

# Package ‘gjam’

February 15, 2022

**Type** Package

**Title** Generalized Joint Attribute Modeling

**Version** 2.5.2

**Date** 2022-6-15

**Author** James S. Clark, Daniel Taylor-Rodriquez

**Maintainer** James S. Clark <jimclark@duke.edu>

**Description** Analyzes joint attribute data (e.g., species abundance) that are combinations of continuous and discrete data with Gibbs sampling. Full model and computation details are described in Clark et al. (2018) <[doi:10.1002/ecm.1241](https://doi.org/10.1002/ecm.1241)>.

**License** GPL (>= 2)

**Imports** Rcpp (>= 0.11.5), MASS, RANN

**Depends** R (>= 2.10)

**LinkingTo** Rcpp, RcppArmadillo

**Suggests** knitr, rmarkdown

**VignetteBuilder** knitr

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2022-02-15 15:20:02 UTC

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gjam-package	<i>Generalized Joint Attribute Modeling</i>
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## Description

Inference and prediction for jointly distributed responses that are combinations of continuous and discrete data. Functions begin with 'gjam' to avoid conflicts with other packages.

## Details

Package: gjam  
 Type: Package  
 Version: 2.5.2  
 Date: 2022-2-15  
 License: GPL (>= 2)  
 URL: <http://sites.nicholas.duke.edu/clarklab/code/>

The generalized joint attribute model (gjam) analyzes multivariate data that are combinations of presence-absence, ordinal, continuous, discrete, composition, zero-inflated, and censored. It does so as a joint distribution over response variables. gjam provides inference on sensitivity to input variables, correlations between responses on the data scale, model selection, and prediction.

Importantly, analysis is done on the observation scale. That is, coefficients and covariances are interpreted on the same scale as the data. Contrast this approach with standard Generalized Linear Models, where coefficients and covariances are difficult to interpret and cannot be compared across responses that are modeled on different scales.

gjam was motivated by species distribution and abundance data in ecology, but can provide an attractive alternative to traditional methods wherever observations are multivariate and combine multiple scales and mixtures of continuous and discrete data.

gjam can be used to model ecological trait data, where species traits are translated to locations as community-weighted means and modes.

Posterior simulation is done by Gibbs sampling. Analysis is done by these functions, roughly in order of how frequently they might be used:

`gjam` fits model with Gibbs sampling.

[gjamSimData](#) simulates data for analysis by gjam.  
[gjamPriorTemplate](#) sets up prior distribution for coefficients.  
[gjamSensitivity](#) evaluates sensitivity to predictors from gjam.  
[gjamCensorY](#) defines censored values and intervals.  
[gjamTrimY](#) trims the response matrix and aggregates rare types.  
[gjamPlot](#) plots output from gjam.  
[gjamSpec2Trait](#) constructs plot by trait matrix.  
[gjamPredict](#) does conditional prediction.  
[gjamConditionalParameters](#) obtains the conditional coefficient matrices.  
[gjamOrdination](#) ordines the response matrix.  
[gjamDeZero](#) de-zeros response matrix for storage.  
[gjamReZero](#) recovers response matrix from de-zeroed format.  
[gjamIIE](#) evaluates indirect effects and interactions.  
[gjamIIEplot](#) plots indirect effects and interactions.  
[gjamSpec2Trait](#) generates trait values.  
[gjamPoints2Grid](#) aggregates incidence data to counts on a lattice.

### Author(s)

Author: James S Clark, <jimclark@duke.edu>, Daniel Taylor-Rodriguez

### References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

Clark, J.S. 2016. Why species tell more about traits than traits tell us about species: Predictive models. *Ecology* 97, 1979-1993.

Taylor-Rodriguez, D., K. Kaufeld, E. M. Schliep, J. S. Clark, and A. E. Gelfand. 2016. Joint species distribution modeling: dimension reduction using Dirichlet processes. *Bayesian Analysis*, in press.

