Estimating Equations (GEE) to estimate Multivariate Accelerated Failure Time Model (AFT). This package implements recently developed inference procedures for AFT models with both the rank-based approach and the least squares approach. For the rank-based approach, the package allows various weight choices and uses an induced smoothing procedure that leads to much more efficient computation than the linear programming method. With the rank-based estimator as an initial value, the generalized estimating equation approach is used as an extension of the least squares approach to the multivariate case. Additional sampling weights are incorporated to handle missing data needed as in case-cohort studies or general sampling schemes.

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References


**See Also**

Useful links:

- [https://github.com/stc04003/aftgee](https://github.com/stc04003/aftgee)
- Report bugs at [https://github.com/stc04003/aftgee/issues](https://github.com/stc04003/aftgee/issues)

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**aftgee**

*Least-Squares Approach for Accelerated Failure Time with Generalized Estimating Equation*

**Description**

Fits a semiparametric accelerated failure time (AFT) model with least-squares approach. Generalized estimating equation is generalized to multivariate AFT modeling to account for multivariate dependence through working correlation structures to improve efficiency.

**Usage**

```r
aftgee(
  formula,
  data,
  subset,
  id = NULL,
  contrasts = NULL,
  weights = NULL,
  margin = NULL,
  corstr = c("independence", "exchangeable", "ar1", "unstructured", "userdefined", "fixed"),
  binit = "srrgehan",
  B = 100,
  control = aftgee.control()
)
```

**Arguments**

- `formula` a formula expression, of the form `response ~ predictors`. The response is a `Surv` object with right censoring. In the case of no censoring, `aftgee` will return an ordinary least estimate when `corstr = "independence"`. See the documentation of `lm`, `coxph` and `formula` for details.
- `data` an optional data.frame in which to interpret the variables occurring in the `formula`.
subset  an optional vector specifying a subset of observations to be used in the fitting process.

id     an optional vector used to identify the clusters. If missing, then each individual row of data is presumed to represent a distinct subject. The length of id should be the same as the number of observations.

contrasts an optional list.

weights an optional vector of observation weights.

margin  a sformula vector; default at 1.

corstr  a character string specifying the correlation structure. The following are permitted:

  • independence
  • exchangeable
  • ar1
  • unstructured
  • userdefined
  • fixed

binit   an optional vector can be either a numeric vector or a character string specifying the initial slope estimator.

  • When binit is a vector, its length should be the same as the dimension of covariates.
  • When binit is a character string, it should be either lm for simple linear regression, or srrgehan for smoothed Gehan weight estimator.

  The default value is "srrgehan".

B      a numeric value specifies the resampling number. When B = 0, only the beta estimate will be displayed.

control controls maxiter and tolerance.

Value

An object of class "aftgee" representing the fit. The aftgee object is a list containing at least the following components:

coefficients a vector of initial value and a vector of point estimates

coef.res    a vector of point estimates

var.res     estimated covariance matrix

coef.init   a vector of initial value

var.init.mat estimated initial covariance matrix

binit       a character string specifying the initial estimator.

conv       An integer code indicating type of convergence after GEE iteration. 0 indicates successful convergence; 1 indicates that the iteration limit maxit has been reached

ini.conv   An integer code indicating type of convergence for initial value. 0 indicates successful convergence; 1 indicates that the iteration limit maxit has been reached

conv.step  An integer code indicating the step until convergence
References


Examples

```r
## Simulate data from an AFT model with possible depended response

datgen <- function(n = 100, tau = 0.3, dim = 2) {
  x1 <- rbinom(dim * n, 1, 0.5)
  x2 <- rnorm(dim * n)
  e <- c(t(exp(MASS::mvrnorm(n = n, mu = rep(0, dim), Sigma = tau + (1 - tau) * diag(dim)))))
  tt <- exp(2 + x1 + x2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen), x1 = x1, x2 = x2, id = rep(1:n, each = dim))
}

set.seed(1); dat <- datgen(n = 50, dim = 2)
fm <- Surv(Time, status) ~ x1 + x2
fit1 <- aftgee(fm, data = dat, id = id, corstr = "ind")
fit2 <- aftgee(fm, data = dat, id = id, corstr = "ex")
summary(fit1)
summary(fit2)
confint(fit1)
confint(fit2)
```

---

**aftgee.control**

**Auxiliary for Controlling AFTGEE Fitting**

**Description**

Auxiliary function as user interface for aftgee and aftsrr fitting.

