

Package ‘mgcViz’

July 4, 2025

Title Visualisations for Generalized Additive Models

Date 2025-07-2

Version 0.2.1

Description Extension of the 'mgcv' package, providing visual tools for Generalized Additive Models that exploit the additive structure of such models, scale to large data sets and can be used in conjunction with a wide range of response distributions. The focus is providing visual methods for better understanding the model output and for aiding model checking and development beyond simple exponential family regression. The graphical framework is based on the layering system provided by 'ggplot2'.

Depends R (>= 4.0), mgcv (>= 1.9), qgam (>= 1.2.3), ggplot2

Imports gamm4, matrixStats, viridis, GGally, KernSmooth, gridExtra,
plyr

Suggests shiny, miniUI, rgl, knitr, rmarkdown, testthat, MASS,
webshot2

License GPL-3

Encoding UTF-8

RoxygenNote 7.3.2

VignetteBuilder knitr

URL <https://github.com/mfasiolo/mgcViz>

BugReports <https://github.com/mfasiolo/mgcViz/issues>

NeedsCompilation no

Author Matteo Fasiolo [aut, cre],
Raphael Nedellec [aut],
Yannig Goude [ctb],
Christian Capezza [ctb],
Simon N. Wood [ctb]

Maintainer Matteo Fasiolo <matteo.fasiolo@gmail.com>

Repository CRAN

Date/Publication 2025-07-04 09:50:02 UTC

Contents

ALE	3
ALE.gam	4
bamV	6
check.gamViz	7
check0D	9
check1D	10
check2D	12
fix.family.cdf	14
gamm4V	14
getGam	16
getViz	16
gridPrint	17
listLayers	18
l_bound	19
l_ciBar	20
l_ciLine	20
l_ciPoly	21
l_clusterLine	22
l_coordContour	22
l_dens1D	23
l_dens2D	23
l_densCheck	24
l_fitBar	26
l_fitContour	27
l_fitDens	27
l_fitLine	28
l_fitPoints	29
l_fitRaster	29
l_glyphs2D	30
l_gridCheck1D	32
l_gridCheck2D	34
l_gridQCheck1D	35
l_gridQCheck2D	36
l_hist	37
l_points	37
l_poly	38
l_pvContour	39
l_pvRaster	39
l_rug	40
l_simLine	40
l_vline	41
mqqamV	42
plot.ALE1D	43
plot.fs.interaction.1D	44
plot.gamViz	45
plot.mgamViz	48

plot.mgcv.smooth.1D	49
plot.mgcv.smooth.2D	52
plot.mgcv.smooth.MD	54
plot.mrf.smooth	56
plot.multi.ptermFactor	57
plot.multi.random.effect	58
plot.nested1D	59
plot.ptermInteraction	60
plot.ptermMatrixNumeric	61
plot.sos.smooth	62
plotDiff	64
plotDiff.mgcv.smooth.1D	65
plotDiff.mgcv.smooth.2D	66
plotDiff.sos.smooth	68
plotRGL	70
plotRGL.mgcv.smooth.2D	71
plotRGL.mgcv.smooth.MD	73
plotSlice	75
postSim	77
print.checkGam	78
print.plotGam	79
print.plotSmooth	80
print.qqGam	80
pterm	81
qgamV	82
qq	83
qq.gamViz	84
qqplots	88
residuals.gamViz	89
shine	90
shine.qqGam	91
simulate.gam	92
sm	93
zoom	94
zoom.qqGam	94
zto1	96
Index	97

ALE

*Generic function for Accumulated Local Effect (ALE)***Description**

Generic function for producing ALE effects, to be plottied using the plot generic.

Usage

```
ALE(o, ...)
```

Arguments

o the model we want to use to produce the ALE effect.
 ... arguments to be passed to methods.

References

Apley, D.W., and Zhu, J, 2016. Visualizing the effects of predictor variables in black box supervised learning models. arXiv preprint arXiv:1612.08468.

See Also

ALE.gam

ALE.gam

Create Accumulated Local Effects (ALE) for GAMs

Description

Create Accumulated Local Effects (ALE) for GAMs

Usage

```
## S3 method for class 'gam'
ALE(
  o,
  x,
  newdata = NULL,
  type = "link",
  nbin = 40,
  bins = NULL,
  oind = 1,
  center = 1,
  ...
)
```

Arguments

o a fitted GAM model.
 x the name of the variable along which we want to produce the ALE effect.
 newdata optional argument indicating the data to be used to produce the ALE effect. If
 NULL the data contained in o will be used.

type	if set to "link" (the default option) the model output will be the linear predictor, if set to "response" the model output is on the scale of the response.
nbin	number of intervals into which the predictor range is divided when calculating the ALE effects. Ignored for factor predictors or if the bins argument is provided.
bins	a grid defining the interval into which the predictor should be binned. Determined automatically by default. Ignored for factor predictors.
oind	relevant only when the model o has multiple linear predictors (e.g. for GAMLSS models or for multinom regression). oind is the index of the output variable used for the ALE effect (i.e., only <code>predict(o)[, oind]</code>).
center	if set to 0 the ALE effect is not centered and the effect is equal to zero at the smallest value on x-grid. If set to 1 (default) the effect is centered as done in Apley and Zhu, 2016. That is, an estimate of the expected value of the uncentered effect is subtracted, so the effect is centered similarly to smooth effects in GAMs. If set to 2, the expected value of the model output at the smallest value on the x-grid is added to the uncentered effect.
...	extra arguments that will be passed to <code>predict</code> and <code>vcov</code> .

Value

An object of class ALEXD, where X is the number of dimensions, which can be plotted using `plot.ALEXD` (only X=1 is provided at the moment).

Author(s)

Matteo Fasiolo and Christian Capezza, with some internal code having been adapted from the ALE-Plot package of Dan Apley.

References

Apley, D.W., and Zhu, J, 2016. Visualizing the effects of predictor variables in black box supervised learning models. arXiv preprint arXiv:1612.08468.

See Also

[plot.ALE1D](#)

Examples

```
# Example using Tweedie distribution
library(mgcViz)
set.seed(3)
n<-400
## Simulate data...
dat <- gamSim(1,n=n,dist="poisson",scale=.2)
dat$y <- rTweedie(exp(dat$f),p=1.3,phi=.5) ## Tweedie response

## Fit a fixed p Tweedie, with wrong link ...
b <- gam(list(y~s(x0)+s(x1)+s(x2)+s(x3),~1,~1), family=twlss(), data=dat)
```

```
plot(ALE(b, "x2", type = "response", oind = 1))

# With manually chosen bins
plot(ALE(b, "x2", type = "response", oind = 1,
        bins = c(0.1, 0.25, 0.5, 0.6, 0.9, 0.95, 0.99, 1)))
```

bamV

Fit a GAM model and get a gamViz object

Description

These are wrapper that fits a GAM model using `mgcv::gam` or `mgcv::bam` and converts it to a `gamViz` object using the `getViz` function. It is essentially a shortcut.

Usage

```
bamV(
  formula,
  family = gaussian(),
  data = list(),
  method = "fREML",
  aGam = list(),
  aViz = list()
)

gamV(
  formula,
  family = gaussian(),
  data = list(),
  method = "REML",
  aGam = list(),
  aViz = list()
)
```

Arguments

formula, family, data, method	same arguments as in <code>mgcv::gam</code> or <code>mgcv::bam</code> .
aGam	list of further arguments to be passed to <code>mgcv::gam</code> or <code>mgcv::bam</code> .
aViz	list of arguments to be passed to <code>getViz</code> .

Value

An object of class "gamViz" which can, for instance, be plotted using `plot.gamViz`.

Examples

```
##### gam example
# Simulate data
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1,n=1000,dist="normal",scale=2)

# Fit GAM and get gamViz object
b <- gamV(y~s(x0)+s(x1, x2)+s(x3), data = dat,
          aGam = list(scale = 2), aViz = list("nsim" = 20))

# This is equivalent to doing
# 1. Fit GAM
# b <- gam(y~s(x0)+s(x1, x2)+s(x3), data=dat, method="REML", scale = 2)
# 2. Convert to gamViz object
# b <- getViz(b, nsim = 20)

# Either way, we plot first and third effects by doing
print(plot(b, select = c(1, 3)), pages = 1)

##### bam example
# Simulate data
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1,n=2000,dist="normal",scale=2)

# Fit using bam() and get gamViz object
b <- bamV(y~s(x0)+s(x1, x2)+s(x3), data = dat,
          aGam = list(discrete = TRUE), aViz = list("nsim" = 0))

# Either way, we plot first and third effects by doing
print(plot(b, select = c(2)), pages = 1)
```

check.gamViz

Some diagnostics for a fitted gam model

Description

Takes a fitted GAM model and produces some diagnostic information about the fitting procedure and results. The default is to produce 4 residual plots, some information about the convergence of the smoothness selection optimization, and to run diagnostic tests of whether the basis dimension choices are adequate.

Usage

```
## S3 method for class 'gamViz'
check(
  obj,
  type = c("auto", "deviance", "pearson", "response", "tunif", "tnormal"),
```

```

    k.sample = 5000,
    k.rep = 200,
    maxpo = 10000,
    a.qq = list(),
    a.hist = list(),
    a.respoi = list(),
    ...
  )

```

Arguments

obj	an object of class gamViz, the output of a getViz() call.
type	type of residuals, see residuals.gamViz , used in all plots.
k.sample	above this k testing uses a random sub-sample of data.
k.rep	how many re-shuffles to do to get p-value for k testing.
maxpo	maximum number of residuals points that will be plotted in the scatter-plots. If number of datapoints > maxpo, then a subsample of maxpo points will be plotted.
a.qq	list of arguments to be passed to qq.gamViz. See qq.gamViz .
a.hist	list of arguments to be passed to ggplot2::geom_histogram.
a.respoi	list of arguments to be passed to ggplot2::geom_point.
...	currently not used.

Details

This is essentially a re-write of mgcv::gam.check using ggplot2. See [mgcv::gam.check](#) for details.

Value

An object of class checkGam, which is simply a list of ggplot objects.

Examples

```

library(mgcViz)
set.seed(0)
dat <- gamSim(1, n = 200)
b <- gam(y ~ s(x0) + s(x1) + s(x2) + s(x3), data = dat)
b <- getViz(b)

# Checks using default options
check(b)

# Change some algorithmic and graphical parameters
check(b,
  a.qq = list(method = "tnorm",
    a.cipoly = list(fill = "light blue")),
  a.respoi = list(size = 0.2),
  a.hist = list(bins = 10))

```


check0D

*Checking GAM simulated residuals or responses***Description**

This function extracts the residuals or responses of a fitted GAM model, then it compares their distribution with that of model-based simulations.

Usage

```
check0D(
  o,
  type = "auto",
  maxpo = 10000,
  na.rm = TRUE,
  trans = NULL,
  useSim = TRUE
)
```

Arguments

<code>o</code>	an object of class <code>gamViz</code> .
<code>type</code>	the type of residuals to be used. See residuals.gamViz . If <code>"type == y"</code> then the raw observations will be used.
<code>maxpo</code>	maximum number of residuals points that will be used by layers such as <code>l_rug()</code> . If number of datapoints > <code>maxpo</code> , then a subsample of <code>maxpo</code> points will be taken.
<code>na.rm</code>	if TRUE missing cases in <code>x</code> or <code>y</code> will be dropped out.
<code>trans</code>	function used to transform the observed and simulated residuals or responses. It must take a vector of as input, and it must either a vector of the same length or a scalar.
<code>useSim</code>	if FALSE then the simulated responses contained in object <code>o</code> will not be used by this function or by any of the layers that can be used with its output.

Value

An object of class `c("plotSmooth", "gg")`.

Examples

```
# The variance of the response distribution changes along x2
library(mgcViz)
n <- 400
x1 <- runif(n, -1, 1)
x2 <- runif(n, -1, 1)
dat <- data.frame("x1" = x1, "x2" = x2,
  "y" = sin(3*x1) + 0.5 * x2^2 + pmax(x2, 0.2) * rnorm(n))
```

```
# Fit model with constant variance and perform posterior simulations (post = TRUE)
# which take into account smoothing parameter uncertainty (unconditional = TRUE)
b <- gamV(y ~ s(x1)+s(x2), data = dat,
          aViz = list(nsim = 50, post = TRUE, unconditional = TRUE))

# Histogram of simulated vs observed residuals: the latter are fat tailed
check0D(b) + l_hist() + l_rug()

# Histogram of simulated 4th central moment (~ kurtosis) of simulated residuals.
# The vertical line is the 4th moment of the observed residuals
check0D(b, trans = function(.y) mean((.y - mean(.y))^4)) + l_dens1D() + l_vline() + l_rug()
# Residuals look very fat tails, but the real problem here is the heteroscedasticity
# which can be diagnosed using check1D(b, "x2") + l_gridCheck1D(sd)
```

check1D

Checking GAM residuals or responses along one covariate

Description

This function extracts the residuals of a fitted GAM model, and orders them according to the value of a single covariate. Then several visual residuals diagnostics can be plotted by adding layers.

Usage

```
check1D(
  o,
  x,
  type = "auto",
  maxpo = 10000,
  na.rm = TRUE,
  trans = NULL,
  useSim = TRUE
)
```

Arguments

<code>o</code>	an object of class <code>gamViz</code> .
<code>x</code>	it can be either a) a single character, b) a numeric vector or c) a list of characters. In case a) it should be the name of one of the variables in the dataframe used to fit <code>o</code> . In case b) its length should be equal to the length of <code>o\$y</code> . In case c) it should be a list of names variables in the dataframe used to fit <code>o</code> .
<code>type</code>	the type of residuals to be used. See residuals.gamViz . If <code>"type == y"</code> then the raw observations will be used.
<code>maxpo</code>	maximum number of residuals points that will be used by layers such as <code>l_rug()</code> . If number of datapoints > <code>maxpo</code> , then a subsample of <code>maxpo</code> points will be taken.
<code>na.rm</code>	if TRUE missing cases in <code>x</code> or <code>y</code> will be dropped out.

trans	function used to transform the observed and simulated residuals or responses. It must take a vector of as input, and must return a vector of the same length.
useSim	if FALSE then the simulated responses contained in object o will not be used by this function or by any of the layers that can be used with its output.

Value

The function will return an object of class `c("plotSmooth", "gg")`, unless argument `x` is a list. In that case the function will return an object of class `c("plotGam", "gg")` containing a checking plot for each variable.

Examples

```
### Example 1: diagnosing heteroscedasticity
library(mgcViz);
set.seed(4124)
n <- 1e4
x <- rnorm(n); y <- rnorm(n);

# Residuals are heteroscedastic w.r.t. x
ob <- (x)^2 + (y)^2 + (0.2*abs(x) + 1) * rnorm(n)
b <- bam(ob ~ s(x,k=30) + s(y, k=30), discrete = TRUE)
b <- getViz(b)

# Look at residuals along "x"
ck <- check1D(b, "x", type = "tnormal")

# Can't see that much
ck + l_dens(type = "cond", alpha = 0.8) + l_points() + l_rug(alpha = 0.2)

# Some evidence of heteroscedasticity
ck + l_densCheck()

# Compare observed residuals std dev with that of simulated data,
# heteroscedasticity is clearly visible
b <- getViz(b, nsim = 50)
check1D(b, "x") + l_gridCheck1D(gridFun = sd, showReps = TRUE)

# This also works with factor or logical data
fac <- sample(letters, n, replace = TRUE)
logi <- sample(c(TRUE, FALSE), n, replace = TRUE)
b <- bam(ob ~ s(x,k=30) + s(y, k=30) + fac + logi, discrete = TRUE)
b <- getViz(b, nsim = 50)

# Look along "fac"
ck <- check1D(b, "fac")
ck + l_points() + l_rug()
ck + l_gridCheck1D(gridFun = sd)

# Look along "logi"
ck <- check1D(b, "logi")
ck + l_points() + l_rug()
```

```
ck + l_gridCheck1D(gridFun = sd)
```

check2D

Checking GAM residuals along two covariates

Description

This function extracts the residuals of a fitted GAM model, and plots them according to the values of two covariates. Then several visual residuals diagnostics can be plotted by adding layers.

Usage

```
check2D(
  o,
  x1,
  x2,
  type = "auto",
  maxpo = 10000,
  na.rm = TRUE,
  trans = NULL,
  useSim = TRUE
)
```

Arguments

o	an object of class gamViz.
x1	it can be either a) a single character, b) a numeric vector or c) a list of characters. In case a) it should be the name of one of the variables in the dataframe used to fit o. In case b) its length should be equal to the length of o\$y. In case c) it should be a list of names of variables in the dataframe used to fit o.
x2	same as x1, but this will appear on the y-axis.
type	the type of residuals to be used. See residuals.gamViz . If "type == y" then the raw observations will be used.
maxpo	maximum number of residuals points that will be used by layers such as <code>l_rug()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
na.rm	if TRUE missing cases in x or y will be dropped out
trans	function used to transform the observed and simulated residuals or responses. It must take a vector of as input, and must return a vector of the same length.
useSim	if FALSE then the simulated responses contained in object o will not be used by this function or by any of the layers that can be used with its output.

Value

The function will return an object of class `c("plotSmooth", "gg")`, unless arguments `x1` and/or `x2` are lists. If they are lists of the same length, then the function will return an object of class `c("plotGam", "gg")` containing a checking plot for each pair of variables. If `x1` is a list and `x2` is not specified, the function will return an object of class `c("plotGam", "gg")` containing a plot for each unique combination of the variables in `x1`.

