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Description A collection of model checking methods for semiparametric accelerated failure time (AFT) models under the rank-based approach. For the (computational) efficiency, Gehan's weight is used. It provides functions to verify whether the observed data fit the specific model assumptions such as a functional form of each covariate, a link function, and an omnibus test. The p-value offered in this package is based on the Kolmogorov-type supremum test and the variance of the proposed test statistics is estimated through the re-sampling method. Furthermore, a graphical technique to compare the shape of the observed residual to a number of the approximated realizations is provided. See the following references; A general model-checking procedure for semiparametric accelerated failure time models, Statistics and Computing, 34 (3), 117 <doi:10.1007/s11222-024-10431-7>; Diagnostics for semiparametric accelerated failure time models with R package 'afttest', Journal of Statistical Software, to appear, <doi:10.48550/arXiv.2511.09823>.

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`afttest` *Model Diagnostics for Semiparametric AFT Models*

Description

Performs model-checking procedures for a semiparametric AFT model. This is a generic function with methods for formulas and fitted objects from the **aftgee** package.

Usage

```
afttest(object, ...)
```

Arguments

`object`	A formula or a fitted model object (e.g., from `aftsrr` or `aftgee`).
`...`	Other arguments passed to methods. See the documentation for `afttest.formula`, `afttest.aftsrr`, and `afttest.aftgee` for details.

Value

An object of class `afttest` or `htest`. An object is a list containing at least the following components:

beta a vector of beta estimates based on `estMethod`

hypothesis null hypothesis for each `testType`

SE_process estimated standard error of the observed process

obs_process observed process

apprx_process approximated process

obs_std_process standardized observed process

apprx_std_process standardized approximated processes

p_value obtained by the unstandardized test

p_std_value obtained by the standardized test

DF a data frame of observed failure time, right censoring indicator, covariates (scaled), time-transformed residual based on beta estimates

npath the number of sample paths

testType testType

eqType eqType

estMethod estMethod

npathsave npathsave

For an omnibus test, the observed process and the realizations are composed of the n by n matrix where rows represent the t and columns represent the x in the time-transformed residual order. The observed process and the simulated processesfor checking a functional form and a link function are given by the n by 1 vectorwhich is a function of x in the time-transformed residual order.

Examples

```
library(survival)
library(aftgee)
library(afttest)

datgen <- function(n = 100) {
  z1 <- rbinom(n, 1, 0.5)
  z2 <- rnorm(n)
  e <- rnorm(n)
  tt <- exp(2 + z1 + z2 + 0.5 * z2^2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
             z1 = z1, z2 = z2, id = 1:n)
}
set.seed(1)
simdata <- datgen(300)

# ------------------------------------------------
# Method 1: Formula (Runs quickly for CRAN tests)
```

```
# ------------------------------------------------
result_form <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                       npath = 50, testType = "covForm", estMethod = "rr",
                       eqType = "ns", covTested = "z2", npathsave = 50,
                       linApprox = TRUE, seed = 1)
print(result_form)
plot(result_form, std = TRUE)


# ------------------------------------------------
# Method 2: Fitted aftsrr object (Induced Smoothing)
# ------------------------------------------------
fit_srr <- aftsrr(Surv(Time, status) ~ z1 + z2, data = simdata,
                  eqType = "is", rankWeights = "gehan")
result_srr <- afttest(fit_srr, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
summary(result_srr)
plot(result_srr, std = FALSE)

# ------------------------------------------------
# Method 3: Fitted aftgee object (Least Squares)
# ------------------------------------------------
fit_gee <- aftgee(Surv(Time, status) ~ z1 + z2, data = simdata)
result_gee <- afttest(fit_gee, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
print(result_gee)

# ------------------------------------------------
# Method 4: Standard Resampling (linApprox = FALSE)
# ------------------------------------------------
result_resamp <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                         npath = 100, testType = "covForm", estMethod = "rr",
                         eqType = "ns", covTested = "z2", npathsave = 50,
                         linApprox = FALSE, seed = 1)
summary(result_resamp)
```

`afttest.aftgee` *Model Diagnostics for Generalized Estimating Equation (aftgee) Objects*

