Package ‘gamlss.add’

March 28, 2024

Title Extra Additive Terms for Generalized Additive Models for Location Scale and Shape

Version 5.1-13

Date 2024-03-17

Description Interface for extra smooth functions including tensor products, neural networks and decision trees.

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URL https://www.gamlss.com/

BugReports https://github.com/gamlss-dev/gamlss.add/issues

Depends R (>= 2.15.0), gamlss.dist, gamlss (>= 2.4.0), mgcv, nnet, rpart, graphics, stats, utils, grDevices, methods

Suggests lattice

LazyLoad yes

NeedsCompilation no

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Repository CRAN

Date/Publication 2024-03-28 08:50:07 UTC

R topics documented:

`gamlss.add-package` *Extra Additive Terms for Generalized Additive Models for Location Scale and Shape*

Description

Interface for extra smooth functions including tensor products, neural networks and decision trees.

Details

The DESCRIPTION file:

Package:	gamlss.add
Title:	Extra Additive Terms for Generalized Additive Models for Location Scale and Shape
Version:	5.1-13
Date:	2024-03-17
Authors@R:	c(person("Mikis", "Stasinopoulos", role = c("aut", "cre"), email = "d.stasinopoulos@gre.ac.uk", comment = c(
Description:	Interface for extra smooth functions including tensor products, neural networks and decision trees.
License:	GPL-2 | GPL-3
URL:	https://www.gamlss.com/
BugReports:	https://github.com/gamlss-dev/gamlss.add/issues
Depends:	R (>= 2.15.0), gamlss.dist, gamlss (>= 2.4.0), mgcv, nnet, rpart, graphics, stats, utils, grDevices, methods
Suggests:	lattice
LazyLoad:	yes
Author:	Mikis Stasinopoulos [aut, cre] (<https://orcid.org/0000-0003-2407-5704>), Robert Rigby [aut] (<https://orcid.c
Maintainer:	Mikis Stasinopoulos <d.stasinopoulos@gre.ac.uk>

Index of help topics:

```
centilesTwo             Centiles contour plots in GAMLSS
fitFixedKnots           Functions to Fit Univariate Break Point
                        Regression Models
fk                      A function to fit break points within GAMLSS
ga                      A interface functions to use Simon Wood's gam()
                        and bam() functions within GAMLSS
gamlss.add-package      Extra Additive Terms for Generalized Additive
                        Models for Location Scale and Shape
gamlss.fk               Support for Function fk()
```

```
gamlss.ga          Support for Function ga() and ba()
gamlss.nn          Support for Function nn()
nn                 A interface function to use nnet() function
                   within GAMLSS
plot.nnet          Plotting fitted neural networks
tr                 A interface function to use rpart() function
                   within GAMLSS
```

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References

Ripley, B. D. (1996) *Pattern Recognition and Neural Networks*. Cambridge.

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

Therneau T. M., Atkinson E. J. (2015) An Introduction to Recursive Partitioning Using the RPART Routines. Vignette in package rpart.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S*. Fourth edition. Springer.

Wood S.N. (2006) *Generalized Additive Models: An Introduction with R*. Chapman and Hall/CRC Press.

See Also

`gamlss`, `gamlss.family`

Examples

```
library(gamlss)
gn <- gamlss(R~ga(~te(Fl,A)), data=rent, family=GA)
```

centilesTwo *Centiles contour plots in GAMLSS*

Description

This function centilesTwo() plots two dimensional centiles contour plots for GAMLSS models.

Usage

```
centilesTwo(object, grid.x1, grid.x2, x1.name, x2.name,
       cent = 0.05, dist = 0.01, points = TRUE,
       other = list(), point.col = 1, point.pch = ".",
       image = FALSE, image.col = heat.colors(12), ...)
```

Arguments

object	an gamlss object
grid.x1	grid values for x-variable one
grid.x2	grid values for x-variable two
x1.name	the name of x-variable on
x2.name	the name of x-variable two
cent	the required centiles
dist	the distance
points	whether to plot the data points
other	a list having other explanatory variables at fixed values
point.col	the colour of the data points
point.pch	the type of the data point
image	whether to plot using the image9 function
image.col	the colour scheme
...	for extra arguments for the contour() function

Details

The function uses the function exclude.too.far() of the package **mgcv**.

Value

Produce a contour plot.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby, Fernanda De Bastiani

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

Wood S.N. (2006) *Generalized Additive Models: An Introduction with R*. Chapman and Hall/CRC Press.

See Also

`centiles`

Examples

```
## Not run:
data(plasma)
m1 <- gamlss(betadiet ~ ga(~te(age, fiber)), sigma.formula = ~1,
    nu.formula = ~ga(~te(age, fiber)), tau.formula = ~1,
    family = BCTo, data = plasma)
centilesTwo(m1, 18:90, seq(2.5,38, 0.5), age, fiber, cent=0.05, dist=.1,
            xlab="age", ylab='fiber')
centilesTwo(m1, 18:90, seq(2.5,38, 0.5), age, fiber, cent=0.95, dist=.1)

## End(Not run)
```

`fitFixedKnots` *Functions to Fit Univariate Break Point Regression Models*

Description

There are two main functions here. The functions `fitFixedKnots` allows the fit a univariate regression using piecewise polynomials with "known" break points while the function `fitFreeKnots` estimates the break points.