Examples

```
## Not run:
library(mgcViz);
#### Example 1: Rosenbrock function
# Simulate data
n <- 1e4
X <- data.frame("x1"=rnorm(n, 0.5, 0.5), "x2"=rnorm(n, 1.5, 1))
X$y <- (1-X$x1)^2 + 100*(X$x2 - X$x1^2)^2 + rnorm(n, 0, 2)
b <- bam(y ~ te(x1, x2, k = 5), data = X, discrete = TRUE)
b <- getViz(b, nsim = 50)

# Plot joint density of observed covariate x1 and x2
check2D(b, x1 = "x1", x2 = "x2") + l_rug() + l_dens(type="joint", alpha=0.6) + l_points()

# Look at how mean of residuals varies across x1 and x2
check2D(b, x1 = "x1", x2 = "x2") + l_gridCheck2D() + l_points()

# Can't see much in previous plot, let's zoom in central area, where most
# data is. Here we can clearly see that the mean model is misspecified
check2D(b, x1 = "x1", x2 = "x2") + l_gridCheck2D(bw = c(0.05, 0.1)) +
  xlim(-1, 1) + ylim(0, 3)

# Fit can be improved by increasing k in the bam() call

#### Example 2: checking along factor variables
# Simulate data where variance changes along factor variable "fac"
n <- 1e4
X <- data.frame("x1"=rnorm(n, 0.5, 0.5), "x2"=rnorm(n, 1.5, 1))
X$fac <- as.factor( sample(letters, n, replace = TRUE) )
X$fac2 <- as.factor( sample(c("F1", "F2", "F3", "F4", "F5"), n, replace = TRUE) )
X$y <- (1-X$x1)^2 + 5*(X$x2 - X$x1^2)^2 + 0.1*as.numeric(X$fac) * rnorm(n, 0, 2)
b <- bam(y ~ te(x1, x2, k = 5) + fac + fac2, data = X, discrete = TRUE)
b <- getViz(b, nsim = 50)

# Check standard deviation of residuals along covariates "x1" and "fac"
a <- check2D(b, x1 = "x2", x2 = "fac")
a + l_gridCheck2D(gridFun = sd) + l_rug() + l_points()

# Points and rug are jittered by default, but we can over-ride this
a + l_rug(position = position_jitter(width = 0, height = 0)) +
  l_points(position = position_jitter(width = 0, height = 0))

# Check standard deviation of residuals along the two factor variables
a <- check2D(b, x1 = "fac", x2 = "fac2")
a + l_gridCheck2D(gridFun = sd, bw = c(1, 4)) + l_rug() + l_points()
```

```
## End(Not run)
```

fix.family.cdf	<i>Getting the CDF of a gam family</i>
----------------	--

Description

Some methods implemented in `mgcViz` require the c.d.f. of the response distribution. This function takes a family object as input and returns the same object, but with the cdf function added to the `$cdf` slot. Mainly for internal use.

Usage

```
fix.family.cdf(fam)
```

Arguments

`fam` an object of class family.

gamm4V	<i>Fit a GAMM or GAMM4 model and get a gamViz object</i>
--------	--

Description

These are wrappers that fit GAM models using `mgcv::gamm` or `gamm4::gamm4` and convert them to a `gamViz` object using the `getViz` function. It is essentially a shortcut.

Usage

```
gamm4V(
  formula,
  random = NULL,
  family = gaussian(),
  data = list(),
  REML = TRUE,
  aGam = list(),
  aViz = list(),
  keepGAMobj = FALSE
)

gammV(
  formula,
  random = NULL,
  family = gaussian(),
```

```
data = list(),
method = "REML",
aGam = list(),
aViz = list(),
keepGAMObj = FALSE
)
```

Arguments

formula, random, family, data	same arguments as in mgcv::gamm or gamm4::gamm4 .
REML	same as in gamm4::gamm4
aGam	list of further arguments to be passed to mgcv::gamm or gamm4::gamm4 .
aViz	list of arguments to be passed to getViz .
keepGAMObj	if TRUE a copy of the gamViz Object is kept under \$gam to assure compatibility with mgcv::gamm and gamm4::gamm4 . Defaults to FALSE.
method	same as in mgcv::gamm

Details

WARNING: Model comparisons (e.g. with anova) should only be done using the mixed model part as described in [gamm4::gamm4](#). For [mgcv::gamm](#) please refer to the original help file.

Value

An object of class "gamViz" which can, for instance, be plotted using [plot.gamViz](#). Also the object has the following additional elements:

- lme mixed model as in [mgcv::gamm](#)
- mer mixed model as in [gamm4::gamm4](#)
- gam a copy of the gamViz Object if setting keepGAMObj = TRUE.

Examples

```
##### gam example
library(mgcViz)
# Simulate data
dat <- gamSim(1,n=400,scale=2) ## simulate 4 term additive truth
## Now add 20 level random effect `fac'...
dat$fac <- fac <- as.factor(sample(1:20,400,replace=TRUE))
dat$y <- dat$y + model.matrix(~fac-1) %*% rnorm(20) * 0.5

br <- gammV(y~s(x0)+x1+s(x2), data=dat,random=list(fac=~1))
summary(br)
plot(br)

summary(br$lme)

## Not run:
```

```
## gamm4::gamm4 example
br4 <- gamm4V(y~s(x0)+x1+s(x2),data=dat,random=~(1|fac))
summary(br4)
plot(br4)

summary(br4$mer)

## End(Not run)
```

getGam

Convert gamViz object to gamObject

Description

Function for converting a gamViz object to a gamObject. It is essentially the inverse of the [getViz](#) function.

Usage

```
getGam(o)
```

Arguments

o a gamViz object, the output of [getViz](#).

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1,n=1000,dist="normal",scale=2)
b <- gam(y~s(x0)+s(x1, x2)+s(x3), data=dat, method="REML")
a <- getViz(b)
identical(b, getGam(a)) # Must be TRUE
```

getViz

Converting gam objects to gamViz objects

Description

This function converts gam objects into gamViz objects, for which mgcViz provides several plotting methods.

Usage

```
getViz(o, nsim = 0, post = FALSE, newdata, ...)
```


Arguments

<code>o</code>	an object of class <code>gam</code> .
<code>nsim</code>	the number of simulated vectors of responses. A positive integer.
<code>post</code>	if TRUE then posterior simulation is performed. That is, we simulate <code>nsim</code> vectors of regression coefficients from a Gaussian approximation to the posterior, and then we simulate a vector of response using each parameter vector. If FALSE, then <code>nsim</code> vectors of responses are simulated using parameters fixed at the posterior mode.
<code>newdata</code>	Optional new data frame used to perform the simulations. To be passed to predict.gam and, if <code>post == TRUE</code> , to <code>postSim</code> .
<code>...</code>	extra arguments to be passed to simulate.gam (if <code>post==FALSE</code>) or postSim (if <code>post==TRUE</code>). For instance, we could pass prior weights <code>w</code> and <code>offset</code> .

Value

An object of class `gamViz`.

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1,n=1000,dist="normal",scale=2)
b <- gam(y~s(x0)+s(x1, x2)+s(x3), data=dat, method="REML")
b <- getViz(b, nsim = 20)
str(b$store$sim) # Simulated responses now stored here

plot(sm(b,1)) + l_fitLine() + l_ciLine() + l_rug() + l_points()
plot(sm(b,2)) + l_rug() + l_fitRaster() + l_fitContour()
```

gridPrint

Plotting plotSmooth objects on a grid

Description

This is a wrapper for `gridExtra::grid.arrange`, which allows to plot several `plotSmooth` objects on a grid.

Usage

```
gridPrint(...)
```

Arguments

`...` arguments to be passed to `gridExtra::grid.arrange`.

Details

This function simply extracts the ggplot objects contained in any object of class plotSmooth and passes them to gridExtra::grid.arrange.

Examples

```
library(mgcViz)
n <- 1e3
x1 <- rnorm(n)
x2 <- rnorm(n)
dat <- data.frame("x1" = x1, "x2" = x2,
                  "y" = sin(x1) + 0.5 * x2^2 + pmax(x2, 0.2) * rnorm(n))
b <- bam(y ~ s(x1)+s(x2), data = dat, method = "FREML", discrete = TRUE)
b <- getViz(b)

o1 <- plot( sm(b, 1) ) + l_fitLine() + l_ciLine()
o2 <- plot( sm(b, 2) ) + l_fitLine() + l_ciLine()
qpl <- qq(b)

# All on one page, method 1:
gridPrint(o1, o2, qpl, ncol = 2)

# All on one page, method 2:
gridPrint(grobs = list(o1, o2, qpl), ncol = 2)

# Works also when some ggplot objects are present
gridPrint(o1, o2, qpl, ggplot(), ncol = 2)
```

listLayers

Lists available layers for plotSmooth objects

Description

This function takes as input an object of class plotSmooth and returns the names of all the possible visual layers that could be used with that object.

Usage

```
listLayers(o)
```

Arguments

o an object of class plotSmooth.

Value

A vector containing the names of the available layers.

Examples

```
library(mgcViz)
n <- 400
x1 <- rnorm(n)
x2 <- rnorm(n)
dat <- data.frame("x1" = x1, "x2" = x2,
                  "y" = sin(x1) + 0.5 * x2^2 + rnorm(n))
b <- gam(y ~ x1+s(x2), data = dat, method = "REML")
b <- getViz(b)

# List layers available for parametric effect plot
o <- plot( pterm(b, 1) )
listLayers(o)

# List layers available for smooth effect plot
o <- plot( sm(b, 1) )
listLayers(o)

# List layers available for checking plot
o <- check1D(b, x1)
listLayers(o)
```

l_bound

Add boundaries to smooth effect plot

Description

This layer adds boundaries to a smooth effect plot.

Usage

```
l_bound(n = 200, ...)
```

Arguments

n	number of discrete intervals along the boundary.
...	graphical arguments to be passed to <code>ggplot2::geom_path</code> .

Value

An object of class `gamLayer`.

See Also

[plot.sos.smooth](#)

l_ciBar	<i>Adding confidence intervals to barplots</i>
---------	--

Description

This layer adds confidence intervals to barplots, such as those produced by factor effects GAM.

Usage

```
l_ciBar(level = 0.95, mul = NULL, ...)
```

Arguments

level	the level of the confidence intervals (e.g. 0.9 means 90% intervals).
mul	number multiplied by the standard errors when calculating standard error curves. By default NULL, if set to a positive number it will over-ride level.
...	graphical arguments to be passed to <code>ggplot2::geom_errorbar</code> .

Value

An object of class `gamLayer`.

See Also

See [plot.ptermFactor](#) for examples.

l_ciLine	<i>Adding confidence intervals to effect plot</i>
----------	---

Description

This layer adds confidence interval lines to smooth, random or parametric effect plots.

Usage

```
l_ciLine(level = 0.95, mul = NULL, ...)
```

Arguments

level	coverage level (e.g. 0.9 means 90% intervals). Should be in (0, 1).
mul	number multiplied by the standard errors when calculating standard error curves. By default NULL, if set to a positive number it will over-ride level.
...	graphical arguments to be passed to <code>ggplot2::geom_line</code> .

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.1D](#), [plot.ptermNumeric](#) or [plot.random.effect](#) for examples.

`l_ciPoly`*Adding confidence band to effect plots*

Description

This layer adds a polygon representing the confidence band of a smooth, random or parametric effect plots.

Usage

```
l_ciPoly(level = 0.95, mul = NULL, ...)
```

Arguments

<code>level</code>	coverage level (e.g. 0.9 means 90% intervals). Should be in (0, 1).
<code>mul</code>	number multiplied by the standard errors when calculating standard error curves. By default <code>NULL</code> , if set to a positive number it will over-ride <code>level</code> .
<code>...</code>	graphical arguments to be passed to <code>ggplot2::geom_polygon</code> .

Value

An object of class `gamLayer`

See Also

See [plot.mgcv.smooth.1D](#), [plot.ptermNumeric](#) or [plot.random.effect](#) for examples.

l_clusterLine	<i>Cluster and plot smooth effects</i>
---------------	--

Description

This layers clusters several smooth effects and plots the cluster centers.

Usage

```
l_clusterLine(centers, cluFun = kmeans, a.clu = list(), ...)
```

Arguments

centers	the number of clusters. This is the same as the centers argument in stats::kmeans .
cluFun	the function used for clustering. It must take (at least) arguments x, centers and data, which have the same interpretation as in stats::kmeans (which is the default).
a.clu	list of further argument to be passed to cluFun.
...	graphical arguments to be passed to <code>ggplot2::geom_line</code> .

Value

An object of class `gamLayer`.

See Also

See [plot.fs.interaction.1D](#) for examples.

l_coordContour	<i>Adding coordinate lines</i>
----------------	--------------------------------

Description

This layers adds coordinate contours to smooth effect plots. It is mainly useful for smooth-on-the-sphere plots.

Usage

```
l_coordContour(brL0 = c(-9:9 * 20), brLA = c(-8:8 * 10), ...)
```

Arguments

brL0	a vector of meridians to be plotted.
brLA	a vector of parallels to be plotted.
...	graphical arguments to be passed to <code>ggplot2::geom_contour</code> .

Value

An object of class `gamLayer`.

See Also

See [plot.sos.smooth](#) for examples.

l_dens1D

Adding density estimate to a plot

Description

This layer adds a density estimate to a plot. It is mainly a wrapper around [ggplot2::geom_density](#).

Usage

```
l_dens1D(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_density`.

Value

An object of class `gamLayer`.

See Also

See [check0D](#) for examples.

l_dens2D

Adding density estimate heatmap

Description

This layer adds a 2D density estimate heat-map to a plot. For 1D effect plots, it adds either the conditional density of the partial residuals, $p(r|x)$, or the joint density $p(r, x)$. For 2D effect plots it adds either $p(x1|x2)$ or $p(x1, x2)$, where $x1$ and $x2$ are the relevant covariates.

Usage

```
l_dens2D(type, n = c(50, 50), bw = NULL, tol = 1e-06, trans = sqrt, ...)
```

```
l_dens(type, n = c(50, 50), bw = NULL, tol = 1e-06, trans = sqrt, ...)
```

Arguments

type	for 1D effect plots, if set to "cond" then the conditional residual density $p(r x)$ is plotted. If set to "joint" the joint density of residuals, $p(r, x)$, is plotted. The behaviour is similar for 2D effect plots, but r indicates the second covariate, not the residuals.
n	vector of two positive integers, indicating the number of grid points at which the density is evaluated on the x and y axes.
bw	vector with two positive entries, indicating the bandwidth to be used by the kernel density estimator of $p(x_1, x_2)$ along x_1 and x_2 .
tol	small positive numerical tolerance. The estimated density at a certain location is set to NA (hence it will appear white) when it falls below $\text{tol}/\sqrt{2\pi\text{sig}}$, where sig is the standard deviation of the residuals. Set tol to -1 plot the density on the whole x - y plane, no matter how low it is.
trans	the density on x - y is transformed using this function before being plotted.
...	graphical arguments to be passed to <code>ggplot2::geom_raster</code> .

Details

The density function is estimated using the fast binned kernel density estimation methods provided by the `KernSmooth` package, hence this function should be able to handle relatively large datasets ($\sim 10^6$ observations).

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.1D](#), [plot.mgcv.smooth.2D](#) and [check1D](#) for examples.

l_densCheck

Checking residuals conditional density

Description

This layer calculates and plots how the empirical conditional density of the residuals, r , differs from its theoretical or model-based counterpart, along a covariate, x .

Usage

```
l_densCheck(n = c(80, 80), bw = NULL, tol = 1e-06, dFun = NULL, ...)
```


Arguments

n	vector of two positive integers, indicating the number of grid points at which the density is evaluated on the x and r axes.
bw	vector with two positive entries, indicating the bandwidth to be used by the kernel density estimator of $p(r x)$ along x and r.
tol	small positive numerical tolerance. The estimated density at a certain location is set to NA (hence it will appear white) when it falls below $\text{tol}/\sqrt{2\pi\text{sig}}$, where sig is the standard deviation of the residuals. Set tol to -1 plot the density on the whole x-y plane, no matter how low it is.
dFun	function used to compute the difference between the empirical (em) and theoretical (th) conditional density of the residuals. By default it is $(\sqrt{\text{em}} - \sqrt{\text{th}})^{1/3}$, where th is computed using either a uniform or a normal density, depending on the type of residuals used in the check1D call. It should have as arguments three vectors: .ed (the empirical conditional density), .gr (the points along the y-axis where the density is evaluated) and .y (the residuals).
...	graphical arguments to be passed to <code>ggplot2::geom_raster</code> .

Details

This layer is mainly meant to work together with the [check1D](#) function. If `check1D()` is called with residual type == "tunif" or "tnormal", then `l_densCheck` compares the conditional distribution of the residuals with $\text{Unif}(0, 1)$ or $N(0, 1)$. By changing the distance function `dFun` one could of course change both the distance metric and the reference distribution (see Examples below).

WARNING: if `check1D()` is called with type != "tunif" or "tnormal", then the default distance used by `l_densCheck` is

```
dFun <- function(.ed, .gr, .y) {
  d <- dnorm(.gr, 0, sd=sd(.y)) # sd=sd(.y) !!!
  d <- sqrt(.ed)-sqrt(d)
  return(sign(d)*abs(d)^(1/3))
}
```

so the residuals are standardized using their own std dev `sd(.y)`. Hence `l_densCheck` might not detect that the mean estimated variance under the fitted model is different from the residuals variance. Hence it is safer to use residual types "tunif" or "tnormal", or a customized distance function `dFun` (see below for an example on how to do this).

Value

An object of class `gamLayer`.

Examples

```
library(mgcViz);
# Dataset where variance increases linearly with x2, for x2 > 0.2
n <- 1e3
x1 <- rnorm(1e3)
x2 <- rnorm(1e3)
dat <- data.frame("x1"=x1,
```

```

      "x2"=x2, "y"=sin(x1) + 0.5*x2^2 + pmax(x2, 0.2)*rnorm(n))
b <- gam(y ~ s(x1)+s(x2), data=dat)
b <- getViz(b)

# (Red) Blue indicates area where the empirical density
# of the residuals is (lower) higher than it should be under
# the model (residuals should be N(0, sigma) here).
# Here there are clear signs of heteroscedasticity:
# the conditional variance is increasing for x2 > 0.2.
check1D(b, "x2", type = "tnormal") + l_densCheck() + l_rug()

# Suppose we want to compare the conditional density of the standardized residuals
# not with a Gaussian, but with a Student-t density with 3 degree of freedom.
# We could achieve this as follows:
myDistance <- function(.ed, .gr, .y){
  d <- dt(.gr / sd(.y), df = 3)
  d <- abs( sqrt(.ed) - sqrt(d) ) # We are using absolute difference between sqrt-densities
}

check1D(b, "x2", type = "response") + l_densCheck(dFun = myDistance) + l_rug()
# NB comparing with a Student density is not useful for this example, but it illustrates
# how both the distance function and the reference density can be customized.

```

l_fitBar

Adding barplot to effect plots

Description

This layer adds a barplot to an effect plots. Mainly useful for factor or binary effect plots.

Usage

```
l_fitBar(a.aes = list(), ...)
```

Arguments

a.aes	list of aesthetic mapping arguments that will be passed to <code>ggplot2::geom_bar</code> . For instance we could set <code>a.aes=list("fill"="red")</code> to change the colour of the barplot.
...	graphical arguments to be passed to ggplot2::geom_bar .

Value

an object of class `gamLayer`.

See Also

See [plot.ptermFactor](#) for examples.

l_fitContour	<i>Adding fitted effect contour lines</i>
--------------	---

Description

This layer adds the contour lines corresponding to a fitted multidimensional effect.

Usage

```
l_fitContour(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_contour`.