Description

Model Diagnostics for Generalized Estimating Equation (aftgee) Objects

Usage

```
## S3 method for class 'aftgee'
```

```
afttest(
  object,
  data,
  npath = 200,
  testType = "omnibus",
  eqType = "ls",
  covTested = 1,
  npathsave = 50,
  linApprox = TRUE,
  seed = NULL,
  ...
)
```

Arguments

`object`	A fitted model object of class `aftgee` from the **aftgee** package.
`data`	An optional data frame in which to interpret the variables occurring in the formula.
`npath`	An integer value specifying the number of approximated processes. The default is given by 200.
`testType`	A character string specifying the type of the test. The following are permitted: `omnibus` an omnibus test `link` a link function test `covForm` a functional form of a covariate
`eqType`	The estimating-equation type used for the diagnostic procedure. For a fitted `aftgee` object, this is fixed to `"ls"`. Any other supplied value is ignored with a warning.
`covTested`	A character string specifying the covariate which will be tested. The argument `covTested` is necessary only if `testType` is `covForm`. The default option for `covTested` is given by "1", which represents the first covariate in the formula argument.
`npathsave`	An integer value specifying the number of paths saved among all the paths. The default is given by 50. Note that it requires a lot of memory if saving all sampled paths (N by N matrix for each npath, and so npath*N*N elements).
`linApprox`	A logical value. If `TRUE`, the multiplier bootstrap is computed using the asymptotic linear approximation, which is significantly faster. If `FALSE`, the estimating equations are solved numerically for each bootstrap replication. Defaults to `TRUE`.
`seed`	An optional integer specifying the random seed for reproducibility.
`...`	Other arguments passed to methods.

`afttest.aftsrr` *Model Diagnostics for Smooth Rank Regression (aftsrr) Objects*

Description

Model Diagnostics for Smooth Rank Regression (aftsrr) Objects

Usage

```
## S3 method for class 'aftsrr'
afttest(
  object,
  data,
  npath = 200,
  testType = "omnibus",
  eqType = NULL,
  covTested = 1,
  npathsave = 50,
  linApprox = TRUE,
  seed = NULL,
  ...
)
```

Arguments

`object`	A fitted model object of class `aftsrr` from the **aftgee** package.
`data`	An optional data frame in which to interpret the variables occurring in the formula.
`npath`	An integer value specifying the number of approximated processes. The default is given by 200.
`testType`	A character string specifying the type of the test. The following are permitted: `omnibus` an omnibus test `link` a link function test `covForm` a functional form of a covariate
`eqType`	An optional character string specifying the type of the estimating equation. For a fitted `aftsrr` object, the estimating equation used in the fitted object is retained. If it cannot be identified from the fitted object, `"ns"` is used. The permitted values are `"ns"` and `"is"`. If a different value from that used in the fitted object is supplied, it is ignored with a warning.
`covTested`	A character string specifying the covariate which will be tested. The argument `covTested` is necessary only if `testType` is `covForm`. The default option for `covTested` is given by "1", which represents the first covariate in the formula argument.

npathsave	An integer value specifying the number of paths saved among all the paths. The default is given by 50. Note that it requires a lot of memory if saving all sampled paths (N by N matrix for each npath, and so npath*N*N elements).
linApprox	A logical value. If TRUE, the multiplier bootstrap is computed using the asymptotic linear approximation, which is significantly faster. If FALSE, the estimating equations are solved numerically for each bootstrap replication. Defaults to TRUE.
seed	An optional integer specifying the random seed for reproducibility.
...	Other arguments passed to methods.

`afttest.formula` *Model Diagnostics for AFT Models using Formulas*

Description

Model Diagnostics for AFT Models using Formulas

Usage

```
## S3 method for class 'formula'
afttest(
  object,
  data,
  npath = 200,
  testType = "omnibus",
  estMethod = "rr",
  eqType = "ns",
  covTested = 1,
  npathsave = 50,
  linApprox = TRUE,
  seed = NULL,
  ...
)
```

Arguments

object	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.
npath	An integer value specifying the number of approximated processes. The default is given by 200.
testType	A character string specifying the type of the test. The following are permitted:
	`omnibus` an omnibus test

`link` a link function test

`covForm` a functional form of a covariate

`estMethod` A character string specifying the type of the estimator used. The readers are referred to the **aftgee** package for details. The following are permitted:

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

`rr` Accelerated Failure Time with Smooth Rank Regression

`eqType` A character string specifying the type of the estimating equation used to obtain the regression parameters. The readers are referred to the **aftgee** package for details. The following are permitted:

`ns` Regression parameters are estimated by directly solving the nonsmooth estimating equations.