Usage

```
fitFixedKnots(y, x, weights = NULL, knots = NULL, data = NULL, degree = 3,
              fixed = NULL, base=c("trun","Bbase"), ...)
fitFreeKnots(y, x, weights = NULL, knots = NULL, degree = 3, fixed =
                   NULL, trace = 0, data = NULL, base=c("trun","Bbase"), ...)
```

Arguments

x	the x variable (explanatory)
y	the response variable
weights	the prior weights
knots	the position of the interior knots for `fitFixedKnots` or starting values for `fitFreeKnots`
data	the data frame
degree	the degree if the piecewise polynomials
fixed	this is to be able to fit fixed break points
base	The basis for the piecewise polynomials, `turn` for truncated (default) and `Bbase` for B-base piecewise polynomials
trace	controlling the trace of of `optim()`
...	for extra arguments

Details

The functions `fitFreeKnots()` is loosely based on the `curfit.free.knot()` function of package **DierckxSpline** of Sundar Dorai-Raj and Spencer Graves.

Value

The functions `fitFixedKnots` and `fitFreeKnots` return an object `FixBreakPointsReg` and `FreeBreakPointsReg` respectively with the following items:

fitted.values	the fitted values of the model
residuals	the residuals of the model
df	the degrees of freedom fitted in the model
rss	the residuals sum of squares
knots	the knots used in creating the beta-function base
fixed	the fixed break points if any
breakPoints	the interior (estimated) break points (or knots)
coef	the coefficients of the linear part of the model
degree	the degree of the piecewise polynomial
y	the y variable
x	the x variable
w	the prior weights

Note

The prediction function in piecewise polynomials using the B-spline basis is tricky because by adding the newdata for x to the current one the B-basis function for the piecewise polynomials changes. This does not seems to be the case with the truncated basis, that is, when the option `base="turn"` is used (see the example below).

If the newdata are outside the range of the old x then there could a considerable discrepancies between the all fitted values and the predicted ones if the option `base="Bbase"` is used. The prediction function for the objects `FixBreakPointsReg` or `FreeBreakPointsReg` has the option `old.x.range=TRUE` which allow the user two choices:

The first is to use the old end-points for the creation of the new B-basis which were determine from the original range of x. This choice is implemented as a default in the `predict` method for `FixBreakPointsReg` and `FreeBreakPointsReg` objects with the argument `old.x.range=TRUE`.

The second is to create new end-points from the new and old data x values. In this case the range of x will be bigger that the original one if the `newdata` has values outside the original x range. In this case (`old.x.range=FALSE`) the prediction could be possible better outside the x range but would not coincide with the original predictions i.e. fitted(model) since basis have changed.

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`

References

Dierckx, P. (1991) *Curve and Surface Fitting with Splines*, Oxford Science Publications

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

Examples

```
# creating  a linear + linear function
   x <- seq(0,10, length.out=201)
knot <- 5
 set.seed(12543)
 mu <- ifelse(x<=knot,5+0.5*x,5+0.5*x+(x-knot))
  y <- rNO(201, mu=mu, sigma=.5)
# plot the data
 plot(y~x, xlim=c(-1,13), ylim=c(3,18))

# fit model using fixed break points
 m1 <- fitFixedKnots(y, x, knots=5, degree=1)
knots(m1)
lines(fitted(m1)~x, col="red")

# now estimating the knot
m2 <- fitFreeKnots(y, x, knots=5, degree=1)
knots(m2)
```

```
summary(m2)

# now predicting
plot(y~x, xlim=c(-5,13), ylim=c(3,18))
lines(fitted(m2)~x, col="green", lwd=3)
points(-2:13,predict(m2, newdata=-2:13), col="red",pch = 21, bg="blue")
points(-2:13,predict(m2, newdata=-2:13, old.x.range=FALSE), col="red",pch = 21, bg="grey")

# fit different basis
m21 <- fitFreeKnots(y, x, knots=5, degree=1, base="Bbase")
deviance(m2)
deviance(m21) # should be identical

# predicting with m21
 plot(y~x, xlim=c(-5,13), ylim=c(3,18))
lines(fitted(m21)~x, col="green", lwd=3)
points(-2:13,predict(m21, newdata=-2:13), col="red",pch = 21, bg="blue")
points(-2:13,predict(m21, newdata=-2:13, old.x.range=FALSE), col="red",pch = 21, bg="grey")
```

---

fk *A function to fit break points within GAMLSS*

Description

The `fk()` function is a additive function to be used for GAMLSS models. It is an interface for the `fitFreeKnots()` function. The functions `fitFreeKnots()` was first based on the `curfit.free.knot()` function of package DierckxSpline of Sundar Dorai-Raj and Spencer Graves. The function `fk()` allows the user to use the free knots function `fitFreeKnots()` within `gamlss`. The great advantage of course comes from the fact GAMLSS models provide a variety of distributions and diagnostics.