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.2D](#), [plot.mgcv.smooth.MD](#), [plot.sos.smooth](#) and [plotSlice](#) for examples.

l_fitDens	<i>Adding density strip of fitted effect</i>
-----------	--

Description

This layer adds a conditional posterior density strip to 1D smooth effects plots. With the default colour scale, the opacity is proportional to the conditional density of the fitted effects, under the usual Gaussian approximation the posterior.

Usage

```
l_fitDens(n = 50, level = 0.95, trans = identity, ...)
```

Arguments

n	sqrt of the number of grid points used to compute the effect plot.
level	confidence level. By default the conditional density of the fit will be plotted between the Gaussian quantiles 0.025 and 0.975, hence the level determines the width of the y-axis.
trans	monotonic function to be applied to the density of the fit, which determines colour of the plot. Monotonicity is not checked.
...	further arguments to be passed to <code>ggplot2::geom_raster</code> .

Details

See Bowman (2018) for explanations about the advantages of density strips, relative to plots including the mean fit + confidence intervals.

Value

An object of class gamLayer.

References

Bowman, D. W (2018). Graphics for uncertainty. Journal of the Royal Statistical Society: Series A.

Examples

```
library(mgcViz)
set.seed(44)
dat <- gamSim(1,n=400,dist="normal",scale=2)
b <- gamV(y~s(x0)+x1+s(x2)+s(x3),data=dat)

plot(sm(b, 1)) + l_fitDens() + l_fitLine()
plot(pterm(b, 1)) + l_fitDens(trans = function(x) x^0.25) + l_fitLine()
```

l_fitLine	<i>Add fitted smooth effect curve</i>
-----------	---------------------------------------

Description

This layer add lines representing a single or a group of parametric or smooth 1D effects.

Usage

```
l_fitLine(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_line`.

Details

When used in conjunction with [plot.fs.interaction.1D](#), which plots smooth effects of type `bs="fs"`, this function uses transparency to avoid over-plotting. This can be avoided by setting `alpha = 1` in the call to `l_fitLine`.

Value

An object of class gamLayer.

See Also

See [plot.mgcv.smooth.1D](#), [plot.ptyermNumeric](#), or [plot.fs.interaction.1D](#) for examples.

l_fitPoints

Adding points representing the fitted effect

Description

This function adds points representing the fitted effect. Mainly useful for plotting factor effects.

Usage

```
l_fitPoints(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_point`.

Value

an object of class `gamLayer`.

See Also

See [plot.ptyermFactor](#) for examples.

l_fitRaster

Adding raster representing the fitted effect

Description

This layer adds a raster or heat-map representing a fitted multidimensional effect.

Usage

```
l_fitRaster(pTrans = function(.p) 1, noiseup = FALSE, mul = 1, ...)
```

Arguments

pTrans	a function from (0, 1) to (0, 1) which takes as input a p-value and returns a value, alpha, which will be passed on to <code>ggplot2::geom_raster</code> , and will determine the opacity of the heat-map. The p-value quantifies the significance of the smooth effect at each location (x1, x2). By default pTrans returns 1, but if we set it to, say, <code>pTrans = function(.p) .p < 0.05</code> then the regions with p-values higher than 0.05 will disappear. The <code>zto1</code> function can be used to specify pTrans in a flexible way.
noiseup	if TRUE the fitted effect, $\mu(x_1, x_2)$, will be perturbed with random noise before being plotted. That is, at each location (x1, x2) a random variable $z(x_1, x_2) \sim N(0, \text{mul} * V(x_1, x_2))$ will be added to $\mu(x_1, x_2)$. Here $V(x_1, x_2)$ is the estimated variance of $\mu(x_1, x_2)$ and mul is a scalar multiplier (see next argument). This is useful for understanding in which areas the smooth is more uncertain, as these areas will appear more noisy.
mul	positive multiplier that scales the variance of the fitted effect. See the noiseup argument.
...	graphical arguments to be passed to <code>ggplot2::geom_raster</code> .

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.2D](#), [plot.sos.smooth](#) or [plotSlice](#) for examples.

l_glyphs2D

Adding glyphs to 2D plots

Description

This layer adds glyphs or subplots to 2D plots. It is mainly meant to be used with [check2D](#) and to produce residuals checks.

Usage

```
l_glyphs2D(
  glyFun,
  ggLay = "geom_points",
  n = c(4, 4),
  mapping = NULL,
  data = NULL,
  polar = FALSE,
  height = ggplot2::rel(0.95),
  width = ggplot2::rel(0.95),
  y_scale = identity,
```

```

    x_scale = identity,
    ...
  )

```

Arguments

glyFun	the function that produces the data needed to construct the glyphs. It will take a single argument (.d), which is a data.frame with columns "x", "y" and "z". When l_glyphs2D is used with check2D, then "x" and "y" will be the locations of the residual "z" in the relevant covariates. glyFun needs to output a data.frame that will be passed to the ggLay function, which does the plotting.
ggLay	the ggplot2 layer function (such as "geom_point") used to plot the glyphs. Its mapping needs to take at least argument "x", "y" and "group". See the mapping argument below.
n	vector of two positive integers, indicating the number of 2D grid cell along x and y in which the data is divided.
mapping	list of aesthetic mappings to be used by ggLay. By default it is aes(x=gx, y=gy, group = gid). Here gx and gy specify the x-y location of each data-point used to plot the glyphs, while gid specifies to which glyph each data-point belongs (there are n[1]*n[2] glyphs).
data	an optional data.frame to be used for computing the glyphs. It must have two variables called x and y. If left to NULL then the glyphs will be computed using the data in the plotSmooth object to which this layer is being added.
polar, height, width, y_scale, x_scale	see GGally::glyphs .
...	graphical arguments to be passed to ggLay function.

Value

An object of class gamLayer.

See Also

[check2D](#).

Examples

```

library(mgcViz);
set.seed(4124)
n <- 1e4
dat <- data.frame("x1" = rnorm(n), "x2" = rnorm(n))

# Residuals are heteroscedastic w.r.t. x1
dat$y <- (dat$x1)^2 + (dat$x2)^2 + (1*abs(dat$x1) + 1) * rnorm(n)
b <- bam(y ~ s(x1,k=30) + s(x2, k=30), data = dat, discrete = TRUE)
b <- getViz(b)

pl <- check2D(b, x1 = "x1", x2 = "x2", type = "tnormal") +
  l_points(colour = "blue", alpha = 0.5)

```

```

# Look at distributions of residuals across x1 and x2
# Approach 1: using binned kernel density estimate
# Colour indicates whether we have more than 50 obs in that bin
glyFun <- function(.d){
  .r <- .d$z
  .qq <- as.data.frame( density(.r)[c("x", "y")], n = 100 )
  .qq$colour <- rep(ifelse(length(.r)>50, "black", "red"), nrow(.qq))
  return( .qq )
}

p1 + l_glyphs2D(glyFun = glyFun, ggLay = "geom_path", n = c(8, 8),
  mapping = aes(x=gx, y=gy, group = gid, colour = I(colour)),
  height=1.5, width = 1)

# Approach 2: using binned worm-plots. These are simply rotated QQplots.
# An horizontal plot indicates well specified residual model.
# Increasing (decreasing) worm indicates over (under) dispersion
glyFun <- function(.d){
  n <- nrow(.d)
  px <- qnorm( (1:n - 0.5)/(n) )
  py <- sort( .d$z )
  clr <- if(n > 50) { "black" } else { "red" }
  clr <- rep(clr, n)
  return( data.frame("x" = px, "y" = py - px, "colour" = clr))
}

p1 + l_glyphs2D(glyFun = glyFun, ggLay = "geom_point", n = c(10, 10),
  mapping = aes(x=gx, y=gy, group = gid, colour = I(colour)),
  height=2, width = 1, size = 0.2)

```

l_gridCheck1D

Binning and checking GAM residuals

Description

This layer bins the residuals, r , according to the value of the corresponding covariate, x . Then the residuals in each bin are summarized using a scalar-valued statistic. Confidence intervals for the statistic corresponding to each bin can be obtained by simulating residuals from the fitted GAM model, binning and summarizing them. Mainly useful in conjunction with [check1D](#).

Usage

```

l_gridCheck1D(
  gridFun = NULL,
  n = 20,
  level = 0.8,
  stand = "none",

```



```

    showReps = TRUE,
    showObs = TRUE,
    ...
  )

```

Arguments

gridFun	scalar-valued function used to summarize the residuals in each bin. It takes a vector as input. By default it is $\text{mean}(r) * \sqrt{\text{length}(r)}$, where r is the vector of residuals in that bin.
n	number of grid intervals along the relevant covariate.
level	the level of the confidence intervals (e.g. 0.9 means 90% intervals).
stand	if "none" the residuals in each bin are transformed by gridFun and the result statistics are plotted directly. If "sc" the statistics in each bin are scaled and centered using the mean and standard deviation of the simulated stats in that bin. If "s" we do only scaling, if "c" only centering.
showReps	if TRUE the individuals simulated statistics are also plotted using small points.
showObs	if TRUE the observed statistics are plotted using large points.
...	graphical arguments to be passed to <code>ggplot2::geom_point</code> .

Value

An object of class `gamLayer`

Examples

```

library(mgcViz);
set.seed(4124)
n <- 1e4
x <- rnorm(n); y <- rnorm(n);

# Residuals are heteroscedastic w.r.t. x
ob <- (x)^2 + (y)^2 + (0.2*abs(x) + 1) * rnorm(n)
b <- bam(ob ~ s(x,k=30) + s(y, k=30), discrete = TRUE)
b <- getViz(b, nsim = 50)

# Don't see much by looking at mean
check1D(b, "x") + l_gridCheck1D()

# Heteroscedasticity clearly visible here
check1D(b, "x") + l_gridCheck1D(gridFun = sd, stand = "sc") # <- we are scaling and centering
# Last point on the right of the rug seems to indicate that a bin is missing.
# It is not an error, only on observation falls in that bin, hence the
# standard deviation is not defined there.

```

l_gridCheck2D

*Binning and checking GAM residuals***Description**

This layer bins the residuals, r , according to the value of the corresponding covariates, x_1 and x_2 . Then the residuals in each bin are summarized using a scalar-valued statistic. Confidence intervals for the statistic corresponding to each bin can be obtained by simulating residuals from the fitted GAM model, which are then binned and summarized. Mainly useful in conjunction with [check2D](#).

Usage

```
l_gridCheck2D(gridFun = mean, bw = c(NA, NA), stand = TRUE, binFun = NULL, ...)
```

Arguments

gridFun	scalar-valued function used to summarize the residuals in each bin.
bw	numeric vector giving bin width in the vertical and horizontal directions. See the binwidth arguments in <code>?ggplot2::stat_summary_hex</code> . If left to NA, it will be set to 1/20 of the ranges of x_1 and x_2 .
stand	if left to TRUE then the observed statistic in the i -th cell is normalized using the simulated statistics in that same cell. That is, we will actually plot <code>std_stat = (obs_stat - mean(sim_stat)) / sd(sim_stat)</code> .
binFun	the ggplot2 function used to perform the binning. By default it is either ggplot2::stat_summary_2d or ggplot2::stat_summary_hex , depending on the class of the covariates x_1 and x_2 .
...	graphical arguments to be passed to <code>ggplot2::stat_summary_hex</code> .

Value

An object of class `gamLayer`

Examples

```
library(mgcViz);
set.seed(4124)
n <- 1e4
x <- rnorm(n); y <- rnorm(n);

# Residuals are heteroscedastic w.r.t. x
ob <- (x)^2 + (y)^2 + (1*abs(x) + 1) * rnorm(n)
b <- bam(ob ~ s(x,k=30) + s(y, k=30), discrete = TRUE)
b <- getViz(b, nsim = 50)

# Don't see much by looking at mean
check2D(b, "x", "y") + l_gridCheck2D(gridFun = mean, bw = c(0.4, 0.4))
```

```
# Variance pattern along x-axis clearer now
check2D(b, "x", "y") + l_gridCheck2D(gridFun = sd, bw = c(0.4, 0.4))
```

l_gridQCheck1D

Checking sign of residuals along one covariate

Description

This layer is mainly useful when checking quantile GAMs fitted using the `qgam` package. The residuals, `r`, are binned according to the corresponding value of a covariate, `x`. Then the proportions of negative residuals within each bin are calculated, and compared with the theoretical value, `qu`. Confidence intervals for the proportion of negative residuals can be derived using binomial quantiles (under an independence assumption). To be used in conjunction with [check1D](#).

Usage

```
l_gridQCheck1D(qu = NULL, n = 20, level = 0.8, ...)
```

Arguments

<code>qu</code>	the quantile of interest. Should be in (0, 1).
<code>n</code>	number of grid intervals.
<code>level</code>	the level of the confidence intervals plotted.
<code>...</code>	graphical arguments to be passed to <code>ggplot2::geom_point</code> .

Value

An object of class `gamLayer`

Examples

```
# Simulate some data
library(mgcViz)
set.seed(3841)
dat <- gamSim(1,n=400,dist="normal",scale=2)
dat$fac <- as.factor( sample(letters[1:8], nrow(dat), replace = TRUE) )
fit <- qgam(y~s(x1)+s(x2)+s(x3)+fac, data=dat, err = 0.05, qu = 0.4)
fit <- getViz(fit)

# "x0" effect is missing, but should be there. l_gridQCheck1D shows
# that fraction of negative residuals is quite different from the theoretical 0.4
# in several places along "x0".
check1D(fit, dat$x0) + l_gridQCheck1D(qu = 0.4, n = 20)
# The problem gets better if s(x0) is added to the model.

# Works also with factor variables
check1D(fit, "fac") + l_gridQCheck1D(qu = 0.4)
```

l_gridQCheck2D

*Binning and checking QGAM residuals***Description**

This layer bins the residuals, r , according to the value of the corresponding covariates, x_1 and x_2 . Then we calculate the proportion of negative residuals in each bin, which should not deviate too much from the theoretical proportion (eg 0.5 if we fit the median). Mainly useful in conjunction with [check2D](#).

Usage

```
l_gridQCheck2D(qu = NULL, bw = c(NA, NA), stand = TRUE, binFun = NULL, ...)
```

Arguments

qu	the quantile of interest. Should be in (0, 1).
bw	numeric vector giving bin width in the vertical and horizontal directions. See the binwidth arguments in <code>?ggplot2::stat_summary_hex</code> . If left to NA, it will be set to 1/20 of the ranges of x_1 and x_2 .
stand	if left to TRUE then the observed proportion of negative residuals \hat{p}_i in the i -th cell is normalized using the standard error $se = \sqrt{qu(1-qu)/n}$, where n is the number of observation in that cell. That is, if <code>stand=TRUE</code> we plot $(\hat{p}_i - qu)/se$ rather than simply \hat{p}_i .
binFun	the ggplot2 function used to perform the binning. By default it is either ggplot2::stat_summary_2d or ggplot2::stat_summary_hex , depending on the class of the covariates x_1 and x_2 .
...	graphical arguments to be passed to <code>ggplot2::stat_summary_hex</code> .

Value

An object of class `gamLayer`

Examples

```
library(mgcViz);
set.seed(4124)
n <- 4e2
dat <- data.frame(x = rnorm(n), y = rnorm(n))

# Simulate some data, residuals are heteroscedastic w.r.t. x
dat$ob <- (dat$x)^2 + (dat$y)^2 + (0.2*abs(dat$x) + 1) * rnorm(n)
b <- qgamV(ob ~ x + s(y), qu = 0.3, data = dat)

# We have a residual pattern along x (increase n above to
# see the problem more clearly)
check2D(b, "x", "y") + l_gridQCheck2D(qu = 0.3, bw = c(0.4, 0.4))
```

```
# We need a smooth wrt x to make the pattern disappear
## Not run:
b1 <- qgamV(ob ~ s(x) + s(y), qu = 0.3, data = dat)

check2D(b1, "x", "y") + l_gridQCheck2D(qu = 0.3, bw = c(0.4, 0.4))

## End(Not run)
```

l_hist

Adding histogram to a plot

Description

This layer adds a histogram to a plot. It is mainly a wrapper around [ggplot2::geom_histogram](#).