**Usage**

```r
aftgee.control(
  maxiter = 50,
  reltol = 0.001,
  trace = FALSE,
  seIni = FALSE,
  parallel = FALSE,
  gp.pwr = -999
)
```
Arguments

maxiter  max number of iteration.
reltol  relative error tolerance.
trace  a binary variable, determine whether to display output for each iteration.
seIni  a logical value indicating whether a new rank-based initial value is computed for each resampling sample in variance estimation.
parallel  an logical value indicating whether parallel computing is used for resampling and bootstrap.
parCl  an integer value indicating the number of CPU cores used when parallel = TRUE.
gp.pwr  an numerical value indicating the GP parameter when rankWeights = GP. The default value is half the CPU cores on the current host.

Details

When trace is TRUE, output for each iteration is printed to the screen.

Value

A list with the arguments as components.

See Also

aftgee

Description

Fits a semiparametric accelerated failure time (AFT) model with rank-based approach. General weights, additional sampling weights and fast sandwich variance estimations are also incorporated. Estimating equations are solved with Barzilar-Borwein spectral method implemented as BBSolve in package BB.

Usage

aftsrr(  formula,  data,  subset,  id = NULL,  contrasts = NULL,  weights = NULL,  B = 100,  )
rankWeights = c("gehan", "logrank", "PW", "GP", "userdefined"),
eqType = c("is", "ns", "mis", "mns"),
se = c("NULL", "bootstrap", "MB", "ZLCF", "ZLMB", "sHCF", "sHMB", "ISCF", "ISMB"),
control = list()
)

Arguments

formula a formula expression, of the form response ~ predictors. The response is a Surv object with right censoring. See the documentation of lm, coxph and formula for details.
data an optional data frame in which to interpret the variables occurring in the formula.
subset an optional vector specifying a subset of observations to be used in the fitting process.
id an optional vector used to identify the clusters. If missing, then each individual row of data is presumed to represent a distinct subject. The length of id should be the same as the number of observation.
contrasts an optional list.
weights an optional vector of observation weights.
B a numeric value specifies the resampling number. When $B = 0$ or $se = NULL$, only the beta estimate will be displayed.
rankWeights a character string specifying the type of general weights. The following are permitted:
  logrank logrank weight
  gehan Gehan’s weight
  PW Prentice-Wilcoxon weight
  GP GP class weight
  userdefined a user defined weight provided as a vector with length equal to the number of subject. This argument is still under-development.
eqType a character string specifying the type of the estimating equation used to obtain the regression parameters. The following are permitted:
  is Regression parameters are estimated by directly solving the induced-smoothing estimating equations. This is the default and recommended method.
  ns Regression parameters are estimated by directly solving the nonsmooth estimating equations.
  mis Regression parameters are estimated by iterating the monotonic smoothed Gehan-based estimating equations. This is typical when rankWeights = "PW" and rankWeights = "GP".
  mns Regression parameters are estimated by iterating the monotonic non-smoothed Gehan-based estimating equations. This is typical when rankWeights = "PW" and rankWeights = "GP".
se a character string specifying the estimating method for the variance-covariance matrix. The following are permitted:
  NULL if se is specified as NULL, the variance-covariance matrix will not be computed.
bootstrap nonparametric bootstrap.
MB multiplier resampling.
ZLCF Zeng and Lin’s approach with closed form V, see Details.
ZLMB Zeng and Lin’s approach with empirical V, see Details.
sHCF Huang’s approach with closed form V, see Details.
sHMB Huang’s approach with empirical V, see Details.
ISCF Johnson and Strawderman’s sandwich variance estimates with closed form V, see Details.
ISMB Johnson and Strawderman’s sandwich variance estimates with empirical V, see Details.

control controls equation solver, maxiter, tolerance, and resampling variance estimation.