Usage

```
fk(x, start=NULL, control=fk.control(...), ...)
fk.control(degree = 1, all.fixed = FALSE, fixed = NULL, base = c("trun", "Bbase"))
```

Arguments

`x`	the x-variable
`start`	starting values for the breakpoints. If are set the number of break points is also determined by the length of `start`
`control`	the degree of the spline function fitted
`...`	for extra arguments
`degree`	the degree of the based function
`all.fixed`	whether to fix all parameter
`fixed`	the fixed break points
`base`	Which base should be used

Details

Note that fk itself does no smoothing; it simply sets things up for the function gamlss() which in turn uses the function additive.fit() for backfitting which in turn uses gamlss.fk(). Note that, finding the break points is not a trivial problem and therefore multiple maximum points can occur. More details about the free knot splines can be found in package Dierckx, (1991).

The gamlss algorithm used a modified backfitting in this case, that is, it fits the linear part fist. Note that trying to predict outside the x-range can be dangerous as the example below shows.

Value

The gamlss object saved contains the last fitted object which can be accessed using obj$par.coefSmo where obj is the fitted gamlss object par is the relevant distribution parameter.

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby

References

Dierckx, P. (1991) *Curve and Surface Fitting with Splines*, Oxford Science Publications

Stasinopoulos D. M., Rigby R.A. and Akantziliotou C. (2006) Instructions on how to use the GAMLSS package in R. Accompanying documentation in the current GAMLSS help files, (see also https://www.gamlss.com/).

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

See Also

gamlss.fk

Examples

```
## creating  a linear + linear function
x <- seq(0,10, length.out=201)
knot <- 5
set.seed(12543)
mu <- ifelse(x<=knot,5+0.5*x,5+0.5*x+1.5*(x-knot))
y <- rNO(201, mu=mu, sigma=.5)
## plot the data
plot(y~x, xlim=c(-1,13), ylim=c(3,23))
## fit model using curfit
m1 <- fitFreeKnots(y, x, knots=3, degree=1)
knots(m1)
## fitted values
lines(fitted(m1)~x, col="red", lwd="3")
## predict
pm1<-predict(m1, newdata=-1:12)
points(-1:12,pm1, col="red",pch = 21, bg="blue")
#------------------------------------------------
## now gamlss
```

```
#------------------------------------------------
## now negative binomial data
knot=4
eta1 <- ifelse(x<=knot,0.8+0.08*x,.8+0.08*x+.3*(x-knot))
plot(eta1~x)
set.seed(143)
y <- rNBI(201, mu=exp(eta1), sigma=.1)
da <- data.frame(y=y,x=x)
plot(y~x, data=da)
## getting the break point using profile deviance
n1 <- quote(gamlss(y ~ x+I((x>this)*(x-this)), family=NBI, data=da))
prof.term(n1, min=1, max=9, criterion="GD", start.prev=FALSE)
## now fit the model using fk
g1 <- gamlss(y~fk(x, degree=1, start=c(4)), data=da, family=NBI)
## get the breakpoint
knots(getSmo(g1))
## summary of the gamlss object FreeBreakPointsReg object
getSmo(g1)
## plot fitted model
plot(y~x, data=da)
lines(fitted(g1)~x, data=da, col="red")
#------------------------------------------------
## the aids data as example where things can go wrong
## using fk()
data(aids)
a1<-gamlss(y~x+fk(x, degree=1, start=25)+qrt, data=aids, family=NBI)
knots(getSmo(a1))
# using profile deviance
aids.1 <- quote(gamlss(y ~ x+I((x>this)*(x-this))+qrt,family=NBI,data=aids))
prof.term(aids.1, min=16, max=21, step=.1,  start.prev=FALSE)
## The Maximum Likelihood estimator is  18.33231 not 17.37064
## plotting the fit
with(aids, plot(x,y,pch=21,bg=c("red","green3","blue","yellow")[unclass(qrt)]))
lines(fitted(a1)~aids$x)
#-------------------------------------------------
```

---

ga *A interface functions to use Simon Wood's gam() and bam() functions within GAMLSS*

Description

The `ga()` and `ba()` functions are a additive functions to be used within GAMLSS models. They are interfaces for the `gam()` and the `bam()` functions of package `mgcv` of Simon Wood. The functions `gam()` and the `bam()` allows the user to use all the available smoothers of the package `mcgv()` within `gamlss`. The great advantage of course come from fitting models outside the exponential family.