Usage

```
l_hist(...)
```

Arguments

... graphical arguments to be passed to [ggplot2::geom_histogram](#).

Value

An object of class `gamLayer`.

See Also

See [check0D](#) for examples.

l_points

Add points to plot

Description

This layers add points to smooth, parametric or random effect plots. It can also be used to add points to the output of `check1D` and `check2D`. The meaning of the added points, which could represent residuals or covariate values, should be clear from context.

Usage

```
l_points(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_point`.

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.1D](#), [plot.mgcv.smooth.2D](#), [check1D](#) or [check2D](#) for examples.

l_poly	<i>Add polygons to effect plots</i>
--------	-------------------------------------

Description

This layers adds polygons to plots and it is mainly usefult for plotting Markov random field smooths.

Usage

```
l_poly(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_polygon`.

Value

An object of class `gamLayer`.

See Also

See [plot.mrf.smooth](#) for examples.

l_pvContour	<i>Adding contour of p-values</i>
-------------	-----------------------------------

Description

This function adds contour lines proportional to the p-value of a multidimensional smooth effects. It is useful for checking where (across covariates x1 and x2) the fitted smooth is significantly different from zero.

Usage

```
l_pvContour(pTrans = identity, ...)
```

Arguments

pTrans	a transformation to be applied to the p-values before plotting.
...	graphical arguments to be passed to <code>ggplot2::geom_contour</code> .

Value

An object of class `gamLayer`.

See Also

See [plotDiff.mgcv.smooth.2D](#) and [plotDiff.sos.smooth](#) for examples.

l_pvRaster	<i>Adding raster or heat-map of p-values</i>
------------	--

Description

This function adds a raster or heat-map proportional to the p-value of a multidimensional smooth effects. It is useful for checking where (across covariates x1 and x2) the fitted smooth is significantly different from zero.

Usage

```
l_pvRaster(pTrans = identity, ...)
```

Arguments

pTrans	a transformation to be applied to the p-values before plotting.
...	graphical arguments to be passed to <code>ggplot2::geom_raster</code> .

Value

An object of class `gamLayer`.

See Also

See [plotDiff.mgcv.smooth.2D](#) and [plotDiff.sos.smooth](#) for examples.

l_rug

Adding rug to margins of a plot

Description

This layer adds a rug plot to the margins of a plot. It is mainly a wrapper around `ggplot2::geom_rug`. Notice that for factor effects plots the rug is jittered by default.

Usage

```
l_rug(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_rug`.

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.1D](#), [plot.mgcv.smooth.2D](#) or [check1D](#) for examples.

l_simLine

Add simulated smooth effect curves

Description

This layer adds curves representing smooth effects simulated from the posterior distribution.

Usage

```
l_simLine(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_line`.

Details

This function uses transparency to avoid over-plotting. This can be avoided by setting `alpha = 1` in the call to `l_simLine`.

Value

An object of class `gamLayer`.

See Also

See [plot.mgcv.smooth.1D](#) for examples.

l_vline	<i>Adding vertical line to a plot</i>
---------	---------------------------------------

Description

This layer adds a vertical to a plot. It is mainly a wrapper around [ggplot2::geom_vline](#).

Usage

```
l_vline(...)
```

Arguments

... graphical arguments to be passed to `ggplot2::geom_vline`.

Value

An object of class `gamLayer`.

See Also

See [check0D](#) for examples.

mqgamV

*Fit multiple QGAM models and get a mgamViz object***Description**

These are wrapper that fits multiple QGAM models using [qgam::mqgam](#) and converts it to a `mgamViz` object using the [getViz](#) function. It is essentially a shortcut.

Usage

```
mqgamV(form, data, qu, lsig = NULL, err = NULL, aQgam = list(), aViz = list())
```

Arguments

`form`, `data`, `qu`, `lsig`, `err`
 same arguments as in [qgam::mqgam](#).

`aQgam` list of further arguments to be passed to [qgam::mqgam](#).

`aViz` list of arguments to be passed to [getViz](#).

Value

An object of class "mgamViz" which can, for instance, be plotted using [plot.mgamViz](#).

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(2,n=500,dist="normal",scale=0.25)$data

# Fit GAM and get gamViz object
b <- mqgamV(y~s(x) + s(z) + I(x*z), data = dat, qu = c(0.25, 0.5, 0.75),
            aQgam = list(argGam = list(select = TRUE)), aViz = list("nsim" = 0))

# This is equivalent to doing
# 1. Fit QGAM
# b <- mqgam(y~s(x) + s(z) + I(x*z), data=dat,
#           qu = c(0.25, 0.5, 0.75), argGam = list(select = TRUE))
# 2. Convert to gamViz object
# b <- getViz(b, nsim = 0)

# Either way, we all effects by doing
print(plot(b, allTerms = TRUE), pages = 1)
```

plot.ALE1D

*Plot 1D Accumulated Local Effects (ALE)***Description**

Plot 1D Accumulated Local Effects (ALE)

Usage

```
## S3 method for class 'ALE1D'
plot(x, trans = identity, maxpo = 10000, nsim = 0, ...)
```

Arguments

x	a 1D ALE effects, produced by the ALE function
trans	monotonic function to apply to the ALE effect, before plotting. Monotonicity is not checked.
maxpo	maximum number of rug lines that will be used by <code>l_rug</code> . If number of data-points > maxpo, then a subsample of maxpo points will be taken.
nsim	number of ALE effect curves to be simulated from the posterior distribution. These can be plotted using the l_simLine layer. See Examples section below.
...	currently not used.

Value

An objects of class `plotSmooth`.

Author(s)

Matteo Fasiolo and Christian Capezza, with some internal code having been adapted from the ALE-Plot package of Dan Apley.

References

Apley, D.W., and Zhu, J, 2016. Visualizing the effects of predictor variables in black box supervised learning models. arXiv preprint arXiv:1612.08468.

Examples

```
library(mgcViz)
# Here x1 and x2 are very correlated, but only
# x1 has influence of the response
set.seed(4141)
n <- 1000
X <- rmvn(n, c(0, 0), matrix(c(1, 0.9, 0.9, 1), 2, 2))
y <- X[, 1] + 0.2 * X[, 1]^2 + rnorm(n, 0, 0.8)
dat <- data.frame(y = y, x1 = X[, 1], x2 = X[, 2])
```

```

fit <- gam(y ~ te(x1, x2), data = dat)

# Marginal plot suggests that E(y) depends on x2, but
# this is due to the correlation between x1 and x2...
plot(dat$x2, fit$fitted.values)

# ... in fact ALE effect of x2 is flat ...
plot(ALE(fit, "x2")) + l_ciPoly() + l_fitLine() + l_rug()

# ... while ALE effect of x1 is strong.
plot(ALE(fit, "x1", center = 2), nsim = 20) +
  l_simLine() + l_fitLine()

```

plot.fs.interaction.1D

Plotting one dimensional smooth factor interactions

Description

This method should be used to plot smooth effects of class "fs.interaction.1D", that is smooth constructed using the basis bs="tp". See [mgcv::s](#).

Usage

```

## S3 method for class 'fs.interaction.1D'
plot(x, n = 100, xlim = NULL, trans = identity, ...)

```

Arguments

x	a smooth effect object.
n	number of grid points used to compute main effect and c.i. lines. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
...	currently unused.

Value

An object of class c("plotSmooth", "gg").

Examples

```
library(mgcViz)
set.seed(0)
## simulate data...
f0 <- function(x) 2 * sin(pi * x)
f1 <- function(x, a = 2, b = -1) exp(a * x) + b
f2 <- function(x) 0.2 * x^11 * (10 * (1 - x))^6 + 10 *
  (10 * x)^3 * (1 - x)^10
n <- 500; nf <- 25
fac <- sample(1:nf, n, replace = TRUE)
x0 <- runif(n); x1 <- runif(n); x2 <- runif(n)
a <- rnorm(nf) * .2 + 2; b <- rnorm(nf) * .5
f <- f0(x0) + f1(x1, a[fac], b[fac]) + f2(x2)
fac <- factor(fac)
y <- f + rnorm(n) * 2
## so response depends on global smooths of x0 and
## x2, and a smooth of x1 for each level of fac.

## fit model (note p-values not available when fit
## using gamm)...
bm <- gamm(y ~ s(x0) + s(x1, fac, bs = "fs", k = 5) + s(x2, k = 20))
v <- getViz(bm$gam)

# Plot with fitted effects and changing title
plot(sm(v, 2)) + l_fitLine(alpha = 0.6) + labs(title = "Smooth factor interactions")

# Changing plotting limits
plot(sm(v, 2)) + l_fitLine() + ylim(-0.5, 0.5) + xlim(0.25, 0.75)

# Change line type and remove legend
plot(sm(v, 2)) + l_fitLine(size = 1.3, linetype="dotted") +
  theme(legend.position="none")

# Clustering smooth effects in 3 groups
plot(sm(v, 2)) + l_fitLine(colour = "grey") +
  l_clusterLine(centers = 3, a.clu = list(nstart = 100))
```

plot.gamViz

Basic GAM plotting

Description

This function is the mgcViz equivalent of [plot.gam](#). It is the workhorse of the mgcViz package, and allows plotting (almost) any type of smooth, parametric or random effects. It is basically a wrapper around plotting methods that are specific to individual smooth effect classes (such as [plot.mgcv.smooth.1D](#) and [plot.random.effect](#)).

Usage

```
## S3 method for class 'gamViz'
plot(x, n = 100, n2 = 40, select = NULL, allTerms = FALSE, ...)
```

Arguments

<code>x</code>	an object of class <code>gamViz</code> , the output of a getViz call.
<code>n</code>	number of points used for each 1-d plot. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
<code>n2</code>	square root of number of grid points used for plotting 2D functions effects using contours or heatmaps.
<code>select</code>	allows plotting a subset of model terms. For instance, if you just want the plot for the second smooth term, set <code>select = 2</code> . Parametric effects always come after smooth or random effects.
<code>allTerms</code>	if TRUE also the parametric effects will be plotted.
<code>...</code>	other parameters, such as <code>maxpo</code> or <code>trans</code> , to be passed to the specific plotting methods for each effect (e.g. to plot.mgcv.smooth.1D).

Value

An object of class `c("plotGam", "gg")`.

Examples

```
library(mgcViz)

##### Basic example
# Simulate some data and fit model
set.seed(2)
dat <- gamSim(1,n=1e3,dist="normal",scale=2)
b <- bam(y~s(x0)+s(x1, x2)+s(x3), data=dat)
b <- getViz(b)

# Default smooth effect plotting
print(plot(b), ask = FALSE)

# Now on one page and with out title on the second plot
print(plot(b) + labs(title = NULL), pages = 1)

# So far we used default layers, added in the printing phase, but
# we might want to specify our own layers. Here we is how to do it
pl <- plot(b) + l_points() + l_fitLine(linetype = 3) + l_fitContour() +
  l_ciLine(colour = 2) + theme_get() + labs(title = NULL)
print(pl, pages = 1)

# We might want to plot only the first smooth
plot(b, select = 1) + l_dens(type = "cond") + l_fitLine() + l_ciLine()

## Not run:
##### Example with "by variable" smooth effect
# Simulate data and fit model
dat <- gamSim(4)
b <- gam(y ~ fac+s(x2,by=fac)+s(x0),data=dat)
b <- getViz(b)
```

```

# print() only needed because we want to plot on a single page
print(plot(b), pages = 1)
print(plot(b, allTerms = TRUE), pages = 1) # Including also parametric effect

##### Example with 3D smooth effect which cannot be plotted
# Simulate data and fit model
n <- 5e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n); z2 <- rnorm(n)

ob <- (x-z)^2 + (y-z)^2 + z2^3 + rnorm(n)
b1 <- bam(ob ~ s(x, y, z) + s(z2), discrete = TRUE)
b1 <- getViz(b1)

# Only second effect get plotted
plot(b1)
# In fact this does not plot anything
plot(b1, select = 1)
# For plotting effects with more than 2D, one we need specific method.
# See ?plot.mgcv.smooth.MD

##### Examples about plotting parametric effects
# 1 Gaussian GAM
set.seed(3)
dat <- gamSim(1,n=2500,dist="normal",scale=20)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )
bs <- "cr"; k <- 12
b <- bam(y ~ x0 + x1 + I(x1^2) + s(x2,bs=bs,k=k) + fac + x3:fac + I(x1*x2) + logi +
        s(x3, bs=bs),data=dat, discrete = TRUE)
b <- getViz(b)

# All effects in one page. Notably 'x3:fac' is missing: we have no methods
# for plotting second order effects.
print(plot(b, allTerms = TRUE), pages = 1)

# Plotting only parametric effects
print(plot(b, select = 3:9), pages = 1)

# 2 GAMLSS Gaussian model
library(mgcv);library(MASS)
mcycle$fac <- as.factor( sample(c("z", "k", "a", "f"), nrow(mcycle), replace = TRUE) )
b <- gam(list(accel~times + I(times^2) + s(times,k=10), ~ times + fac + s(times)),
        data=mcycle,family=gaulss())
b <- getViz(b)

# All effects on one page: effect of second linear predictor end with '.1'
print(plot(b, allTerms = TRUE), pages = 1)

## End(Not run)

```

plot.mgamViz

*Plotting multiple quantile GAMs***Description**

This function is similar to [plot.gamViz](#), but it is used to plot multiple quantile GAM models fitted using [mqgamV](#) or [mqgam](#). It allows plotting standards 1D and 2D smooths, and parametric effects, It is basically a wrapper around plotting methods that are specific to individual smooth effect classes (such as [plot.multi.mgcv.smooth.1D](#)).

Usage

```
## S3 method for class 'mgamViz'
plot(x, n = 100, n2 = 40, select = NULL, allTerms = FALSE, ...)
```

Arguments

x	an object of class mgamViz, the output of a getViz call. Alternatively x can be a list of fitted GAM models, each having the same model formula.
n	number of points used for each 1-d plot. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
n2	square root of number of grid points used for plotting 2D functions effects using contours or heatmaps.
select	allows plotting a subset of model terms. For instance, if you just want the plot for the second smooth term, set select = 2. Parametric effects always come after smooth or random effects.
allTerms	if TRUE also the parametric effects will be plotted.
...	other parameters, such as maxpo or trans, to be passed to the specific plotting methods for each effect (e.g. to plot.multi.mgcv.smooth.1D).

Value

An object of class c("plotGam", "gg").

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1,n=500,dist="normal",scale=2)
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )

dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )

# Fit GAM and get gamViz object
fit <- mqgamV(y ~ fac + s(x0) + s(x1, x2) + x3 + logi, data = dat,
             qu = c(0.2, 0.4, 0.6, 0.8))
```



```

print(plot(fit, select = 1:4, allTerms = T), pages = 1)

## Not run:
# Example where we are fitting the same model to different datasets, but
# plotting the estimate effects together
dat <- list()
for(ii in 1:4){
  # Simulate 4 datasets, we are adding 2 factor variables "fac" and "ref" just
  # for illustrating the plotting method (the two factors have no effect on y)
  n <- 1000
  dat[[ii]] <- gamSim(1,n=n,dist="normal",scale=2)
  dat[[ii]]$fac <- as.factor( sample(c("A1", "A2", "A3"), n, replace = TRUE) )
  dat[[ii]]$ref <- as.factor( sample(letters[1:10], n, replace = TRUE) )
}

# Estimating model on each dataset
mods <- list()
for(ii in 1:4){
  mods[[ii]] <- gamV(y~s(x0)+s(x1, x2)+x3+fac+s(ref, bs = "re"), data = dat[[ii]])
}

# Names will be used to identify the four models we have fitted
names(mods) <- c("M1", "M2", "M3", "M4")
# Plotting on the same plots
print(plot.mgamViz(mods, allTerms = TRUE), pages = 1)

## End(Not run)

```

plot.mgcv.smooth.1D *Plotting one dimensional smooth effects*

Description

Plotting method for one dimensional smooth effects.

Usage

```

## S3 method for class 'mgcv.smooth.1D'
plot(
  x,
  n = 100,
  xlim = NULL,
  maxpo = 10000,
  trans = identity,
  unconditional = FALSE,
  seWithMean = FALSE,
  nsim = 0,
  ...

```

```

)

## S3 method for class 'multi.mgcv.smooth.1D'
plot(
  x,
  n = 100,
  xlim = NULL,
  maxpo = 10000,
  trans = identity,
  unconditional = FALSE,
  seWithMean = FALSE,
  asFact = NULL,
  ...
)

```

Arguments

x	a smooth effect object, extracted using sm .
n	number of grid points used to compute main effect and c.i. lines. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
maxpo	maximum number of residuals points that will be used by layers such as <code>resRug()</code> and <code>resPoints()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
seWithMean	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
nsim	number of smooth effect curves to be simulated from the posterior distribution. These can be plotted using the l_simLine layer. See Examples section below.
...	currently unused.
asFact	determines whether to use a factor or colour bar legend for <code>plot.multi.mgcv.smooth.1D</code> . For most models the default is TRUE. When working with QGAM models fitted with mqgamV , the default is FALSE for less than 10 quantiles, TRUE otherwise. For QGAM models there a third option, <code>asFact = "force"</code> , which forces the use of a discrete colour scale.