`is` Regression parameters are estimated by directly solving the induced-smoothing estimating equations.

`covTested` A character string specifying the covariate which will be tested. The argument `covTested` is necessary only if `testType` is `covForm`. The default option for `covTested` is given by "1", which represents the first covariate in the formula argument.

`npathsave` An integer value specifying the number of paths saved among all the paths. The default is given by 50. Note that it requires a lot of memory if saving all sampled paths (N by N matrix for each npath, and so npath*N*N elements).

`linApprox` A logical value. If `TRUE`, the multiplier bootstrap is computed using the asymptotic linear approximation, which is significantly faster. If `FALSE`, the estimating equations are solved numerically for each bootstrap replication. Defaults to `TRUE`.

`seed` An optional integer specifying the random seed for reproducibility.

`...` Other arguments passed to methods.

`plot.afttest` *Plotting Method for Semiparametric AFT Model Diagnostics*

Description

Plotting Method for Semiparametric AFT Model Diagnostics

Usage

```
## S3 method for class 'afttest'
plot(x, npath = 50, std = TRUE, quantile = NULL, ...)
```

Arguments

x	An object of class afttest.
npath	A numeric value specifying the number of approximated processes to plot. The default is set to 50.
std	A logical value specifying if the graph is based on the standardized test statistics (TRUE) or unstandardized (FALSE). The default is TRUE.
quantile	A numeric vector specifying 5 quantiles within the range [0,1]. The default is set to c(0.1, 0.25, 0.5, 0.75, 0.9).
...	Other arguments passed to methods for future extension.

Value

plot.afttest returns a plot based on the testType:

omnibus an x of the omnibus test is the form of n by n matrix, some quantiles of x, which are used in weight, are plotted for graphs, i.e. 10%, 25%, 50%, 75%, and 90% are used by default.

link an x of the link function test is the form of n by 1 matrix

covForm an x of the functional form test is the form of n by 1 matrix

See the documentation of **ggplot2** and **gridExtra** for details.

Examples

```
library(survival)
library(aftgee)
library(afttest)

datgen <- function(n = 100) {
  z1 <- rbinom(n, 1, 0.5)
  z2 <- rnorm(n)
  e <- rnorm(n)
  tt <- exp(2 + z1 + z2 + 0.5 * z2^2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
             z1 = z1, z2 = z2, id = 1:n)
}
set.seed(1)
simdata <- datgen(300)

# ------------------------------------------------
# Method 1: Formula (Runs quickly for CRAN tests)
# ------------------------------------------------
result_form <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                       npath = 50, testType = "covForm", estMethod = "rr",
                       eqType = "ns", covTested = "z2", npathsave = 50,
                       linApprox = TRUE, seed = 1)
print(result_form)
plot(result_form, std = TRUE)
```

```
# ------------------------------------------------
# Method 2: Fitted aftsrr object (Induced Smoothing)
# ------------------------------------------------
fit_srr <- aftsrr(Surv(Time, status) ~ z1 + z2, data = simdata,
                  eqType = "is", rankWeights = "gehan")
result_srr <- afttest(fit_srr, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
summary(result_srr)
plot(result_srr, std = FALSE)

# ------------------------------------------------
# Method 3: Fitted aftgee object (Least Squares)
# ------------------------------------------------
fit_gee <- aftgee(Surv(Time, status) ~ z1 + z2, data = simdata)
result_gee <- afttest(fit_gee, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
print(result_gee)

# ------------------------------------------------
# Method 4: Standard Resampling (linApprox = FALSE)
# ------------------------------------------------
result_resamp <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                         npath = 100, testType = "covForm", estMethod = "rr",
                         eqType = "ns", covTested = "z2", npathsave = 50,
                         linApprox = FALSE, seed = 1)
summary(result_resamp)
```

`print.afttest` *Print Method for Semiparametric AFT Model Diagnostics*

Description

Print Method for Semiparametric AFT Model Diagnostics

Usage

```
## S3 method for class 'afttest'
print(x, ...)
```

Arguments

`x`	An object of class `afttest`.
`...`	Other arguments passed to methods.

Value

`print.afttest` returns a summary of an `afttest` fit.