Usage

```
ga(formula, control = ga.control(...), ...)
```

```
ba(formula, control = ba.control(...), ...)

ga.control(offset = NULL, method = "REML",
         optimizer = c("outer", "newton"), control = list(),
         scale = 0, select = FALSE, knots = NULL,
         sp = NULL, min.sp = NULL, H = NULL, gamma = 1,
         paraPen = NULL, in.out = NULL,
         drop.unused.levels = TRUE, drop.intercept = NULL,
         discrete = FALSE, ...)

ba.control(offset = NULL, method = "fREML", control = list(),
          select = FALSE, scale = 0, gamma = 1, knots = NULL,
          sp = NULL, min.sp = NULL, paraPen = NULL,
          chunk.size = 10000, rho = 0, AR.start = NULL,
          discrete = TRUE, cluster = NULL, nthreads = 2,
          gc.level = 1, use.chol = FALSE, samfrac = 1,
          coef = NULL, drop.unused.levels = TRUE,
          drop.intercept = NULL, ...)
```

Arguments

`formula`	A formula containing `s()` and `te` functions i.e. ~s(x1)+ te(x2,x3).
`offset`	the offset in the formula
`method`	the `method` argument in `gam()` and `bam()`
`optimizer`	the method optimizer in `gam()`
`control`	values for the `gam.control()`
`scale`	for the scale parameter
`select`	the `select` argument in `gam()` and `bam()`
`knots`	the `knots` argument in `gam()` and `bam()`
`sp`	the sp argument in `gam()` and `bam()`
`min.sp`	the `min.sp` argument in `gam()` and `bam()`
`H`	a user supplied fixed quadratic penalty on the parameters in `gam()`
`gamma`	the `gamma` argument in `gam()` and `bam()`
`paraPen`	the `paraPen` argument in `gam()` and `bam()`
`in.out`	the `in.out` argument in `gam()`
`drop.unused.levels`	by default unused levels are dropped from factors before fitting for `gam()` and `bam()`
`drop.intercept`	set to TRUE to force the model to really not have the a constant in the parametric model part for `gam()` and `bam()`
`discrete`	see `bam` and `gam` for details
`chunk.size`	see the help for `bam()`.

`rho`	for an `AR1` error model, see the help for `bam()`
`AR.start`	for an `AR1` error model, see the help for `bam()`
`cluster`	see the help for `bam()`
`nthreads`	Number of threads to use for non-cluster computation see the help for `bam()`
`gc.level`	keepingf the memory footprint down, see the help for `bam()`
`use.chol`	see the help for `bam()`
`samfrac`	see the help for `bam()`
`coef`	initial values for model coefficients
`...`	extra options to pass to gam.control()

Details

Note that `ga` itself does no smoothing; it simply sets things up for the function `gamlss()` which in turn uses the function `additive.fit()` for back-fitting which in turn uses `gamlss.ga()`

Note that, in our (limited) experience, for normal errors or exponential family, the fitted models using `gam()` and `ga()` within `gamlss()` are identical or at least very similar. This is particularly true if the default values for `gam()` are used.

Value

the fitted values of the smoother is returned, endowed with a number of attributes. The smoother fitted values are used in the construction of the overall fitted values of the particular distribution parameter. The attributes can be use to obtain information about the individual fit. In particular the `coefSmo` within the parameters of the fitted model contains the final additive fit.

Warning

The function is experimental so please report any peculiar behaviour to the authors

Author(s)

Mikis Stasinopoulos, <d.stasinopoulos@londonmet.ac.uk>

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

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(see also https://www.gamlss.com/).

Wood S.N. (2006) *Generalized Additive Models: An Introduction with R*. Chapman and Hall/CRC Press.