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```
library(mgcViz)
n <- 1e3
x1 <- rnorm(n)
x2 <- rnorm(n)
dat <- data.frame("x1" = x1, "x2" = x2,
                  "y" = sin(x1) + 0.5 * x2^2 + pmax(x2, 0.2) * rnorm(n))
b <- bamV(y ~ s(x1)+s(x2), data = dat, method = "fREML", aGam = list(discrete = TRUE))

o <- plot(sm(b, 1), nsim = 50) # 50 posterior simulations

## Not run:
# Plot with fitted effect + posterior simulations + rug on x axis
( o <- o + l_simLine() + l_fitLine(colour = "red") +
  l_rug(alpha = 0.8) )

# Add CI lines at 1*sigma and 5*sigma
( o <- o + l_ciLine(mul = 1) + l_ciLine(mul = 5, colour = "blue", linetype = 2) )

# Add partial residuals and change theme
( o + l_points(shape = 19, size = 1, alpha = 0.2) + theme_classic() )

# Get second effect plot
o2 <- plot( sm(b, 2) )

# Plot it with polygon for partial residuals
o2 + l_ciPoly(mul = 5, fill = "light blue") +
  l_fitLine(linetype = 2, colour = "red")

# Plot is with conditional density of partial residuals
o2 + l_dens(type = "cond", alpha = 0.9) +
  l_fitLine(linetype = 2, colour = "red")

#####
# Quantile GAM example
#####
# Fit model
b <- mqgamV(y ~ s(x1) + s(x2), qu = c(0.2, 0.5, 0.8), data = dat)

plot(sm(b, 1)) + l_fitLine(linetype = 2) + l_rug(colour = "blue")

## End(Not run)
```

plot.mgcv.smooth.2D *Plotting two dimensional smooth effects*

Description

Plotting method for two dimensional smooth effects.

Usage

```
## S3 method for class 'mgcv.smooth.2D'
plot(
  x,
  n = 40,
  xlim = NULL,
  ylim = NULL,
  maxpo = 10000,
  too.far = 0.1,
  trans = identity,
  seWithMean = FALSE,
  unconditional = FALSE,
  ...
)

## S3 method for class 'multi.mgcv.smooth.2D'
plot(
  x,
  n = 30,
  xlim = NULL,
  ylim = NULL,
  maxpo = 10000,
  too.far = 0.1,
  trans = identity,
  seWithMean = FALSE,
  unconditional = FALSE,
  a.facet = list(),
  ...
)
```

Arguments

x	a smooth effect object, extracted using sm .
n	sqrt of the number of grid points used to compute the effect plot.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
ylim	if supplied then this pair of numbers are used as the y limits for the plot.

maxpo	maximum number of residuals points that will be used by layers such as <code>resRug()</code> and <code>resPoints()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
too.far	if greater than 0 then this is used to determine when a location is too far from data to be plotted. This is useful since smooths tend to go wild away from data. The data are scaled into the unit square before deciding what to exclude, and too.far is a distance within the unit square. Setting to zero can make plotting faster for large datasets, but care then needed with interpretation of plots.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
seWithMean	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.
a.facet	arguments to be passed to <code>ggplot2::facet_wrap</code> or <code>ggplot2::facet_grid</code> . The former gets called when <code>fix</code> contains one vector, the latter when <code>fix</code> contains two vectors.

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. *Scandinavian Journal of Statistics*.

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(1, n = 700, dist = "normal", scale = 2)
b <- gam(y ~ s(x0) + s(x1, x2) + s(x3), data = dat, method = "REML")
b <- getViz(b)

# Plot 2D effect with noised-up raster, contour and rug for design points
# Opacity is proportional to the significance of the effect
plot(sm(b, 2)) + l_fitRaster(pTrans = zto1(0.05, 2, 0.1), noiseup = TRUE) +
  l_rug() + l_fitContour()

# Plot contour of effect joint density of design points
plot(sm(b, 2)) + l_dens(type = "joint") + l_points() + l_fitContour() +
  coord_cartesian(expand = FALSE) # Fill the plot
```

```
###
# Quantile GAM example
###
b <- mqgamV(y ~ s(x0) + s(x1, x2) + s(x3), qu = c(0.3, 0.7), data = dat)

plot(sm(b, 2)) + l_fitRaster(noiseup = TRUE) + l_fitContour(colour = 2)
```

plot.mgcv.smooth.MD *Plotting slice of higher-dimensional smooth effects*

Description

This function plots a 2D slice of a higher-dimensional smooth effects.

Usage

```
## S3 method for class 'mgcv.smooth.MD'
plot(
  x,
  fix,
  n = 40,
  xlim = NULL,
  ylim = NULL,
  maxpo = 10000,
  too.far = c(0.1, NA),
  trans = identity,
  seWithMean = FALSE,
  unconditional = FALSE,
  ...
)
```

Arguments

<code>x</code>	a smooth effect object, extracted using sm .
<code>fix</code>	a named vector indicating which variables must be kept fixed and to what values. When plotting a smooth in (d+2) dimensions, then d variables must be fixed.
<code>n</code>	sqrt of the number of grid points used to compute the effect plot.
<code>xlim</code>	if supplied then this pair of numbers are used as the x limits for the plot.
<code>ylim</code>	if supplied then this pair of numbers are used as the y limits for the plot.
<code>maxpo</code>	maximum number of residuals points that will be used by layers such as <code>resRug()</code> and <code>resPoints()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.

too.far	a numeric vector with two entries. The first has the same interpretation as in plot.mgcv.smooth.2D and it avoids plotting the smooth effect in areas that are too far from any observation. The distance will be calculated only using the variables which are not in <code>fix</code> (see above). Hence in two dimensions, not in the full $d+2$ dimensions. Set it to -1 to plot the whole smooth. The second entry determines which residuals and covariates pairs are closed enough to the selected slice. If left to NA on the 10\ closest (in terms of scaled Euclidean distance) to the current slice will be plotted. Set it to -1 to plot all the residuals.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
seWithMean	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. *Scandinavian Journal of Statistics*.

Examples

```
## Not run:
## 3D example
library(mgcViz)
n <- 1e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n)

ob <- (x-z)^2 + (y-z)^2 + rnorm(n)
b <- gam(ob ~ s(x, y, z))
b <- getViz(b)

# Plot one 2D slice
plot( sm(b, 1), fix = c("z"=0) ) + l_fitRaster(noiseup = TRUE, mul = 3) +
  l_fitContour(linetype = 2) + l_points(shape = 2)

## 4D
n <- 5e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n); z2 <- rnorm(n)

ob <- (x-z)^2 + (y-z)^2 + z2^3 + rnorm(n)
```

```

b1 <- bam(ob ~ s(x, y, z, z2), discrete = TRUE)
b1 <- getViz(b1)

# Plot one 2D slice
plot(sm(b1, 1), fix = c("z"=0, "z2"=1)) + l_fitRaster() + l_fitContour()

## End(Not run)

```

plot.mrf.smooth	<i>Plotting Markov random field smooths</i>
-----------------	---

Description

This is the plotting method for Markov random field smooths.

Usage

```

## S3 method for class 'mrf.smooth'
plot(x, trans = identity, seWithMean = FALSE, unconditional = FALSE, ...)

```

Arguments

x	a smooth effect object, extracted using sm .
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
seWithMean	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Value

An objects of class plotSmooth.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```

library(mgcViz)
## 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
par(mfrow=c(2,2))
## First a full rank MRF...
b <- gam(crime ~ s(district,bs="mrf",xt=xt),data=columb,method="REML")
b <- getViz(b)

# Manual plot
plot(sm(b, 1)) + l_poly(colour = 2) +
  scale_fill_gradientn(colours = heat.colors(50))

# Default plot
plot(b)

```

plot.multi.ptermFactor

Plotting factor or logical parametric effects

Description

These are the plotting methods for parametric factor or logical effects.

Usage

```

## S3 method for class 'multi.ptermFactor'
plot(x, a.facet = list(), asFact = TRUE, ...)

## S3 method for class 'multi.ptermLogical'
plot(x, ...)

## S3 method for class 'ptermFactor'
plot(x, maxpo = 10000, trans = identity, ...)

## S3 method for class 'ptermLogical'
plot(x, maxpo = 10000, trans = identity, ...)

```

Arguments

x	a factor or logical parametric effect object, extracted using pterm .
a.facet	arguments to be passed to ggplot2::facet_wrap or ggplot2::facet_grid . The former gets called when fix contains one vector, the latter when fix contains two vectors.

asFact	relevant only when working with models fitted with mqgamV . If FALSE quantile of interest (qu) is treated as a continuous variable, otherwise as a factor.
...	currently unused.
maxpo	maximum number of residuals points that will be used by layers such as <code>resRug()</code> and <code>resPoints()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
trans	monotonic function to apply to the fit, confidence intervals and residuals, before plotting. Monotonicity is not checked.

Value

An object of class `plotSmooth`.

Examples

```
# Simulate data and fit GAM
set.seed(3)
dat <- gamSim(1,n=2000,dist="normal",scale=20)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )
bs <- "cr"; k <- 12
b <- gam(y~fac + s(x0) + s(x1) + s(x2) + s(x3) + logi, data=dat)
o <- getViz(b, nsim = 0)

# Extract factor terms and plot it
pt <- pterm(o, 1)
plot(pt) + l_ciBar() + l_fitPoints(colour = 2) + l_rug(alpha = 0.2)

# Use barplot instead of points
pt <- pterm(o, 1)
plot(pt) + l_fitBar() + l_ciBar()

# Same with binary variable
pt <- pterm(o, 2)
plot(pt) + l_fitPoints() + l_ciBar()
```

plot.multi.random.effect

Plotting random effects

Description

This is the plotting method for random effects (simple random intercepts).

Usage

```
## S3 method for class 'multi.random.effect'
plot(x, trans = identity, ...)

## S3 method for class 'random.effect'
plot(x, trans = identity, ...)
```

Arguments

x	a random effect object, extracted using sm .
trans	monotonic function to apply to the fit, confidence intervals and residuals, before plotting. Monotonicity is not checked.
...	currently unused.

Value

An object of class plotSmooth.

Examples

```
library(mgcViz)
b <- gam(travel~s(Rail,bs="re"), data=Rail, method="REML")
b <- getViz(b)
plot(sm(b, 1)) + l_fitLine(colour = 2, linetype = 2) + l_points() +
  l_ciLine(colour = 4, linetype = 3)

plot(sm(b, 1)) + l_ciPoly() + l_points()

# Default
plot(b)

###
# Quantile GAM version
###
b <- mqgamV(travel~s(Rail,bs="re"), data=as.data.frame(Rail), qu = c(0.2, 0.4, 0.6, 0.8))

plot(sm(b, 1)) + l_ciPoly() + l_points()

# Default
plot(b)
```

plot.nested1D

Plotting one dimensional nested effects

Description

This method should be used to plot smooth effects of class "si.smooth.1D".

Usage

```
## S3 method for class 'nested1D'
plot(
  x,
  inner = FALSE,
  n = 100,
  xlim = NULL,
  ylim = NULL,
  maxpo = 10000,
  trans = identity,
  ...
)
```

Arguments

x	a smooth effect object.
inner	if TRUE we are doing to plot the inner transformation, rather than outer smooth effect.
n	number of grid points used to compute main effect and c.i. lines. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
ylim	if supplied then this pair of numbers are used as the y limits for the plot.
maxpo	maximum number of residuals points that will be used by layers such as resRug() and resPoints(). If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
...	currently unused.

Value

An object of class c("plotSmooth", "gg").

plot.ptermInteraction *Plotting parametric interactions*

Description

This function is here only to deal with parametric interactions (eg x0:fact), which cannot be plotted at the moment.

Usage

```
## S3 method for class 'ptermInteraction'
plot(x, ...)

## S3 method for class 'multi.ptermInteraction'
plot(x, ...)
```

Arguments

x a parametric interaction object, extracted using [pterm](#).
 ... currently unused.

Value

Currently it returns NULL.

```
plot.ptermMatrixNumeric
```

Plotting numeric parametric effects

Description

This is the plotting method for parametric numerical effects.

Usage

```
## S3 method for class 'ptermMatrixNumeric'
plot(x, n = 100, xlim = NULL, trans = identity, ...)

## S3 method for class 'multi.ptermNumeric'
plot(x, ...)

## S3 method for class 'ptermNumeric'
plot(x, n = 100, xlim = NULL, maxpo = 10000, trans = identity, ...)
```

Arguments

x a numerical parametric effect object, extracted using [pterm](#).
 n number of grid points used to compute main effect and c.i. lines.
 xlim if supplied then this pair of numbers are used as the x limits for the plot.
 trans monotonic function to apply to the fit, confidence intervals and residuals, before plotting. Monotonicity is not checked.
 ... currently unused.
 maxpo maximum number of residuals points that will be used by layers such as `resRug()` and `resPoints()`. If number of datapoints > maxpo, then a subsample of maxpo points will be taken.

Value

An object of class plotSmooth.

Examples

```
# Simulate data and fit GAM
set.seed(3)
dat <- gamSim(1,n=2000,dist="normal",scale=20)
bs <- "cr"; k <- 12
b <- gam(y ~ x0 + x1 + I(x1^2) + s(x2,bs=bs,k=k) +
          I(x1*x2) + s(x3, bs=bs), data=dat)
o <- getViz(b, nsim = 0)

# Extract first terms and plot it
pt <- pterm(o, 1)
plot(pt, n = 60) + l_ciPoly() + l_fitLine() + l_ciLine()

# Extract I(x1^2) terms and plot it with partial residuals
pt <- pterm(o, 3)
plot(pt, n = 60) + l_ciPoly() + l_fitLine() + l_ciLine() + l_points()
```

plot.sos.smooth

Plotting smooths on the sphere

Description

This is the plotting method for smooth effects on the sphere.

Usage

```
## S3 method for class 'sos.smooth'
plot(
  x,
  n = 40,
  xlim = NULL,
  ylim = NULL,
  maxpo = 10000,
  too.far = 0.1,
  phi = 30,
  theta = 30,
  trans = identity,
  scheme = 0,
  seWithMean = FALSE,
  unconditional = FALSE,
  ...
)
```

Arguments

<code>x</code>	a smooth effect object, extracted using sm .
<code>n</code>	sqrt of the number of grid points used to compute the effect plot.
<code>xlim</code>	if supplied then this pair of numbers are used as the x limits for the plot.
<code>ylim</code>	if supplied then this pair of numbers are used as the y limits for the plot.
<code>maxpo</code>	maximum number of residuals points that will be used by layers such as <code>resRug()</code> and <code>resPoints()</code> . If number of datapoints > maxpo, then a subsample of maxpo points will be taken.
<code>too.far</code>	if greater than 0 then this is used to determine when a location is too far from data to be plotted. This is useful since smooths tend to go wild away from data. The data are scaled into the unit square before deciding what to exclude, and <code>too.far</code> is a distance within the unit square. Setting to zero can make plotting faster for large datasets, but care then needed with interpretation of plots.
<code>phi</code>	one of the plotting angles, relevant only if <code>scheme = 0</code> .
<code>theta</code>	the other plotting angle, relevant only if <code>scheme = 0</code> .
<code>trans</code>	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
<code>scheme</code>	if 0 the smooth effect is plotted on the sphere. If 1 the smooth effect is plotted on the two hemispheres.
<code>seWithMean</code>	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
<code>unconditional</code>	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
<code>...</code>	currently unused.

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. *Scandinavian Journal of Statistics*.

Examples

```
library(mgcViz)
set.seed(0)
n <- 400

f <- function(la,lo) { ## a test function...
```

```

    sin(lo)*cos(la-.3)
  }

  ## generate with uniform density on sphere...
  lo <- runif(n)*2*pi-pi ## longitude
  la <- runif(3*n)*pi-pi/2
  ind <- runif(3*n)<=cos(la)
  la <- la[ind];
  la <- la[1:n]

  ff <- f(la,lo)
  y <- ff + rnorm(n)*.2 ## test data

  ## generate data for plotting truth...
  lam <- seq(-pi/2,pi/2,length=30)
  lom <- seq(-pi,pi,length=60)
  gr <- expand.grid(la=lam,lo=lom)
  fz <- f(gr$la,gr$lo)
  zm <- matrix(fz,30,60)

  require(mgcv)
  dat <- data.frame(la = la *180/pi, lo = lo *180/pi, y=y)

  ## fit spline on sphere model...
  bp <- gam(y~s(la,lo,bs="sos",k=60),data=dat)
  bp <- getViz(bp)

  # Plot on sphere
  plot(sm(bp, 1), scheme=0) + l_fitRaster() + l_fitContour() +
    l_points(shape = 19) + l_rug() + l_coordContour() + l_bound()

  # Plotting as in standard 2D plots
  plot(sm(bp, 1), scheme=1) + l_fitRaster() + l_fitContour() +
    l_points(shape = 19) + l_rug()

```

plotDiff

Generic plotting of differences

Description

Generic function for plotting differences between objects. Useful mainly for plotting the differences between two smooth effects.

Usage

```
plotDiff(...)
```

Arguments

... arguments to be passed to methods. This first one will determine which method will be called.

See Also

[plotDiff.mgcv.smooth.1D](#), [plotDiff.mgcv.smooth.2D](#), [plotDiff.sos.smooth](#)

```
plotDiff.mgcv.smooth.1D
```

Plotting differences between two 1D smooth effects

Description

This method can be used to plot the difference between two 1D smooth effects. Mainly meant to be used with by-factor smooths.

Usage

```
## S3 method for class 'mgcv.smooth.1D'
plotDiff(s1, s2, n = 100, trans = identity, unconditional = FALSE, ...)
```

Arguments

s1	a smooth effect object, extracted using sm .
s2	another smooth effect object.
n	number of grid points used to compute main effects and c.i. lines. For a nice smooth plot this needs to be several times the estimated degrees of freedom for the smooth.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Details

Let sd be the difference between the fitted smooths, that is: $sd = s1 - s2$. sd is a vector of length n , and its covariance matrix is $Cov(sd) = X1 \backslash$ where: $X1$ ($X2$) and $Sig11$ ($Sig22$) are the design matrix and the covariance matrix of the coefficients of $s1$ ($s2$), while $Sig12$ is the cross-covariance matrix between the coefficients of $s1$ and $s2$. To get the confidence intervals we need only $diag(Cov(sd))$, which here is calculated efficiently (without computing the whole of $Cov(sd)$).

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```
# Simulate data and add factors uncorrelated to the response
library(mgcViz)
set.seed(6898)
dat <- gamSim(1,n=1500,dist="normal",scale=20)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )
bs <- "cr"; k <- 12
b <- gam(y ~ s(x2,bs=bs,by = fac), data=dat)
o <- getViz(b, nsim = 0)

# Extract the smooths corresponding to "A1" and "A2" and plot their differences
# with credible intervals
plotDiff(s1 = sm(o, 1), s2 = sm(o, 2)) + l_ciPoly() +
  l_fitLine() + geom_hline(yintercept = 0, linetype = 2)
```

```
plotDiff.mgcv.smooth.2D
```

Plotting differences between two 2D smooth effects

Description

This method can be used to plot the difference between two 2D smooth effects. Mainly meant to be used with by-factor smooths.

