Package 'xwf'

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Title Extrema-Weighted Feature Extraction

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Description Extrema-weighted feature extraction for varying length functional data. Functional data analysis method that performs dimensionality reduction based on predefined features and allows for quantile weighting. Method implemented as presented in Van den Boom et al. (2017) <arXiv:1709.10467>.

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Imports mgcv

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R topics documented:

default_psi *Default psi list*

Description

List with the same local feature functions psi as in the original paper

Usage

```
default_psi()
```

Value

List with 4 different local features psi

Examples

```
default_psi()
```

xwf *Compute XWFs*

Description

Compute extrema-weighted features based on functions, predefined local features, and weighting functions

Usage

```
xwf(xx, t, n.i, psi, w = function(t, i) ifelse(left, min(1, (1 -
  F(xx[[i]](t)))/(1 - b)), min(1, F(xx[[i]](t))/b)), b = 0.5, F = NULL,
  t.min = NULL, t.max = NULL, t.range = NULL, rel.shift = 0.001,
  left = TRUE)
```

Arguments

xx	List of function for which to compute the XWFs
t	Matrix containing the times at which the functions xx were measured: Element (i,j) contains the time of the j-th measurement of the i-th function.
n.i	Vector containing the number of measurements for each function. The first n.i[i] elements of the i-th row of t should not be NA.
psi	Predefined local feature which is a function of a function (first argument) and a measurement time (second argument)
w	Weighting function. The default is the one used in the original paper.

b	Parameter of the weighting function. See original paper for details. Ignored if weighting function w is not the default.
F	CDF of the values of the functions xx. Ignored if weighting function w is not the default.
t.min	Vector with time of first measurement for each function. Computed from t if omitted but providing it saves computational cost.
t.max	Analogous to t.min but now the time of the last measurement.
t.range	Vector with differences between t.max and t.min. Can be supplied to avoid recomputation.
rel.shift	Optional relative reduction of the integration range to avoid instabilities at the end of the integration ranges. Set to 0 if no such correction is desired.
left	Boolean specifying whether the left (TRUE) or right (FALSE) extrema-weighted features should be computed: Left and right refer to the weighting function. Ignored if weighting function w is not the default.

Value

Vector containing the extrema-weighted features obtained by numerical integration for each of the functions.

Examples

```
xwf(
xx = list(function(t) t),
t = (1:10)/10,
n.i = 10,
psi = function(x, t) x(t),
b = .2,
F = function(x) x
)
```

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xwfGAM *Evaluate the GAM*

Description

Evaluate the generalized additive model for a set of computed extrema-weighted features

Usage

```
xwfGAM(wL, wR, y, z = NULL)
```

Arguments

wL	Matrix with left extrema-weighted features
wR	Matrix with right extrema-weighted features
y	Binary vector with outcomes
z	Optional matrix z with extra, linear predictors

Examples

```
xwf:::xwfGAM(wL = rep(1:45, 10), wR = rep(1:90, 5), y = c(rep(0:1, 225)))
```

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xwfGridsearch *Adaptive grid search*

Description

Adaptive grid search to optimize the weighting functions in the extrema-weighted features.

Usage

```
xwfGridsearch(y, xx, t, n.i, psi.list = default_psi(), F = NULL, z = NULL,
  iter = 3, w = function(t, i, b, left) ifelse(left, min(1, (1 -
  F(xx[[i]](t)))/(1 - b)), min(1, F(xx[[i]](t))/b)), rel.shift = 0.001,
  progressbar = TRUE)
```

Arguments

y	Vector with binary outcomes data
xx	List of functions for which to compute the XWFs
t	Matrix containing the times at which the functions xx were measured: Element (i,j) contains the time of the j-th measurement of the i-th function.
n.i	Vector containing the number of measurements for each function. The first n.i[i] elements of the i-th row of t should not be NA.
psi.list	List of predefined local features which are functions of a function (first argument) and a measurement time (second argument)
F	CDF of the values of the functions xx. Ignored if weighting function w is not the default.
z	Optional matrix with covariates to be included as linear predictors in the generalized additive model
iter	Number of levels in the adaptive grid search. The resolution in b obtained is 2^-1-iter.
w	Weighting function. The default is the one used in the original paper. See the default for what the roles of its 3 arguments are.

rel.shift	Optional relative reduction of the integration range to avoid instabilities at the end of the integration ranges. Set to 0 if no such correction is desired.
progressbar	Boolean specifying whether a progress bar indicating what level of the adaptive grid has been completed should be displayed.

Value

List containing the final XWFs (wL and wR), the parameters for the optimal weighting functions (b.left and b.right), and the gmcv::gamObject corresponding to the final optimal generalized additive model fit.