Examples

```
library(mgcv)
data(rent)
#-----------------------------------------------------------
## normal errors one x-variable
ga1 <- gam(R~s(Fl, bs="ps", k=20), data=rent, method="REML")
gn1 <- gamlss(R~ga(~s(Fl, bs="ps", k=20), method="REML"), data=rent) # additive
gb1 <- gamlss(R~pb(Fl), data=rent) # additive
AIC(ga1,gn1, gb1, k=0)
AIC(ga1,gn1, gb1)
#----------------------------------------------------------
## normal error additive in Fl and A
ga2 <- gam(R~s(Fl)+s(A), method="REML", data=rent)
gn2 <- gamlss(R~ga(~s(Fl)+s(A), method="REML"),  data=rent) # additive
gb2 <- gamlss(R~pb(Fl)+pb(A), data=rent) # additive
AIC(ga2,gn2, gb2, k=0)
AIC(ga2,gn2, gb2)
#-----------------------------------------------------------
## Not run:
## gamma error additive in Fl and A
ga3 <- gam(R~s(Fl)+s(A), method="REML", data=rent, family=Gamma(log))
gn3 <- gamlss(R~ga(~s(Fl)+s(A), method="REML"), data=rent, family=GA)# additive
gb3 <- gamlss(R~pb(Fl)+pb(A), data=rent, family=GA) # additive
AIC(ga3,gn3, gb3, k=0)
AIC(ga3,gn3, gb3)
#-----------------------------------------------------------
## gamma error surface fitting
ga4 <-gam(R~s(Fl,A), method="REML", data=rent, family=Gamma(log))
gn4 <- gamlss(R~ga(~s(Fl,A), method="REML"), data=rent, family=GA)
AIC(ga4,gn4, k=0)
AIC(ga4,gn4)
## plot the fitted surfaces
op<-par(mfrow=c(1,2))
vis.gam(ga4)
vis.gam(getSmo(gn4))
par(op)
## contour plot using mgcv's plot() function
plot(getSmo(gn4))
#-----------------------------------------------------------
## predict
newrent <- data.frame(expand.grid(Fl=seq(30,120,5), A=seq(1890,1990,5 )))
newrent1 <-newrent2 <- newrent
newrent1$pred <- predict(ga4, newdata=newrent, type="response")
newrent2$pred <- predict(gn4, newdata=newrent, type="response")
library(lattice)
wf1<-wireframe(pred~Fl*A, newrent1, aspect=c(1,0.5), drape=TRUE,
             colorkey=(list(space="right", height=0.6)), main="gam()")
wf2<-wireframe(pred~Fl*A, newrent2, aspect=c(1,0.5), drape=TRUE,
          colorkey=(list(space="right", height=0.6)), main="gamlss()")
print(wf1, split=c(1,1,2,1), more=TRUE)
print(wf2, split=c(2,1,2,1))
#-----------------------------------------------------------
```

```
##gamma error two variables te() function
ga5 <-  gam(R~te(Fl,A), data=rent, family=Gamma(log))
gn5 <- gamlss(R~ga(~te(Fl,A)), data=rent, family=GA)
AIC(ga5,gn5)
AIC(ga5,gn5, k=0)
op<-par(mfrow=c(1,2))
vis.gam(ga5)
vis.gam(getSmo(gn5))
par(op)
#----------------------------------------------------------
## use of Markov random fields
## example from package mgcv of Simon Wood
## Load Columbus Ohio crime data (see ?columbus for details and credits)
data(columb)       ## data frame
data(columb.polys) ## district shapes list
xt <- list(polys=columb.polys) ## neighbourhood structure info for MRF
## First a full rank MRF...
b <- gam(crime ~ s(district,bs="mrf",xt=xt),data=columb,method="REML")
bb <- gamlss(crime~ ga(~s(district,bs="mrf",xt=xt), method="REML"), data=columb)
AIC(b,bb, k=0)
op<-par(mfrow=c(2,2))
plot(b,scheme=1)
plot(bb$mu.coefSmo[[1]], scheme=1)
## Compare to reduced rank version...
b <- gam(crime ~ s(district,bs="mrf",k=20,xt=xt),data=columb,method="REML")
bb <- gamlss(crime~ ga(~s(district,bs="mrf",k=20,xt=xt), method="REML"),
             data=columb)
AIC(b,bb, k=0)
plot(b,scheme=1)
plot(bb$mu.coefSmo[[1]], scheme=1)
par(op)
## An important covariate added...
b <- gam(crime ~ s(district,bs="mrf",k=20,xt=xt)+s(income),
         data=columb,method="REML")
## x in gam()
bb <- gamlss(crime~ ga(~s(district,bs="mrf",k=20,xt=xt)+s(income),
             method="REML"), data=columb)
## x in gamlss()
bbb <- gamlss(crime~ ga(~s(district,bs="mrf",k=20,xt=xt),
             method="REML")+pb(income), data=columb)
AIC(b,bb,bbb)
## ploting the fitted models
op<-par(mfrow=c(2,2))
plot(b,scheme=c(0,1))
plot(getSmo(bb), scheme=c(0,1))
par(op)
plot(getSmo(bbb, which=2))
## plot fitted values by district
op<- par(mfrow=c(1,2))
fv <- fitted(b)
names(fv) <- as.character(columb$district)
fv1 <- fitted(bbb)
names(fv1) <- as.character(columb$district)
```

```
polys.plot(columb.polys,fv)
polys.plot(columb.polys,fv1)
par(op)
## End(Not run)
## bam
```

---

gamlss.fk *Support for Function fk()*

Description

This is support for the functions `fk()`. It is not intended to be called directly by users. T he function `gamlss.fk` is calling on the R function `curfit.free.knot()` of Sundar Dorai-Raj

Usage

```
gamlss.fk(x, y, w, xeval = NULL, ...)
```

Arguments

x	the design matrix
y	the response variable
w	prior weights
xeval	used in prediction
...	for extra arguments

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby

References

Dierckx, P. (1991) *Curve and Surface Fitting with Splines*, Oxford Science Publications

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

See Also

`fk`

gamlss.ga *Support for Function ga() and ba()*

Description

This is support for the smoother functions `ga()` and `ba()` intefaces for Simon Woood's `gam()` and `bam()` functions from package **mgcv**. It is not intended to be called directly by users.