Usage

```
## S3 method for class 'mgcv.smooth.2D'
plotDiff(
  s1,
  s2,
  n = 40,
  too.far = 0.1,
  trans = identity,
  unconditional = FALSE,
  ...
)
```

Arguments

s1	a smooth effect object, extracted using sm .
s2	another smooth effect object.
n	sqrt of the number of grid points used to compute the effect plot.
too.far	if greater than 0 then this is used to determine when a location is too far from data to be plotted. This is useful since smooths tend to go wild away from data. The data are scaled into the unit square before deciding what to exclude, and

	too.far is a distance within the unit square. Setting to zero can make plotting faster for large datasets, but care then needed with interpretation of plots.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Details

Let sd be the difference between the fitted smooths, that is: $sd = s_1 - s_2$. sd is a vector of length n , and its covariance matrix is $Cov(sd) = X_1 \backslash X_2$ where: X_1 (X_2) and $Sig11$ ($Sig22$) are the design matrix and the covariance matrix of the coefficients of s_1 (s_2), while $Sig12$ is the cross-covariance matrix between the coefficients of s_1 and s_2 . To get the confidence intervals we need only $diag(Cov(sd))$, which here is calculated efficiently (without computing the whole of $Cov(sd)$).

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. *Scandinavian Journal of Statistics*.

Examples

```
# Simulate data and add factors uncorrelated to the response
library(mgcviz)
set.seed(235)
dat <- gamSim(1,n=1500,dist="normal",scale=20)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )
bs <- "cr"; k <- 12
b <- gam(y ~ s(x2, x1, by = fac), data=dat)
o <- getViz(b, nsim = 0)

# Extract the smooths corresponding to "A1" and "A2" and plot their difference
p1 <- plotDiff(s1 = sm(o, 1), s2 = sm(o, 2))
p1 + l_fitRaster() + l_fitContour()

# Plot p-values for differences between the two smooths
p1 + l_pvRaster() + l_pvContour()
```

plotDiff.sos.smooth *Plotting differences between two smooths on the sphere*

Description

This method can be used to plot the difference between two smooth effects on the sphere. Mainly meant to be used with by-factor smooths.

Usage

```
## S3 method for class 'sos.smooth'
plotDiff(
  s1,
  s2,
  n = 40,
  too.far = 0.1,
  phi = 30,
  theta = 30,
  scheme = 0,
  trans = identity,
  unconditional = FALSE,
  ...
)
```

Arguments

s1	a smooth effect object, extracted using sm .
s2	another smooth effect object.
n	sqrt of the number of grid points used to compute the effect plot.
too.far	if greater than 0 then this is used to determine when a location is too far from data to be plotted. This is useful since smooths tend to go wild away from data. The data are scaled into the unit square before deciding what to exclude, and too.far is a distance within the unit square. Setting to zero can make plotting faster for large datasets, but care then needed with interpretation of plots.
phi	one of the plotting angles, relevant only if scheme = 0.
theta	the other plotting angle, relevant only if scheme = 0.
scheme	if 0 the smooth effect is plotted on the sphere. If 1 the smooth effect is plotted on the two hemispheres.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Details

Let sd be the difference between the fitted smooths, that is: $sd = s1 - s2$. sd is a vector of length n , and its covariance matrix is $Cov(sd) = X1 \backslash$ where: $X1$ ($X2$) and $Sig11$ ($Sig22$) are the design matrix and the covariance matrix of the coefficients of $s1$ ($s2$), while $Sig12$ is the cross-covariance matrix between the coefficients of $s1$ and $s2$. To get the confidence intervals we need only $diag(Cov(sd))$, which here is calculated efficiently (without computing the whole of $Cov(sd)$).

Value

An objects of class `plotSmooth`.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```
## Not run:
#### 1) Simulate data and add factors uncorrelated to the response
library(mgcViz)
set.seed(0)
n <- 500

f <- function(la,lo) { ## a test function...
  sin(lo)*cos(la-.3)
}

## generate with uniform density on sphere...
lo <- runif(n)*2*pi-pi ## longitude
la <- runif(3*n)*pi-pi/2
ind <- runif(3*n)<=cos(la)
la <- la[ind];
la <- la[1:n]

ff <- f(la,lo)
y <- ff + rnorm(n)*.2 ## test data

## generate data for plotting truth...
lam <- seq(-pi/2,pi/2,length=30)
lom <- seq(-pi,pi,length=60)
gr <- expand.grid(la=lam,lo=lom)
fz <- f(gr$la,gr$lo)
zm <- matrix(fz,30,60)

dat <- data.frame(la = la *180/pi, lo = lo *180/pi, y=y)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )

#### 2) fit spline on sphere model...
bp <- gam(y~s(la,lo,bs="sos",k=60, by = fac),data=dat)
bp <- getViz(bp)
```

```

# Extract the smooths corresponding to "A1" and "A3" and plot their difference
# Using scheme = 0
pl0 <- plotDiff(s1 = sm(bp, 1), s2 = sm(bp, 3))
pl0 + l_fitRaster() + l_fitContour() + l_coordContour() + l_bound()

# Plot p-values for significance of differences
pl0 + l_pvRaster() + l_pvContour(breaks=c(0.05, 0.1, 0.2, 0.3, 0.5))

# Using scheme = 1
pl1 <- plotDiff(s1 = sm(bp, 1), s2 = sm(bp, 2), scheme = 1)
pl1 + l_fitRaster() + l_fitContour()

# Plot p-values for significance of differences
pl1 + l_pvRaster() + l_pvContour(breaks=c(0.05, 0.1, 0.2, 0.3, 0.5))

## End(Not run)

```

plotRGL

Generic RGL plotting function

Description

Generic function for producing an interactive RGL plot.

Usage

```
plotRGL(x, ...)
```

Arguments

x	the object we want to plot using the rgl package.
...	arguments to be passed to methods.

See Also

[plotRGL.mgcv.smooth.2D](#), [plotRGL.mgcv.smooth.MD](#)

plotRGL.mgcv.smooth.2D

Visualizing 2D smooth effects in 3D

Description

This method plots an interactive 3D representation of a 2D smooth effect, using the rgl package.

Usage

```
## S3 method for class 'mgcv.smooth.2D'
plotRGL(
  x,
  se = TRUE,
  n = 40,
  residuals = FALSE,
  type = "auto",
  maxpo = 1000,
  too.far = 0,
  xlab = NULL,
  ylab = NULL,
  main = NULL,
  xlim = NULL,
  ylim = NULL,
  se.mult = 1,
  trans = identity,
  seWithMean = FALSE,
  unconditional = FALSE,
  ...
)
```

Arguments

x	a smooth effect object, extracted using sm .
se	when TRUE (default) upper and lower surfaces are added to the plot at se.mult (see below) standard deviations for the fitted surface.
n	sqrt of the number of grid points used to compute the effect plot.
residuals	if TRUE, then the partial residuals will be added.
type	the type of residuals that should be plotted. See residuals.gamViz .
maxpo	maximum number of residuals points that will be plotted. If number of data-points > maxpo, then a subsample of maxpo points will be taken.
too.far	if greater than 0 then this is used to determine when a location is too far from data to be plotted. This is useful since smooths tend to go wild away from data. The data are scaled into the unit square before deciding what to exclude, and too.far is a distance within the unit square. Setting to zero can make plotting faster for large datasets, but care is then needed when interpreting the plots.

xlab	if supplied then this will be used as the x label of the plot.
ylab	if supplied then this will be used as the y label of the plot.
main	used as title for the plot if supplied.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
ylim	if supplied then this pair of numbers are used as the y limits for the plot.
se.mult	a positive number which will be the multiplier of the standard errors when calculating standard error surfaces.
trans	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
seWithMean	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
unconditional	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
...	currently unused.

Value

Returns NULL invisibly.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```
# Example 1: taken from ?mgcv::te, shows how tensor product deals nicely with
# badly scaled covariates (range of x 5% of range of z )
library(mgcViz)

# Simulate some data
test1 <- function(x,z,sx=0.3,sz=0.4) {
  x <- x*20
  (pi*sx*sz)*(1.2*exp(-(x-0.2)^2/sx^2-(z-0.3)^2/sz^2)+
    0.8*exp(-(x-0.7)^2/sx^2-(z-0.8)^2/sz^2))
}
n <- 500
old.par <- par(mfrow=c(2,2))
x <- runif(n)/20;z <- runif(n);
xs <- seq(0,1,length=30)/20;zs <- seq(0,1,length=30)
pr <- data.frame(x=rep(xs,30),z=rep(zs,rep(30,30)))
truth <- matrix(test1(pr$x,pr$z),30,30)
f <- test1(x,z)
y <- f + rnorm(n)*0.2
```



```

# Fit with t.p.r.s. basis and plot
b1 <- gam(y~s(x,z))
plotRGL(sm(getViz(b1), 1))

# Need to load rgl at this point
## Not run:
library(rgl)
rgl.close() # Close

# Fit with tensor products basis and plot (with residuals)
b2 <- gam(y~te(x,z))
plotRGL(sm(getViz(b2), 1), residuals = TRUE)

# We can still work on the plot, for instance change the aspect ratio
aspect3d(1, 2, 1)

rgl.close() # Close

## End(Not run)

```

plotRGL.mgcv.smooth.MD

Visualizing a 2D slice of a smooth effects in 3D

Description

This method plots an interactive 3D representation of a 2-dimensional slice of a multi-dimensional smooth effect, using the rgl package.

Usage

```

## S3 method for class 'mgcv.smooth.MD'
plotRGL(
  x,
  fix,
  se = TRUE,
  n = 40,
  residuals = FALSE,
  type = "auto",
  maxpo = 1000,
  too.far = c(0, NA),
  xlab = NULL,
  ylab = NULL,
  main = NULL,
  xlim = NULL,
  ylim = NULL,
  se.mult = 1,

```

```

    trans = identity,
    seWithMean = FALSE,
    unconditional = FALSE,
    ...
  )

```

Arguments

<code>x</code>	a smooth effect object, extracted using sm .
<code>fix</code>	a named vector indicating which variables must be kept fixed and to what values. When plotting a smooth in (d+2) dimensions, then d variables must be fixed.
<code>se</code>	when TRUE (default) upper and lower surfaces are added to the plot at <code>se.mult</code> (see below) standard deviations for the fitted surface.
<code>n</code>	sqrt of the number of grid points used to compute the effect plot.
<code>residuals</code>	if TRUE, then the partial residuals will be added.
<code>type</code>	the type of residuals that should be plotted. See residuals.gamViz .
<code>maxpo</code>	maximum number of residuals points that will be plotted. If number of data-points > maxpo, then a subsample of maxpo points will be taken.
<code>too.far</code>	a numeric vector with two entries. The first has the same interpretation as in plot.mgcv.smooth.2D and it avoids plotting the smooth effect in areas that are too far from any observation. The distance will be calculated only using the variables which are not in <code>fix</code> (see above). Hence in two dimensions, not in the full d+2 dimensions. Set it to -1 to plot the whole smooth. The second entry determines which residuals and covariates pairs are closed enough to the selected slice. If left to NA on the 10\ closest (in terms of scaled Euclidean distance) to the current slice will be plotted. Set it to -1 to plot all the residuals.
<code>xlab</code>	if supplied then this will be used as the x label of the plot.
<code>ylab</code>	if supplied then this will be used as the y label of the plot.
<code>main</code>	used as title for the plot if supplied.
<code>xlim</code>	if supplied then this pair of numbers are used as the x limits for the plot.
<code>ylim</code>	if supplied then this pair of numbers are used as the y limits for the plot.
<code>se.mult</code>	a positive number which will be the multiplier of the standard errors when calculating standard error surfaces.
<code>trans</code>	monotonic function to apply to the smooth and residuals, before plotting. Monotonicity is not checked.
<code>seWithMean</code>	if TRUE the component smooths are shown with confidence intervals that include the uncertainty about the overall mean. If FALSE then the uncertainty relates purely to the centred smooth itself. Marra and Wood (2012) suggests that TRUE results in better coverage performance, and this is also suggested by simulation.
<code>unconditional</code>	if TRUE then the smoothing parameter uncertainty corrected covariance matrix is used to compute uncertainty bands, if available. Otherwise the bands treat the smoothing parameters as fixed.
<code>...</code>	currently unused.

Value

Returns NULL invisibly.

References

Marra, G and S.N. Wood (2012) Coverage Properties of Confidence Intervals for Generalized Additive Model Components. Scandinavian Journal of Statistics.

Examples

```
# Example 1: taken from ?mgcv::te, shows how tensor product deals nicely with
# badly scaled covariates (range of x 5% of range of z )
library(mgcViz)
n <- 1e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n)

ob <- (x-z)^2 + (y-z)^2 + rnorm(n)
b <- gam(ob ~ s(x, y, z))
v <- getViz(b)

plotRGL(sm(v, 1), fix = c("z" = 0))

# Need to load rgl at this point
## Not run:
library(rgl)
rgl.close() # Close

plotRGL(sm(v, 1), fix = c("z" = 1), residuals = TRUE)

# We can still work on the plot, for instance change the aspect ratio
aspect3d(1, 2, 1)

rgl.close() # Close

## End(Not run)
```

plotSlice

Plotting sequence of slices of 2D smooth effect

Description

This function allows to slice a multi-dimensional ($D > 2$) smooth effect, and to plot the resulting sequence of 2D slices in an array of plots.

Usage

```
plotSlice(x, fix, a.facet = list(), ...)
```

Arguments

<code>x</code>	a smooth effect object, extracted using sm .
<code>fix</code>	a named list of vectors, where the <i>i</i> -th entry of each vector indicates the value we want to use for the covariate for <i>i</i> -th slice. When plotting a smooth in (<i>d</i> +2) dimensions, we need <i>d</i> vectors, because <i>d</i> variables must be fixed. All vectors must have either the same length (the number of slices) or length 1. <code>fix</code> can contain at most 2 vectors, so if <i>d</i> ≥ 5, we need to set at least one covariate to a scalar.
<code>a.facet</code>	arguments to be passed to ggplot2::facet_wrap or ggplot2::facet_grid . The former gets called when <code>fix</code> contains one vector, the latter when <code>fix</code> contains two vectors.
<code>...</code>	further arguments to be passed to plot.mgcv.smooth.MD .

Value

An objects of class `plotSmooth`.

Examples

```
## Not run:
### Example 1: plotting slices of 3D smooth
# Simulate data and fit GAM
library(mgcViz)
n <- 1e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n)
ob <- (x-z)^2 + (y-z)^2 + rnorm(n)
b <- gam(ob ~ s(x, y, z))
v <- getViz(b)

# Get plot of slices and add layers
pl <- plotSlice(x = sm(v, 1),
               fix = list("z" = seq(-2, 2, length.out = 9)))
pl + l_fitRaster() + l_fitContour() + l_points() + l_rug()

# Over-ride default layout
pl <- plotSlice(x = sm(v, 1),
               fix = list("z" = seq(-2, 2, length.out = 9)),
               a.facet = list(nrow = 2))
pl + l_fitRaster() + l_fitContour() + theme(panel.spacing = unit(0.5, "lines"))

### Example 2: plotting slices of 4D smooth
# Simulate data and fit GAM
n <- 5e3
x <- rnorm(n); y <- rnorm(n); z <- rnorm(n); z2 <- rnorm(n)
ob <- (x-z)^2 + (y-z)^2 + z2^3 + rnorm(n)
b <- bam(ob ~ s(x, y, z, z2), discrete = TRUE)
v <- getViz(b)

# Plot slices across "z" and "x"
pl <- plotSlice(x = sm(v, 1),
```

```

      fix = list("z" = seq(-2, 2, length.out = 3), "x" = c(-1, 0, 1)))
pl + l_fitRaster() + l_fitContour() + l_points() + l_rug()

# Plot slices across "x", keeping "z" fixed
pl <- plotSlice(x = sm(v, 1),
               fix = list("z" = 0, "x" = seq(-3, 3, length.out = 9)))
pl + l_fitRaster() + l_fitContour() + l_points() + l_rug()

## End(Not run)

```

postSim

Posterior simulation from a GAM object

Description

This method can be used to simulate vectors of responses from the Gaussian posterior approximation of a `gamObject`.