Examples

```
# Data simulation similar to Section 3.2 of the paper

# Sample size
n <- 100

# Length of trajectories
n.i <- rep(5, n)
max.n.i <- max(n.i)

# Times
t <- matrix(NA_integer_, nrow = n, ncol = max.n.i)
for(i in 1:n) t[i, 1:n.i[i]] <- 1:n.i[i]


# Sample periods
phi <- runif(n = n, min = 1, max = 10)

# Sample offsets
m <- 10*runif(n = n)

# Blood pressure measurements
x <- t
for(i in 1:n) x[i, 1:n.i[i]] <- sin(phi[i] * 2*pi/max.n.i * t[i, 1:n.i[i]]) + m[i]

# Matrix with covariates z
q <- 2 # Number of covariates
z <- matrix(rnorm(n = n*q), nrow = n, ncol = q)

# Generate outcomes
temp <- phi*min(m, 7)
temp <- 40*temp
prob <- 1/(1+exp( 2*( median(temp)-temp ) ))
y <- rbinom(n = n, size = 1, prob = prob)

xx <- list()
for(i in 1:n) xx[[i]] <- approxfun(x = t[i,1:n.i[i]], y = x[i,1:n.i[i]], rule = 2)

# Estimate f
weights <- matrix(1/n.i, ncol = max.n.i, nrow = n)[!is.na(t)]
```

```
f <- density(
x = t(sapply(X = 1:n, FUN = function(i) c(xx[[i]](t[i,1:n.i[i]]), rep(NA, max.n.i-n.i[i])))),
weights = weights/sum(weights),
na.rm = T
)

# Define CDF of f, F
CDF <- c(0)
for(i in 2:length(f$x)) CDF[i] <- CDF[i-1]+(f$x[i]-f$x[i-1])*(f$y[i]+f$y[i-1])/2
F <- approxfun(x = f$x, y = CDF/max(CDF), yleft = 0, yright = 1)

psi <- list(
  function(x, t) abs(x(t)-x(t-1))
)

XWFresult <- xwfGridsearch(y = y, xx = xx, t = t, n.i = n.i, psi.list = psi, F = F, z = z)

summary(XWFresult$GAMobject)
XWFresult$b.left
XWFresult$b.right
```

`XWFpValues` *p-value computation for XWFs*

Description

Randomization method to compute p-values for an optimized extrema-weighted features generalized additive model fit.

Usage

```
XWFpValues(GAMobject, xx, t, n.i, psi.list = NULL, F, z = NULL,
  w = function(t, i, b, left) ifelse(left, min(1, (1 - F(xx[[i]](t)))/(1 -
  b)), min(1, F(xx[[i]](t))/b)), n.boot = 100, progressbar = TRUE)
```

Arguments

`GAMobject`	The GAMobject returned by `xwfGridsearch`
`xx`	List of function for which to compute the XWFs
`t`	Matrix containing the times at which the functions xx were measured: Element (i,j) contains the time of the j-th measurement of the i-th function.
`n.i`	Vector containing the number of measurements for each function. The first n.i[i] elements of the i-th row of t should not be NA.
`psi.list`	List of predefined local features which are functions of a function (first argument) and a measurement time (second argument)

F	CDF of the values of the functions xx. Ignored if weighting function w is not the default.
z	Optional matrix with covariates to be included as linear predictors in the generalized additive model
w	Weighting function. The default is the one used in the original paper. See the default for what the roles of its 3 arguments are.
n.boot	Number for randomizations used to obtain the p-values. The resolution of the p-values is 1/n.boot
progressbar	Boolean specifying whether a progress bar indicating which randomizations have been completed should be displayed.

Value

Named vector with p-values

Examples

```
# Data simulation similar to Section 3.2 of the paper

# Sample size
n <- 100

# Length of trajectories
n.i <- rep(5, n)
max.n.i <- max(n.i)

# Times
t <- matrix(NA_integer_, nrow = n, ncol = max.n.i)
for(i in 1:n) t[i, 1:n.i[i]] <- 1:n.i[i]


# Sample periods
phi <- runif(n = n, min = 1, max = 10)

# Sample offsets
m <- 10*runif(n = n)

# Blood pressure measurements
x <- t
for(i in 1:n) x[i, 1:n.i[i]] <- sin(phi[i] * 2*pi/max.n.i * t[i, 1:n.i[i]]) + m[i]

# Matrix with covariates z
q <- 2 # Number of covariates
z <- matrix(rnorm(n = n*q), nrow = n, ncol = q)

# Generate outcomes
temp <- phi*min(m, 7)
temp <- 40*temp
prob <- 1/(1+exp( 2*( median(temp)-temp ) ))
y <- rbinom(n = n, size = 1, prob = prob)
```

```
xx <- list()
for(i in 1:n) xx[[i]] <- approxfun(x = t[i,1:n.i[i]], y = x[i,1:n.i[i]], rule = 2)

# Estimate f
weights <- matrix(1/n.i, ncol = max.n.i, nrow = n)[!is.na(t)]
f <- density(
x = t(sapply(X = 1:n, FUN = function(i) c(xx[[i]](t[i,1:n.i[i]]), rep(NA, max.n.i-n.i[i])))),
weights = weights/sum(weights),
na.rm = T
)

# Define CDF of f, F
CDF <- c(0)
for(i in 2:length(f$x)) CDF[i] <- CDF[i-1]+(f$x[i]-f$x[i-1])*(f$y[i]+f$y[i-1])/2
F <- approxfun(x = f$x, y = CDF/max(CDF), yleft = 0, yright = 1)

psi <- list(
  function(x, t) abs(x(t)-x(t-1))
)

XWFresult <- xwfGridsearch(y = y, xx = xx, t = t, n.i = n.i, psi.list = psi, F = F, z = z)

XWFpValues(
GAMobject = XWFresult$GAMobject,
xx = xx,
t = t,
n.i = n.i,
psi.list = psi,
F = F,
z = z,
n.boot = 3
)
```

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