Usage

```
gamlss.ga(x, y, w, xeval = NULL, ...)
gamlss.ba(x, y, w, xeval = NULL, ...)
```

Arguments

`x`	the explanatory variables
`y`	iterative y variable
`w`	iterative weights
`xeval`	if xeval=TRUE then predicion is used
`...`	for extra arguments

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

Wood S.N. (2006) Generalized Additive Models: An Introduction with R. Chapman and Hall/CRC Press.

gamlss.nn *Support for Function nn()*

Description

This is support for the smoother function nn() an interface for Brian Reply's `nnet()` function. It is not intended to be called directly by users.

Usage

```
gamlss.nn(x, y, w, xeval = NULL, ...)
```

Arguments

x	the explanatory variables
y	iterative y variable
w	iterative weights
xeval	if xeval=TRUE then predicion is used
...	for extra arguments

Author(s)

Mikis Stasinopoulos <d.stasinopoulos@londonmet.ac.uk>, Bob Rigby

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Ripley, B. D. (1996) *Pattern Recognition and Neural Networks*. Cambridge.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also `https://www.gamlss.com/`).

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S*. Fourth edition. Springer.

See Also

`fk`

nn — *A interface function to use nnet() function within GAMLSS*

Description

The nn() function is a additive function to be used for GAMLSS models. It is an interface for the nnet() function of package nnet of Brian Ripley. The function nn() allows the user to use neural networks within gamlss. The great advantage of course comes from the fact GAMLSS models provide a variety of distributions and diagnostics.

Usage

```
nn(formula, control = nn.control(...), ...)
nn.control(size = 3, linout = TRUE, entropy = FALSE, softmax = FALSE,
           censored = FALSE, skip = FALSE, rang = 0.7, decay = 0,
           maxit = 100, Hess = FALSE, trace = FALSE,
           MaxNWts = 1000, abstol = 1e-04, reltol = 1e-08)
```

Arguments

formula	A formula containing the expolanatory variables i.e. ~x1+x2+x3.
control	control to pass the arguments for the nnet() function
...	for extra arguments
size	number of units in the hidden layer. Can be zero if there are skip-layer units
linout	switch for linear output units. Default is TRUE, identily link
entropy	switch for entropy (= maximum conditional likelihood) fitting. Default by least-squares.
softmax	switch for softmax (log-linear model) and maximum conditional likelihood fitting. linout, entropy, softmax and censored are mutually exclusive.
censored	A variant on softmax, in which non-zero targets mean possible classes. Thus for softmax a row of (0, 1, 1) means one example each of classes 2 and 3, but for censored it means one example whose class is only known to be 2 or 3.
skip	switch to add skip-layer connections from input to output
rang	Initial random weights on `[-rang, rang]`. Value about 0.5 unless the inputs are large, in which case it should be chosen so that `rang * max(|x|)` is about 1
decay	parameter for weight decay. Default 0.
maxit	parameter for weight decay. Default 0.
Hess	If true, the Hessian of the measure of fit at the best set of weights found is returned as component Hessian.
trace	switch for tracing optimization. Default FALSE
MaxNWts	The maximum allowable number of weights. There is no intrinsic limit in the code, but increasing MaxNWts will probably allow fits that are very slow and time-consuming.

`abstol` Stop if the fit criterion falls below abstol, indicating an essentially perfect fit.

`reltol` Stop if the optimizer is unable to reduce the fit criterion by a factor of at least 1 - reltol.

Details

Note that, neural networks are over parameterized models and therefor notorious for multiple maximum. There is no guarantee that two identical fits will produce identical results.

Value

Note that `nn` itself does no smoothing; it simply sets things up for the function `gamlss()` which in turn uses the function `additive.fit()` for backfitting which in turn uses `gamlss.nn()`

Warning

You may have to fit the model several time to unsure that you obtain a reasonable minimum

Author(s)

Mikis Stasinopoulos `<d.stasinopoulos@londonmet.ac.uk>`, Bob Rigby based on work of Venables & Ripley wich also based on work by Kurt Hornik and Albrecht Gebhardt.

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Ripley, B. D. (1996) *Pattern Recognition and Neural Networks*. Cambridge.

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Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC. (see also `https://www.gamlss.com/`).

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S*. Fourth edition. Springer.