Usage

```

postSim(
  o,
  nsim,
  newdata,
  trans = NULL,
  method = "auto",
  w = NULL,
  offset = NULL,
  savePar = FALSE,
  ...
)

```

Arguments

<code>o</code>	the output of a <code>gam()</code> or <code>bam()</code> call.
<code>nsim</code>	the number of simulated vectors of responses. A positive integer.
<code>newdata</code>	Optional new data frame used to perform the simulations. To be passed to predict.gam .
<code>trans</code>	function used to transform or summarize each vector of simulated responses. It must take a vector as argument, but it can output a vector or a scalar. Potentially useful for saving storage (e.g. by transforming each simulated vector to a scalar). If left to <code>NULL</code> then <code>trans = identity</code> will be used.
<code>method</code>	the method used for the simulation of responses. See simulate.gam .
<code>w</code>	vector of prior weights of each response. See simulate.gam .

offset	numeric vector of offsets. For GAMs with multiple linear predictor (see eg gaulss) it must be a list of vectors. If newdata!=NULL the offsets will be assumed to be zero, unless their are explicitly provided. If newdata==NULL the simulations will use the offsets used during model fitting, unless offset is explicitly provided.
savePar	if TRUE than also the simulated parameters will be returned.
...	arguments to be passed to vcov.gam .

Value

If savePar == FALSE the function will return a matrix where each column is a vector of simulated responses or a transformed version of it. If savePar == TRUE it will return a list where the \$simY entry will contain the simulated responses and \$simBeta the simulated parameters.

Examples

```
library(mgcViz)
library(MASS)
b <- gam(accel~s(times, k=20), data=mcycle)

# Simulate list of 10 vectors of responses from posterior, taking into
# account smoothing parameters uncertainty (see ?vcov.gam)
n <- 10
sim <- postSim(o = b, nsim = n, unconditional = TRUE)

# Posterior simulations in grey and data in red
plot(rep(mcycle$times, n), as.vector(sim), col = "grey",
      ylab = "Acceleration", xlab = "Times")
points(mcycle$times, mcycle$accel, col = 2)

# There is clear disagreement between simulations' and data's
# conditional variance, which can be solved using flexible GAMLSS model:
b <- gam(list(accel~s(times, k=20), ~s(times)), data=mcycle, family = gaulss)
sim <- postSim(o = b, nsim = n)
plot(rep(mcycle$times, n), as.vector(sim), col = "grey",
      ylab = "Acceleration", xlab = "Times")
points(mcycle$times, mcycle$accel, col = 2)
```

print.checkGam

Printing the output of check.gamViz

Description

This method prints the output of [check.gamViz](#).

Usage

```
## S3 method for class 'checkGam'
print(x, lay = NULL, ...)
```

Arguments

x	the output of <code>check.gamViz</code> .
lay	the <code>layout_matrix</code> passed to gridExtra::grid.arrange .
...	further arguments to be passed to <code>grid.arrange</code> .

Value

Returns the output of `grid.arrange`, invisibly.

print.plotGam	<i>Printing the output of <code>plot.gamViz</code></i>
---------------	--

Description

This method prints the output of [plot.gamViz](#).

Usage

```
## S3 method for class 'plotGam'
print(x, ask = TRUE, pages = NULL, addLay = TRUE, ...)
```

Arguments

x	an object of class <code>plotGam</code> .
ask	should we ask before moving from one page to the next?
pages	the number of pages over which to spread the output.
addLay	if TRUE, and if the <code>\$empty</code> slot of the <code>plotGam</code> object is TRUE, we add some default layers to the plots, before printing. Does not have any affect if the <code>plotGam</code> object already contains some layers.
...	further arguments to be passed to <code>grid.arrange</code> .

Value

Returns the output of [gridExtra::grid.arrange](#), invisibly.

print.plotSmooth	<i>Printing plots of smooth effects</i>
------------------	---

Description

This method prints objects of class plotSmooth.

Usage

```
## S3 method for class 'plotSmooth'  
print(x, addLay = TRUE, ...)
```

Arguments

x	an object of class plotSmooth.
addLay	if TRUE, and if the \$empty slot of the plotSmooth object is TRUE or NULL, we add some default layers to the plots, before printing. Does not have any affect if the plotSmooth object already contains some layers (e.g. l_rug()).
...	currently unused.

Value

Returns NULL, invisibly.

print.qqGam	<i>Printing the output of qq.gamViz</i>
-------------	---

Description

This method prints the output of [qq.gamViz](#).

Usage

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

Arguments

x	an object of class qqGam.
...	currently unused.

Value

Returns NULL, invisibly.

pterm

*Extracting parametric effects from a GAM model***Description**

This function can be used to extract a parametric effect from an object of class gamViz.

Usage

```
pterm(o, select)
```

Arguments

o an object of class gamViz, the output of a getViz() call.
select index of the selected parametric effect.

Value

An object of class "pTermSomething" where "Something" is substituted with the class of the variable of interest. For instance if this "numeric", the pterm will return an object of class "ptermNumeric".

Examples

```
##### 1. Gaussian GAM
library(mgcViz)
set.seed(3)
dat <- gamSim(1,n=1500,dist="normal",scale=20)
dat$fac <- as.factor( sample(c("A1", "A2", "A3"), nrow(dat), replace = TRUE) )
dat$logi <- as.logical( sample(c(TRUE, FALSE), nrow(dat), replace = TRUE) )
bs <- "cr"; k <- 12
b <- gam(y ~ x0 + x1 + I(x1^2) + s(x2,bs=bs,k=k) + fac + x3:fac + I(x1*x2) + logi,data=dat)
o <- getViz(b)

# Plot effect of 'x0'
pt <- pterm(o, 1)
plot(pt, n = 60) + l_ciPoly() + l_fitLine() + l_ciLine() + l_points()

# Plot effect of 'x3'
pt <- pterm(o, 1)
plot(pt, n = 60) + l_fitLine() + l_ciLine(colour = 2)

# Plot effect of 'fac'
pt <- pterm(o, 4)
plot(pt) + l_ciBar(colour = "blue") + l_fitPoints(colour = "red") +
  l_rug(alpha = 0.3)

# Plot effect of 'logi'
pt <- pterm(o, 6)
```

```

plot(pt) + l_fitBar(a.aes = list(fill = I("light blue")))) + l_ciBar(colour = "blue")

# Plot effect of 'x3:fac': no method available yet available for second order terms
pt <- pterm(o, 7)
plot(pt)

## Not run:
##### 1. Continued: Quantile GAMs
b <- mqgamV(y ~ x0 + x1 + I(x1^2) + s(x2,bs=bs,k=k) + x3:fac +
            I(x1*x2) + logi, data=dat, qu = c(0.3, 0.5, 0.8))

plot(pterm(b, 3)) + l_ciBar(colour = 2) + l_fitPoints()

plot(pterm(b, 4)) + l_fitBar(colour = "blue", fill = 3) + l_ciBar(colour = 2)

# Don't know how to plot this interaction
plot(pterm(b, 6))

##### 2. Gaussian GAMLSS model
library(MASS)
mcycle$fac <- as.factor( sample(c("z", "k", "a", "f"), nrow(mcycle), replace = TRUE) )
b <- gam(list(accel~times + I(times^2) + s(times,k=10), ~ times + fac + s(times)),
           data=mcycle,family=gaulss(), optimizer = "efs")
o <- getViz(b)

# Plot effect of 'I(times^2)' on mean: notice that partial residuals
# are unavailable for GAMLSS models, hence l_point does not do anything here.
pt <- pterm(o, 2)
plot(pt) + l_ciPoly() + l_fitLine() + l_ciLine() + l_points()

# Plot effect of 'times' in second linear predictor.
# Notice that partial residuals are unavailable.
pt <- pterm(o, 3)
plot(pt) + l_ciPoly() + l_fitLine() + l_ciLine(linetype = 3) + l_rug()

# Plot effect of 'fac' in second linear predictor.
pt <- pterm(o, 4)
plot(pt) + l_ciBar(colour = "blue") + l_fitPoints(colour = "red") +
  l_rug()

## End(Not run)

```

Description

These are wrapper that fits a QGAM model using [qgam::qgam](#) and converts it to a gamViz object using the [getViz](#) function. It is essentially a shortcut.

Usage

```
qgamV(form, data, qu, lsig = NULL, err = NULL, aQgam = list(), aViz = list())
```

Arguments

```
form, data, qu, lsig, err
      same arguments as in qgam::qgam.

aQgam      list of further arguments to be passed to qgam::qgam.
aViz       list of arguments to be passed to getViz.
```

Value

An object of class "gamViz" which can, for instance, be plotted using [plot.gamViz](#).

Examples

```
library(mgcViz)
set.seed(2) ## simulate some data...
dat <- gamSim(2,n=1000,dist="normal",scale=0.25)$data

# Fit GAM and get gamViz object
b <- qgamV(y~s(x) + s(z) + I(x*z), data = dat, qu = 0.2,
          aQgam = list(argGam = list(select = TRUE)), aViz = list("nsim" = 0))

# This is equivalent to doing
# 1. Fit QGAM
# b <- qgam(y~s(x) + s(z) + I(x*z), data=dat, qu = 0.2, argGam = list(select = TRUE))
# 2. Convert to gamViz object
# b <- getViz(b, nsim = 0)

# Either way, we all effects by doing
print(plot(b, allTerms = TRUE), pages = 1)
```

 qq

Generic QQ plots

Description

Generic function for producing QQ-plots.

Usage

```
qq(...)
```

Arguments

```
...      arguments to be passed to methods. This first one will determine which method
         will be called.
```

See Also[qq.gamViz](#)

qq.gamViz*QQ plots for gam model residuals*

Description

Takes a fitted gam object, converted using [getViz](#), and produces QQ plots of its residuals (conditional on the fitted model coefficients and scale parameter). If the model distributional assumptions are met then usually these plots should be close to a straight line (although discrete data can yield marked random departures from this line).

Usage

```
## S3 method for class 'gamViz'
qq(
  o,
  rep = 10,
  level = 0.8,
  method = "auto",
  type = "auto",
  CI = "none",
  worm = FALSE,
  showReps = FALSE,
  sortFun = NULL,
  discrete = NULL,
  ngr = 1000,
  xlim = NULL,
  ylim = NULL,
  a.qqpoi = list(),
  a.ablin = list(),
  a.cipoly = list(),
  a.replin = list(),
  ...
)
```

Arguments

<code>o</code>	an object of class <code>gamViz</code> , the output of a <code>getViz()</code> call.
<code>rep</code>	how many replicate datasets to generate to simulate quantiles of the residual distribution. Relevant only if <code>method</code> is set to <code>"simul1"</code> or <code>"simul2"</code> .
<code>level</code>	the level of the confidence intervals (e.g. 0.9 means 90% intervals).

method	the method used to calculate the QQ-plot and, possibly, the confidence intervals. If set to ("tunif") "tnormal" the residuals are transformed to (uniform) normal, for which analytic expression for the confidence intervals are available. If set to "simul1" or "simul2" the theoretical QQ-line is constructed by simulating residuals from the model. Method "simul2" does not produce confidence intervals. If set to "normal" no simulation or transformation is performed, and a simple normal QQ-plot is produced. If set to "auto" the method used to produce the QQ-plot is determined automatically.
type	the type of residuals to be used. See residuals.gamViz .
CI	the type of confidence intervals to be plotted. If set to "none" they are not added, if set to "normal" they will be based on the assumption that the theoretical quantile distribution is Gaussian and if set to "quantile" they will be sample quantiles of simulated responses from the model.
worm	if TRUE a worm-plot (a de-trended QQ-plot) is plotted.
showReps	if TRUE all the QQ-lines corresponding to the simulated (model-based) QQ-plots.
sortFun	the function to be used for sorting the residuals. If left to NULL it will be set to <code>function(.x) sort(.x, method = "quick")</code> internally.
discrete	if TRUE the QQ-plot is discretized into ngr bins before plotting, in order to save plotting time (when the number of observations is large). If left to NULL, the discretization is used if there are more than 10^4 observations.
ngr	number of bins to be used in the discretization.
xlim	if supplied then this pair of numbers are used as the x limits for the plot.
ylim	if supplied then this pair of numbers are used as the y limits for the plot.
a.qqpoi	list of arguments to be passed to <code>ggplot2::geom_point</code> , which plots the main QQ-plot.
a.ablin	list of arguments to be passed to <code>ggplot2::geom_abline</code> , which adds the reference line.
a.cipoly	list of arguments to be passed to <code>ggplot2::geom_polygon</code> , which add the confidence intervals.
a.replin	list of arguments to be passed to <code>ggplot2::geom_line</code> , which adds a line for each simulated QQ-plot.
...	currently unused.

Details

Here `method = "simul1"` corresponds to the algorithm described in section 2.1 of Augustin et al. (2012), which involves direct simulations of residuals from the models. This requires `o$family$rd` to be defined. Setting `method = "simul2"` results in a cheaper method, described in section 2.2 of Augustin et al. (2012), which requires `o$family$qf` to be defined.

Value

An object of class `c("qqGam", "plotSmooth", "gg")`.

References

Augustin, N.H., Sauleau, E.A. and Wood, S.N., 2012. On quantile quantile plots for generalized linear models. Computational Statistics & Data Analysis, 56(8), pp.2404-2409.

Examples

```
##### Example: simulate binomial data
library(mgcViz)
set.seed(0)
n.samp <- 400
dat <- gamSim(1,n = n.samp, dist = "binary", scale = .33)
p <- binomial()$linkinv(dat$f) ## binomial p
n <- sample(c(1, 3), n.samp, replace = TRUE) ## binomial n
dat$y <- rbinom(n, n, p)
dat$n <- n
lr.fit <- gam(y/n ~ s(x0) + s(x1) + s(x2) + s(x3)
              , family = binomial, data = dat,
              weights = n, method = "REML")
lr.fit <- getViz(lr.fit)

# Quick QQ-plot of deviance residuals
qq(lr.fit, method = "simul2")

# Same, but changing points share and type of reference list
qq(lr.fit, method = "simul2",
    a.qqpoi = list("shape" = 1), a.ablin = list("linetype" = 2))

# Simulation based QQ-plot with reference bands
qq(lr.fit, rep = 100, level = .9, CI = "quantile")

# Simulation based QQ-plot, Pearson resids, all simulations lines shown
qq(lr.fit, rep = 100, CI = "none", showReps = TRUE, type = "pearson",
    a.qqpoi = list(shape=19, size = 0.5))

### Now fit the wrong model and check
pif <- gam(y ~ s(x0) + s(x1) + s(x2) + s(x3)
          , family = poisson, data = dat, method = "REML")
pif <- getViz(pif)

qq(pif, method = "simul2")

qq(pif, rep = 100, level = .9, CI = "quantile")

qq(pif, rep = 100, type = "pearson", CI = "none", showReps = TRUE,
    a.qqpoi = list(shape=19, size = 0.5))

##### Example: binary data model violation so gross that you see a problem
##### on the QQ plot
y <- c(rep(1, 10), rep(0, 20), rep(1, 40), rep(0, 10), rep(1, 40), rep(0, 40))
x <- 1:160
b <- glm(y ~ x, family = binomial)
class(b) <- c("gamViz", class(b)) # Tricking qq.gamViz to use it on a glm
```

```

# Note that the next two are not necessarily similar under gross
# model violation...
qq(b, method = "simul2")
qq(b, rep = 50, CI = "none", showReps = TRUE)

### alternative model
b <- gam(y ~ s(x, k = 5), family = binomial, method = "ML")
b <- getViz(b)

qq(b, method = "simul2")
qq(b, rep = 50, showReps = TRUE, CI = "none", shape = 19)

## Not run:
##### "Big Data" example:
set.seed(0)
n.samp <- 50000
dat <- gamSim(1,n=n.samp,dist="binary",scale=.33)
p <- binomial()$linkinv(dat$f) ## binomial p
n <- sample(c(1,3),n.samp,replace=TRUE) ## binomial n
dat$y <- rbinom(n,n,p)
dat$n <- n
lr.fit <- bam(y/n ~ s(x0) + s(x1) + s(x2) + s(x3)
              , family = binomial, data = dat,
              weights = n, method = "fREML", discrete = TRUE)
lr.fit <- getViz(lr.fit)

# Turning discretization off (on by default for large datasets).
set.seed(414) # Setting the seed because qq.gamViz is doing simulations
o <- qq(lr.fit, rep = 10, method = "simul1", CI = "normal", showReps = TRUE,
        discrete = F, a.replin = list(alpha = 0.1))
o # This might take some time!

# Using default discretization
set.seed(414)
o <- qq(lr.fit, rep = 10, method = "simul1", CI = "normal", showReps = TRUE,
        a.replin = list(alpha = 0.1))
o # Much faster plotting!

# Very coarse discretization
set.seed(414)
o <- qq(lr.fit, rep = 10, method = "simul1", CI = "normal", showReps = TRUE,
        ngr = 1e2, a.replin = list(alpha = 0.1), a.qqpoi = list(shape = 19))
o

# We can also zoom in at no extra costs (most work already done by qq.gamViz)
zoom(o, xlim = c(-0.25, 0.25), showReps = TRUE, discrete = TRUE, a.replin = list(alpha = 0.2))

## End(Not run)

```

Description

This is a re-write of the QQ-plotting functions provided by stats, using the ggplot2 library. qqnorm is a generic function the default method of which produces a normal QQ plot of the values in y. qqline adds a line to a “theoretical”, by default normal, quantile-quantile plot which passes through the probs quantiles, by default the first and third quartiles. qqplot produces a QQ plot of two datasets.