The available equation solvers are BBsolve and dfsane of the BB package. The default algorithm control parameters are used when these functions are called. However, the monotonicity parameter, M, can be specified by users via the control list. When M is specified, the merit parameter, noimp, is set at

$$10 \times M$$

The readers are referred to the BB package for details. Instead of searching for the zero crossing, options including BBoptim and optim will return solution from maximizing the corresponding objective function. When se = "bootstrap" or se = "MB", an additional argument parallel = TRUE can be specified to enable parallel computation. The number of CPU cores can be specified with parC1, the default number of CPU cores is the integer value of detectCores() / 2.

Details

When se = "bootstrap" or se = "MB", the variance-covariance matrix is estimated through a bootstrap fashion. Bootstrap samples that failed to converge are removed when computing the empirical variance matrix. When bootstrap is not called, we assume the variance-covariance matrix has a sandwich form

$$\Sigma = A^{-1}V(A^{-1})^T,$$

where V is the asymptotic variance of the estimating function and A is the slope matrix. In this package, we provide several methods to estimate the variance-covariance matrix via this sandwich form, depending on how V and A are estimated. Specifically, the asymptotic variance, V, can be estimated by either a closed-form formulation (CF) or through bootstrap the estimating equations (MB). On the other hand, the methods to estimate the slope matrix A are the inducing smoothing approach (IS), Zeng and Lin’s approach (ZL), and the smoothed Huang’s approach (sH).

Value

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

beta A vector of beta estimates
covmat A list of covariance estimates
**convergence** An integer code indicating type of convergence.
- 0 indicates successful convergence.
- 1 indicates that the iteration limit `maxit` has been reached.
- 2 indicates failure due to stagnation.
- 3 indicates error in function evaluation.
- 4 is failure due to exceeding 100 step length reductions in line-search.
- 5 indicates lack of improvement in objective function.

**bhist** When variance = "MB", bhist gives the bootstrap samples.

**References**


**Examples**

```r
## Simulate data from an AFT model
datgen <- function(n = 100) {
  x1 <- rbinom(n, 1, 0.5)
  x2 <- rnorm(n)
  e <- rnorm(n)
  tt <- exp(2 + x1 + x2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
             x1 = x1, x2 = x2, id = 1:n)
}
set.seed(1); dat <- datgen(n = 50)
summary(aftsrr(Surv(Time, status) ~ x1 + x2, data = dat, se = c("ISMB", "ZLMB"), B = 10))

## Data set with sampling weights
data(nwtco, package = "survival")
subinx <- sample(1:nrow(nwtco), 668, replace = FALSE)
nwtco$subcohort <- 0
nwtco$subcohort[subinx] <- 1
pn <- mean(nwtco$subcohort)
nwtco$hi <- nwtco$rel + (1 - nwtco$rel) * nwtco$subcohort / pn
```
nwtco$age12 <- nwtco$age / 12
nwtco$study <- factor(nwtco$study)
nwtco$histol <- factor(nwtco$histol)
sub <- nwtco[subinx,]
fit <- aftsrr(Surv(edrel, rel) ~ histol + age12 + study, id = seqno,
    weights = hi, data = sub, B = 10, se = c("ISMB", "ZLMB"),
    subset = stage == 4)
summary(fit)
confint(fit)

---

export_is.Surv is.Surv function imported from survival

**Description**

This function is imported from the survival package. See *is.Surv*.

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export_Surv Surv function imported from survival

**Description**

This function is imported from the survival package. See *Surv*.

---

QIC Quasi Information Criterion

**Description**

Implementation based on MES::QIC.geeglm

**Usage**

QIC(object)

**Arguments**

object is a aftgee fit
Examples

## Simulate data from an AFT model with possible depended response

datgen <- function(n = 100, tau = 0.3, dim = 2) {
  x1 <- rbinom(dim * n, 1, 0.5)
  x2 <- rnorm(dim * n)
  e <- c(t(exp(MASS::mvrnorm(n = n, mu = rep(0, dim), Sigma = tau + (1 - tau) * diag(dim)))))
  tt <- exp(2 + x1 + x2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
              x1 = x1, x2 = x2, id = rep(1:n, each = dim))
}

set.seed(1); dat <- datgen(n = 50, dim = 2)
fm <- Surv(Time, status) ~ x1 + x2
fit1 <- aftgee(fm, data = dat, id = id, corstr = "ind")
fit2 <- aftgee(fm, data = dat, id = id, corstr = "ex")

QIC(fit1)
QIC(fit2)
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