Examples

```
library(nnet)
data(rock)
area1<- with(rock,area/10000)
peri1<- with (rock,peri/10000)
rock1<- with(rock, data.frame(perm, area=area1, peri=peri1, shape))
# fit nnet
r1 <- nnet(log(perm)~area+peri+shape, rock1, size=3, decay=1e-3, linout=TRUE,
            skip=TRUE, max=1000, Hess=TRUE)
summary(r1)
# get gamlss
```

```
library(gamlss)
cc <- nn.control(size=3, decay=1e-3, linout=TRUE, skip=TRUE, max=1000,
      Hess=TRUE)
g1 <- gamlss(log(perm)~nn(~area+peri+shape,size=3, control=cc), data=rock1)
summary(g1$mu.coefSmo[[1]])
# predict
Xp <- expand.grid(area=seq(0.1,1.2,0.05), peri=seq(0,0.5, 0.02), shape=0.2)
rocknew <- cbind(Xp, fit=predict(r1, newdata=Xp))
library(lattice)
wf1<-wireframe(fit~area+peri, rocknew, screen=list(z=160, x=-60),
               aspect=c(1, 0.5), drape=TRUE,  main="nnet()")
rocknew1 <- cbind(Xp, fit=predict(g1, newdata=Xp))
wf2<-wireframe(fit~area+peri, rocknew1, screen=list(z=160, x=-60),
               aspect=c(1, 0.5), drape=TRUE,  main="nn()")
print(wf1, split=c(1,1,2,1), more=TRUE)
print(wf2, split=c(2,1,2,1))
#-------------------------------------------------------------------------
 data(rent)
 mr1 <- gamlss(R~nn(~Fl+A, size=5, decay=0.001), data=rent, family=GA)
 library(gamlss.add)
 mg1<-gamlss(R~ga(~s(Fl,A)), data=rent, family=GA)
 AIC(mr1,mg1)
newrent <- newrent1 <-newrent2 <- data.frame(expand.grid(Fl=seq(30,120,5),
                   A=seq(1890,1990,5 )))
newrent1$fit <- predict(mr1, newdata=newrent, type="response") ##nn
newrent2$fit <- predict(mg1, newdata=newrent, type="response")# gam
 library(lattice)
 wf1<-wireframe(fit~Fl+A, newrent1, aspect=c(1,0.5), drape=TRUE,
                colorkey=(list(space="right", height=0.6)), main="nn()")
 wf2<-wireframe(fit~Fl+A, newrent2, aspect=c(1,0.5), drape=TRUE,
                colorkey=(list(space="right", height=0.6)), main="ga()")
print(wf1, split=c(1,1,2,1), more=TRUE)
print(wf2, split=c(2,1,2,1))
#--------------------------------------------------------------------------
## Not run:
data(db)
mdb1 <- gamlss(head~nn(~age,size=20, decay=0.001), data=db)
plot(head~age, data=db)
points(fitted(mdb1)~db$age, col="red")
mdb2 <- gamlss(head~nn(~age,size=20, decay=0.001), data=db, family=BCT)
plot(head~age, data=db)
points(fitted(mdb2)~db$age, col="red")

## End(Not run)
```

`plot.nnet` *Plotting fitted neural networks*

Description

A function to plot the results of a neural network fit based on the `plotnet()` function of the package **NeuralNetTools**

Usage

```
## S3 method for class 'nnet'
## S3 method for class 'nnet'
plot(x, nid = TRUE, all.out = TRUE, all.in = TRUE, bias = TRUE,
wts.only = FALSE, rel.rsc = 5, circle.cex = 5, node.labs = TRUE,
var.labs = TRUE, x.lab = NULL, y.lab = NULL, line.stag = NULL,
struct = NULL, cex.val = 1, alpha.val = 1, circle.col = "lightblue",
pos.col = "black", neg.col = "grey", max.sp = FALSE, ...)
```

Arguments

`x`	A neural network fitted model
`nid`	logical value indicating if neural interpretation diagram is plotted, default is `TRUE`
`all.out`	character string indicating names of response variables for which connections are plotted, default all
`all.in`	character string indicating names of input variables for which connections are plotted, default all
`bias`	logical value indicating if bias nodes and connections are plotted, not applicable for networks from mlp function, default `TRUE`
`wts.only`	logical value indicating if connections weights are returned rather than a plot, default `FALSE`
`rel.rsc`	numeric value indicating maximum width of connection lines, default 5
`circle.cex`	numeric value indicating size of nodes, passed to cex argument, default 5
`node.labs`	logical value indicating if text labels are plotted, default `TRUE`
`var.labs`	logical value indicating if variable names are plotted next to nodes, default `TRUE`
`x.lab`	character string indicating names for input variables, default from model object
`y.lab`	character string indicating names for output variables, default from model object
`line.stag`	numeric value that specifies distance of connection weights from nodes
`struct`	numeric value of length three indicating network architecture (no nodes for input, hidden, output), required only if mod.in is a numeric vector
`cex.val`	numeric value indicating size of text labels, default 1
`alpha.val`	numeric value (0-1) indicating transparency of connections, default 1
`circle.col`	text value indicating colour of nodes default "lighrblue"
`pos.col`	text value indicating colour of the possitive connections, default "black"
`neg.col`	text value indicating colour of the negative connections, default "gray"
`max.sp`	logical value indication whether the space betwwen nodes in each laers is maximised
`...`	for further arguments

Details

The function `plot.nnet()` is (almost) identical to the function `plot.nnet()` created by Marcus W. Beck it was first published in the web but now is part of the **NeuralNetTools** package in R under the name `plotnet()`. Here we modify the function it so it works within the **gamlss.add** package. This involves of borrowing the functions `rescale()`, `zero_range()` and `alpha()` from package **scales**.