Usage

```
qqnorm(
  y,
  ylim,
  main = "Normal Q-Q Plot",
  xlab = "Theoretical Quantiles",
  ylab = "Sample Quantiles",
  datax = FALSE
)

qqplot(
  x,
  y,
  xlab = deparse(substitute(x)),
  ylab = deparse(substitute(y)),
  main = "Q-Q Plot"
)

qqline(
  y,
  datax = FALSE,
  distribution = qnorm,
  probs = c(0.25, 0.75),
  qtype = 7,
  ...
)
```

Arguments

y	The second or only data sample.
ylim, ...	Graphical parameters.
main, xlab, ylab	Plot labels. The xlab and ylab refer to the y and x axes respectively if datax = TRUE.
datax	Logical. Should data values be on the x-axis ?

x	The first sample for qqplot.
distribution	quantile function for reference theoretical distribution.
probs	numeric vector of length two, representing probabilities. Corresponding quantile pairs define the line drawn.
qtype	the type of quantile computation used in quantile .

Note

Help file is mainly from `stats::qqnorm` since this is a rewrite of `stats::qqplot`, `stats::qqline` and `stats::qqnorm` using the `ggplot2` library.

Examples

```
library(mgcViz)
y <- rt(500, df = 5)

# Compare new and old version of qqnorm
stats::qqnorm(y)
qqnorm(y)

# Compare new and old version of qqplot
x <- rt(200, df = 5)
y <- rt(300, df = 5)
stats::qqplot(x, y)
qqplot(x, y)
# add a qqline()
ggplot2::last_plot() + qqline(y = rt(500, df = 4.8), col = "green")

## "QQ-Chisquare" : -----
y <- rchisq(500, df = 3)
## Q-Q plot for Chi^2 data against true theoretical distribution:
x <- qchisq(ppoints(500), df = 3)
stats::qqplot(qchisq(ppoints(500), df = 3), rchisq(500, df = 3),
  main = expression("Q-Q plot for" ~~ {chi^2}[nu == 3]))
qqplot(qchisq(ppoints(500), df = 3), rchisq(500, df = 3),
  main = expression("Q-Q plot for" ~~ {chi^2}[nu == 3])) + theme_bw()
```

Description

Extension of `mgcv::residuals.gam`. Returns residuals for a fitted GAM model object. Pearson, deviance, working and response residuals are available as in the method from `mgcv`, but this version also provides residual types "tunif" and "tnormal". The former are obtained using the cdf of the response distribution (if available). The latter are obtained by further transforming the uniform residuals using the quantile function (i.e. the inverse cdf) of a standard normal variable.

Usage

```
## S3 method for class 'gamViz'
residuals(object, type = "deviance", ...)
```

Arguments

object	an object of class gamViz, the output of a getViz() call.
type	the type of residuals wanted. If should be one of "deviance", "pearson", "scaled.pearson", "working", "response", "tunif" or "tnormal". Not all are available for each family.
...	further arguments passed to mgcv::residuals.gam .

See Also

See also [mgcv::residuals.gam](#) for details.

shine

Generic shine function

Description

Generic function for taking an object and transforming it into a shiny app.

Usage

```
shine(o, ...)
```

Arguments

o	the object we want to transform into a shiny app.
...	arguments to be passed to methods.

See Also

shine.qqGam

Description

This function takes the output of [qq.gamViz](#) and transforms it into an interactive shiny app.

Usage

```
## S3 method for class 'qqGam'
shine(o, ...)
```

Arguments

o	the output of qq.gamViz .
...	currently not used.

Details

In RStudio, this function returns a call to [qq.gamViz](#) that reproduces the last plot rendered in the interactive shiny window.

Examples

```
## Not run:

## simulate binomial data...
library(mgcv)
library(mgcViz)
set.seed(0)
n.samp <- 400
dat <- gamSim(1,n = n.samp, dist = "binary", scale = .33)
p <- binomial()$linkinv(dat$f) ## binomial p
n <- sample(c(1, 3), n.samp, replace = TRUE) ## binomial n
dat$y <- rbinom(n, n, p)
dat$n <- n
lr.fit <- gam(y/n ~ s(x0) + s(x1) + s(x2) + s(x3)
             , family = binomial, data = dat,
             weights = n, method = "REML")
lr.fit <- getViz(lr.fit)

# Need to load shiny and miniUI at this point
# launch shiny gadget
shine(qq(lr.fit))

## End(Not run)
```

simulate.gam

*Simulating responses from a GAM object***Description**

This method can be used to simulate vectors of responses from a gamObject.

Usage

```
## S3 method for class 'gam'
simulate(
  object,
  nsim = 1,
  seed = NULL,
  method = "auto",
  newdata,
  u = NULL,
  w = NULL,
  offset = NULL,
  trans = NULL,
  ...
)
```

Arguments

object	the output of a gam() or bam() call.
nsim	the number of simulated vectors of responses. A positive integer.
seed	currently not used.
method	the method used for the simulation. If set to "rd" then o\$family\$rd() will be used, if available. If set to "qf" then o\$family\$qf() (which is the inverse cdf of the response distribution) will be used to transform some uniform variates.
newdata	Optional new data frame or list to be passed to predict.gam .
u	a matrix where each row is a vector of uniform random variables in (0, 1). This will be used to simulate responses only if method = "qf".
w	vector of prior weights to be used in the simulations. If newdata==NULL then w is set to object\$prior.weights otherwise it is a vector of ones.
offset	numeric vector of offsets. For GAMs with multiple linear predictor (see eg gauss) it must be a list of vectors. NB: if newdata!=NULL the offsets will be assumed to be zero, unless they are explicitly provided. If newdata==NULL then simulations will use the offsets used during model fitting, and offset argument will be ignored.
trans	function used to transform or summarize each vector of simulated responses. It must take a vector as argument, but it can output a vector or a scalar. Potentially useful for saving storage (e.g. by transforming each simulated vector to a scalar). If left to NULL then trans = identity will be used.
...	extra arguments passed to predict.gam.

Value

A matrix where each column is a vector of simulated responses. The number of rows is equal to the number of responses in the fitted object.

Examples

```
library(mgcViz)

set.seed(2) ## simulate some data...
dat <- gamSim(1,n=400,dist="normal",scale=2)
b <- gam(y~s(x0)+s(x1)+s(x2)+s(x3),data=dat)

# Simulate three vectors of responses
matplot(simulate(b, nsim = 3), pch = 19, col = c(1, 3, 4))
```

sm

Extracting a smooth effect from a GAM model

Description

This function can be used to extract a smooth or random effect from an object of class `gamViz`.

Usage

```
sm(o, select)
```

Arguments

<code>o</code>	an object of class <code>gamViz</code> , the output of a getViz call.
<code>select</code>	index of the selected smooth or random effect.

Value

An object representing a smooth effect.

See Also

See [getViz](#) for examples.

zoom	<i>Generic zooming function</i>
------	---------------------------------

Description

Generic function for zooming, mainly meant to work with graphical objects.

Usage

```
zoom(o, ...)
```

Arguments

o	the object we want to zoom into.
...	arguments to be passed to methods.

See Also

zoom.qqGam

zoom.qqGam	<i>Efficiently zooming on GAM QQ-plots</i>
------------	--

Description

This function allows to zoom into a QQ-plot produced by [qq.gamViz](#), in a computationally efficient manner.

Usage

```
## S3 method for class 'qqGam'
zoom(
  o,
  xlim = NULL,
  ylim = NULL,
  discrete = NULL,
  ngr = 1000,
  adGrid = TRUE,
  CI = FALSE,
  worm = FALSE,
  showReps = FALSE,
  a.qqpoi = list(),
  a.ablin = list(),
  a.cipoly = list(),
  a.replin = list(),
  ...
)
```

Arguments

<code>o</code>	the output of <code>mgcViz::qq.gamViz</code> .
<code>xlim</code>	if supplied then this pair of numbers are used as the x limits for the plot.
<code>ylim</code>	if supplied then this pair of numbers are used as the y limits for the plot.
<code>discrete</code>	if TRUE the QQ-plot is discretized into <code>ngr</code> bins before plotting, in order to save plotting time (when the number of observations is large). If left to NULL, the discretization is used if there are more than 10^4 observations.
<code>ngr</code>	number of bins to be used in the discretization.
<code>adGrid</code>	if TRUE the discretization grid is computed using the QQ-points falling within <code>xlim</code> . If FALSE, <code>zoom.qqGam</code> will compute <code>ngr</code> values using all the QQ-points used in the original <code>qq.gamViz</code> call (but only those falling within <code>xlim</code> and <code>ylim</code> will be plotted).
<code>CI</code>	if TRUE confidence intervals are plotted.
<code>worm</code>	if TRUE a worm-plot (a de-trended QQ-plot) is plotted, rather than a QQ-plot.
<code>showReps</code>	if TRUE all the QQ-lines corresponding to the simulated (model-based) QQ-plots.
<code>a.qqpoi</code>	list of arguments to be passed to <code>ggplot2::geom_point</code> , which plots the main QQ-plot.
<code>a.ablin</code>	list of arguments to be passed to <code>ggplot2::geom_abline</code> , which adds the reference line.
<code>a.cipoly</code>	list of arguments to be passed to <code>ggplot2::geom_polygon</code> , which add the confidence intervals.
<code>a.replin</code>	list of arguments to be passed to <code>ggplot2::geom_line</code> , which adds a line for each simulated QQ-plot.
<code>...</code>	currently unused.

Examples

```
library(mgcViz);
set.seed(0)
n.samp <- 500
dat <- gamSim(1,n=n.samp,dist="binary",scale=.33)
p <- binomial()$linkinv(dat$f) ## binomial p
n <- sample(c(1,3),n.samp,replace=TRUE) ## binomial n
dat$y <- rbinom(n,n,p)
dat$n <- n
lr.fit <- bam(y/n ~ s(x0) + s(x1) + s(x2) + s(x3)
             , family = binomial, data = dat,
             weights = n, method = "REML")
lr.fit <- getViz(lr.fit)

set.seed(414)
o <- qq(lr.fit, rep = 50, method = "simul1", CI = "normal")
o # This is the whole qqplot

# We can zoom in along x at little extra costs (most computation already done by qq.gamViz)
zoom(o, xlim = c(0, 1), showReps = TRUE,
     a.replin = list(alpha = 0.1), a.qqpoi = list(shape = 19))
```

zto1*Constructing a decreasing function from (0,1) to (0,1)*

Description

This function returns a non-increasing function from (0, 1) to (0, 1). It takes inputs o, a and m, and it returns the function $f(p) = \{z = \max(0, p - o); \text{return}(\max((1 - z)^a, m))\}$. The function $f(p)$ can be used, for instance, for transforming p-values before plotting them.

Usage

```
zto1(o, a, m)
```

Arguments

o, a, m the output function's parameters, as described above.

Value

A function whose parameters o, a and m have been fixed.

Examples

```
library(mgcViz)
x <- seq(0, 1, by = 0.01)
plot(x, zto1(0.05, 2, 0.1)(x), ylim = c(0, 1), type = 'l')
lines(x, zto1(0.05, 1, 0.2)(x), col = 2)
lines(x, zto1(0.1, 3, 0)(x), col = 3)
```


Index

ALE, [3](#)
ALE.gam, [4](#)

bamV, [6](#)

check.gamViz, [7](#), [78](#)
check0D, [9](#), [23](#), [37](#), [41](#)
check1D, [10](#), [24](#), [25](#), [32](#), [35](#), [38](#), [40](#)
check2D, [12](#), [30](#), [31](#), [34](#), [36](#), [38](#)

fix.family.cdf, [14](#)

gamm4::gamm4, [14](#), [15](#)
gamm4V, [14](#)
gammV (gamm4V), [14](#)
gamV (bamV), [6](#)
gauss, [78](#), [92](#)
getGam, [16](#)
getViz, [6](#), [14–16](#), [16](#), [42](#), [46](#), [48](#), [82–84](#), [93](#)
GGally::glyphs, [31](#)
ggplot2::facet_grid, [53](#), [57](#), [76](#)
ggplot2::facet_wrap, [53](#), [57](#), [76](#)
ggplot2::geom_bar, [26](#)
ggplot2::geom_density, [23](#)
ggplot2::geom_histogram, [37](#)
ggplot2::geom_raster, [30](#)
ggplot2::geom_rug, [40](#)
ggplot2::geom_vline, [41](#)
ggplot2::stat_summary_2d, [34](#), [36](#)
ggplot2::stat_summary_hex, [34](#), [36](#)
gridExtra::grid.arrange, [79](#)
gridPrint, [17](#)

l_bound, [19](#)
l_ciBar, [20](#)
l_ciLine, [20](#)
l_ciPoly, [21](#)
l_clusterLine, [22](#)
l_coordContour, [22](#)
l_dens (l_dens2D), [23](#)
l_dens1D, [23](#)

l_dens2D, [23](#)
l_densCheck, [24](#)
l_fitBar, [26](#)
l_fitContour, [27](#)
l_fitDens, [27](#)
l_fitLine, [28](#)
l_fitPoints, [29](#)
l_fitRaster, [29](#)
l_glyphs2D, [30](#)
l_gridCheck1D, [32](#)
l_gridCheck2D, [34](#)
l_gridQCheck1D, [35](#)
l_gridQCheck2D, [36](#)
l_hist, [37](#)
l_points, [37](#)
l_poly, [38](#)
l_pvContour, [39](#)
l_pvRaster, [39](#)
l_rug, [40](#)
l_simLine, [40](#), [43](#), [50](#)
l_vline, [41](#)
listLayers, [18](#)

mgcv::bam, [6](#)
mgcv::gam, [6](#)
mgcv::gam.check, [8](#)
mgcv::gamm, [14](#), [15](#)
mgcv::residuals.gam, [90](#)
mgcv::s, [44](#)
mqgam, [48](#)
mqgamV, [42](#), [48](#), [50](#), [58](#)

plot.ALE1D, [5](#), [43](#)
plot.fs.interaction.1D, [22](#), [28](#), [29](#), [44](#)
plot.gam, [45](#)
plot.gamViz, [6](#), [15](#), [45](#), [48](#), [79](#), [83](#)
plot.mgamViz, [42](#), [48](#)
plot.mgcv.smooth.1D, [21](#), [24](#), [29](#), [38](#), [40](#), [41](#),
[45](#), [46](#), [49](#)

plot.mgcv.smooth.2D, [24](#), [27](#), [30](#), [38](#), [40](#), [52](#),
 [55](#), [74](#)
 plot.mgcv.smooth.MD, [27](#), [54](#), [76](#)
 plot.mrf.smooth, [38](#), [56](#)
 plot.multi.mgcv.smooth.1D, [48](#)
 plot.multi.mgcv.smooth.1D
 (plot.mgcv.smooth.1D), [49](#)
 plot.multi.mgcv.smooth.2D
 (plot.mgcv.smooth.2D), [52](#)
 plot.multi.ptermFactor, [57](#)
 plot.multi.ptermInteraction
 (plot.ptermInteraction), [60](#)
 plot.multi.ptermLogical
 (plot.multi.ptermFactor), [57](#)
 plot.multi.ptermNumeric
 (plot.ptermMatrixNumeric), [61](#)
 plot.multi.random.effect, [58](#)
 plot.nested1D, [59](#)
 plot.ptermFactor, [20](#), [26](#), [29](#)
 plot.ptermFactor
 (plot.multi.ptermFactor), [57](#)
 plot.ptermInteraction, [60](#)
 plot.ptermLogical
 (plot.multi.ptermFactor), [57](#)
 plot.ptermMatrixNumeric, [61](#)
 plot.ptermNumeric, [21](#), [29](#)
 plot.ptermNumeric
 (plot.ptermMatrixNumeric), [61](#)
 plot.random.effect, [21](#), [45](#)
 plot.random.effect
 (plot.multi.random.effect), [58](#)
 plot.sos.smooth, [19](#), [23](#), [27](#), [30](#), [62](#)
 plotDiff, [64](#)
 plotDiff.mgcv.smooth.1D, [65](#), [65](#)
 plotDiff.mgcv.smooth.2D, [39](#), [40](#), [65](#), [66](#)
 plotDiff.sos.smooth, [39](#), [40](#), [65](#), [68](#)
 plotRGL, [70](#)
 plotRGL.mgcv.smooth.2D, [70](#), [71](#)
 plotRGL.mgcv.smooth.MD, [70](#), [73](#)
 plotSlice, [27](#), [30](#), [75](#)
 postSim, [17](#), [77](#)
 predict.gam, [17](#), [77](#), [92](#)
 print.checkGam, [78](#)
 print.plotGam, [79](#)
 print.plotSmooth, [80](#)
 print.qqGam, [80](#)
 pterm, [57](#), [61](#), [81](#)

 qqam::mqgam, [42](#)

 qqam::qqam, [82](#), [83](#)
 qqamV, [82](#)
 qq, [83](#)
 qq.gamViz, [8](#), [80](#), [84](#), [84](#), [91](#), [94](#)
 qqline (qqplots), [88](#)
 qqnorm (qqplots), [88](#)
 qqplot (qqplots), [88](#)
 qqplots, [88](#)
 quantile, [89](#)

 residuals.gamViz, [8–10](#), [12](#), [71](#), [74](#), [85](#), [89](#)

 shine, [90](#)
 shine.qqGam, [91](#)
 simulate.gam, [17](#), [77](#), [92](#)
 sm, [50](#), [52](#), [54](#), [56](#), [59](#), [63](#), [65](#), [66](#), [68](#), [71](#), [74](#),
 [76](#), [93](#)
 stats::kmeans, [22](#)

 vcov.gam, [78](#)

 zoom, [94](#)
 zoom.qqGam, [94](#)
 zto1, [30](#), [96](#)