Examples

```
library(survival)
library(aftgee)
library(afttest)

datgen <- function(n = 100) {
  z1 <- rbinom(n, 1, 0.5)
  z2 <- rnorm(n)
  e <- rnorm(n)
  tt <- exp(2 + z1 + z2 + 0.5 * z2^2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
             z1 = z1, z2 = z2, id = 1:n)
}
set.seed(1)
simdata <- datgen(300)

# ------------------------------------------------
# Method 1: Formula (Runs quickly for CRAN tests)
# ------------------------------------------------
result_form <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                       npath = 50, testType = "covForm", estMethod = "rr",
                       eqType = "ns", covTested = "z2", npathsave = 50,
                       linApprox = TRUE, seed = 1)
print(result_form)
plot(result_form, std = TRUE)


# ------------------------------------------------
# Method 2: Fitted aftsrr object (Induced Smoothing)
# ------------------------------------------------
fit_srr <- aftsrr(Surv(Time, status) ~ z1 + z2, data = simdata,
                  eqType = "is", rankWeights = "gehan")
result_srr <- afttest(fit_srr, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
summary(result_srr)
plot(result_srr, std = FALSE)

# ------------------------------------------------
# Method 3: Fitted aftgee object (Least Squares)
# ------------------------------------------------
fit_gee <- aftgee(Surv(Time, status) ~ z1 + z2, data = simdata)
result_gee <- afttest(fit_gee, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
print(result_gee)

# ------------------------------------------------
# Method 4: Standard Resampling (linApprox = FALSE)
# ------------------------------------------------
result_resamp <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
```

```
                          npath = 100, testType = "covForm", estMethod = "rr",
                          eqType = "ns", covTested = "z2", npathsave = 50,
                          linApprox = FALSE, seed = 1)
summary(result_resamp)
```

---

summary.afttest *Summary Method for Semiparametric AFT Model Diagnostics*

Description

Summary Method for Semiparametric AFT Model Diagnostics

Usage

```
## S3 method for class 'afttest'
summary(object, ...)
```

Arguments

object	An object of class afttest.
...	Other arguments passed to methods.

Value

summary.afttest returns a detailed summary of an afttest fit.

Examples

```
library(survival)
library(aftgee)
library(afttest)

datgen <- function(n = 100) {
  z1 <- rbinom(n, 1, 0.5)
  z2 <- rnorm(n)
  e <- rnorm(n)
  tt <- exp(2 + z1 + z2 + 0.5 * z2^2 + e)
  cen <- runif(n, 0, 100)
  data.frame(Time = pmin(tt, cen), status = 1 * (tt < cen),
             z1 = z1, z2 = z2, id = 1:n)
}
set.seed(1)
simdata <- datgen(300)

# ------------------------------------------------
# Method 1: Formula (Runs quickly for CRAN tests)
# ------------------------------------------------
result_form <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
```

```
                        npath = 50, testType = "covForm", estMethod = "rr",
                        eqType = "ns", covTested = "z2", npathsave = 50,
                        linApprox = TRUE, seed = 1)
print(result_form)
plot(result_form, std = TRUE)


# ------------------------------------------------
# Method 2: Fitted aftsrr object (Induced Smoothing)
# ------------------------------------------------
fit_srr <- aftsrr(Surv(Time, status) ~ z1 + z2, data = simdata,
                  eqType = "is", rankWeights = "gehan")
result_srr <- afttest(fit_srr, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
summary(result_srr)
plot(result_srr, std = FALSE)

# ------------------------------------------------
# Method 3: Fitted aftgee object (Least Squares)
# ------------------------------------------------
fit_gee <- aftgee(Surv(Time, status) ~ z1 + z2, data = simdata)
result_gee <- afttest(fit_gee, data = simdata, npath = 100, testType = "covForm",
                      covTested = "z2", npathsave = 50,
                      linApprox = TRUE, seed = 1)
print(result_gee)

# ------------------------------------------------
# Method 4: Standard Resampling (linApprox = FALSE)
# ------------------------------------------------
result_resamp <- afttest(Surv(Time, status) ~ z1 + z2, data = simdata,
                         npath = 100, testType = "covForm", estMethod = "rr",
                         eqType = "ns", covTested = "z2", npathsave = 50,
                         linApprox = FALSE, seed = 1)
summary(result_resamp)
```

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