Value

The function is producing a plot

Author(s)

Marcus W. Beck <mbafs2012@gmail.com> modified by Mikis Stasinopoulos

References

Marcus W. Beck (2015). NeuralNetTools: Visualization and Analysis Tools for Neural Networks. R package version 1.4.1. https://cran.r-project.org/package=NeuralNetTools

Hadley Wickham (2014). scales: Scale functions for graphics. R package version 0.4.0. https://cran.r-project.org/package=scales

See Also

nn

Examples

```
r1 <- gamlss(R~nn(~Fl+A+H+loc, size=10, decay=0.2), data=rent,
      family=GA, gd.tol=1000, n.cyc=5)
getSmo(r1)
plot(getSmo(r1), y.lab=expression(eta[1]))
plot(getSmo(r1), y.lab=expression(g[1](mu)))
## Not run:
r2 <- gamlss(R~nn(~Fl+A+H+loc, size=10, decay=0.2),
      sigma.fo=~nn(~Fl+A+H+loc, size=10, decay=0.2),data=rent,
      family=GA, gd.tol=1000, n.cyc=5)
plot(getSmo(r2), y.lab=expression(g[1](mu)))
plot(getSmo(r2, what="sigma"), y.lab=expression(g[2](sigma)))

## End(Not run)
```

tr *A interface function to use rpart() function within GAMLSS*

Description

The tr() function is a additive function to be used for GAMLSS models. It is an interface for the `rpart()` function of package `rpart`. The function tr() allows the user to use regression trees within gamlss. The great advantage of course comes from the fact GAMLSS models provide a variety of distributions and diagnostics. Note that the function gamlss.tr is not used by the user but it needed for the backfitting.

Usage

```
tr(formula, method = c("rpart"), control = rpart.control(...), ...)
gamlss.tr(x, y, w, xeval = NULL, ...)
```

Arguments

`formula`	A formula containing the expolanatory variables i.e. `~x1+x2+x3`.
`method`	only method "rpart" is supported at the moment
`control`	control here is equivalent to `rpart.control()` function od package `rpart`
`x`	object passing informatio to the function
`y`	the iterative y variable
`w`	the iterative weights
`xeval`	whether prediction or not is used
`...`	additional arguments

Details

Note that, the gamlss fit maybe would not coverged. Also occasianly the `gd.tol` argument in `gamlss` has to be increased. The

Value

Note that `tr` itself does no smoothing; it simply sets things up for the function `gamlss()` which in turn uses the function `additive.fit()` for backfitting which in turn uses `gamlss.tr()` The result is a `rpart` object.

Author(s)

Mikis Stasinopoulos <mikis.stasinopoulos@gamlss.org>, Bob Rigby based on work of Therneau and Atkison (2015)

References

Rigby, R. A. and Stasinopoulos D. M. (2005). Generalized additive models for location, scale and shape,(with discussion), *Appl. Statist.*, **54**, part 3, pp 507-554.

Rigby R.A., Stasinopoulos D. M., Heller G., and De Bastiani F., (2019) *Distributions for Modeling Location, Scale and Shape: Using GAMLSS in R*, Chapman and Hall/CRC.

Ripley, B. D. (1996) *Pattern Recognition and Neural Networks*. Cambridge.

Stasinopoulos D. M. Rigby R.A. (2007) Generalized additive models for location scale and shape (GAMLSS) in R. *Journal of Statistical Software*, **23**(7), 1–46, doi:10.18637/jss.v023.i07

Stasinopoulos D. M., Rigby R.A., Heller G., Voudouris V., and De Bastiani F., (2017) *Flexible Regression and Smoothing: Using GAMLSS in R*, Chapman and Hall/CRC.

(see also https://www.gamlss.com/).

Therneau T. M., Atkinson E. J. (2015) An Introduction to Recursive Partitioning Using the RPART Routines. Vignette in package rpart.

Venables, W. N. and Ripley, B. D. (2002) *Modern Applied Statistics with S*. Fourth edition. Springer.

See Also

See Also as nn

Examples

```
data(rent)
#--- fitting gamlss+tree Nornal
library(rpart)
data(rent)
rg1 <- gamlss(R ~ tr(~A+Fl), data=rent, family=NO)
plot(rg1)
plot(getSmo(rg1))
text(getSmo(rg1))
## Not run:
# fitting Gamma  errors
rg2 <- gamlss(R ~ tr(~A+Fl), data=rent, family=GA)
plot(rg2)
plot(getSmo(rg2))
text(getSmo(rg2))
#--- fitting also model in the variance
rg3 <- gamlss(R ~ tr(~A+Fl), sigma.fo=~tr(~Fl+A), data=rent,
                family=GA, gd.tol=100, c.crit=0.1)
plot(rg3)
plot(getSmo(rg3))
text(getSmo(rg3))
plot(getSmo(rg3, what="sigma"))
text(getSmo(rg3, what="sigma"))
## End(Not run)
```

Index