### See Also

[gjam](#), [gjamSimData](#), [gjamPriorTemplate](#), [gjamSensitivity](#), [gjamCensorY](#), [gjamTrimY](#), [gjamPredict](#), [gjamSpec2Trait](#), [gjamPlot](#), [gjamPredict](#), [gjamConditionalParameters](#), [gjamDeZero](#), [gjamReZero](#)

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

gjam

*Gibbs sampler for gjam data***Description**

Analyzes joint attribute data (e.g., species abundance) with Gibbs sampling. Input can be output from [gjamSimData](#). Returns a list of objects from Gibbs sampling that can be plotted by [gjamPlot](#).

**Usage**

```
gjam(formula, xdata, ydata, modellist)

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

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

**Arguments**

formula	R formula for model, e.g., $\sim x_1 + x_2$ .
xdata	data.frame containing predictors in formula. If not found in xdata variables, they must be available from the user's workspace.
ydata	n by S response matrix or data.frame. Column names are unique labels, e.g., species names. All columns will be included in the analysis.
modellist	list specifying inputs, including ng (number of Gibbs steps), burnin, and typeNames. Can include the number of holdouts for out-of-sample prediction, holdoutN. See <b>Details</b> .
x	object of class <a href="#">gjam</a> .
object	currently, also an object of class <a href="#">gjam</a> .
...	further arguments not used here.

**Details**

Note that formula begins with  $\sim$ , not  $y \sim$ . The response matrix is passed in the form of a n by S matrix or data.frame ydata.

Both predictors in xdata and responses in ydata can include missing values as NA. Factors in xdata should be declared using factor. For computational stability variables that are not factors are standardized by mean and variance, then transformed back to original scales in output. To retain a variable in its original scale during computation include it in the character string notStandard as part of the list modellist. (example shown in the vignette on traits).

modellist has these defaults and provides these options:

ng = 2000, number of Gibbs steps.

burnin = 500, no. initial steps, must be less than ng.

typeName can be 'PA' (presenceAbsence), 'CON' (continuous on  $(-\infty, \infty)$ ), 'CA' (continuous abundance, zero censoring), 'DA' (discrete abundance), 'FC' (fractional composition), 'CC' (count composition), 'OC' (ordinal counts), 'CAT' (categorical classes). typeName can be a single value that applies to all columns in ydata, or there can be one value for each column.

holdoutN = 0, number of observations to hold out for out-of-sample prediction.

holdoutIndex = numeric(0), numeric vector of observations (row numbers) to holdout for out-of-sample prediction.

censor = NULL, list specifying columns, values, and intervals for censoring, see [gjamCensorY](#).

effort = NULL, list containing 'columns', a vector of length  $\leq S$  giving the names of columns in in y, and 'values', a length-n vector of effort or a n by S matrix (see Examples). effort can be plot area, search time, etc. for discrete count data 'DA'.

FULL = F in modelList will save full prediction chains in \$chains\$ygibbs.

notStandard = NULL, character vector of column names in xdata that should not be standardized.

reductList = list(N = 20, r = 3), list of dimension reduction parameters, invoked when reductList is included in modelList or automatically when ydata has too many columns. See vignette on Dimension Reduction.

random, character string giving the name of a column in xdata that will be used to specify random effects. The random group column should be declared as a factor. There should be replication, i.e., each group level occurs multiple times.

REDUCT = F in modelList overrides automatic dimension reduction.

FCgroups, CCgroups, are length-S vectors assigned to columns in ydata indicating composition 'FC' or 'CC' group membership. For example, if there are two 'CA' columns in ydata followed by two groups of fractional composition data, each having three columns, then typeName = c('CA', 'CA', 'FC', 'FC', 'FC', 'FC', 'FC', 'FC') and FCgroups = c(0, 0, 1, 1, 1, 2, 2, 2). note: gjamSimData is not currently set up to simulate multiple composition groups, but gjam will model it.

PREDICTX = T executes inverse prediction of x. Speed-up by setting PREDICTX = F.

ematAlpha = .5 is the probability assigned for conditional and marginal independence in the ematrix.

traitList = list(plotByTrait, traitTypes, specByTrait), list of trait objects. See vignette on Trait analysis.

More detailed vignettes can be obtained with:

```
browseVignettes('gjam')
```

## Value

Returns an object of class "gjam", which is a list containing the following components:

call	function call
chains	list of MCMC matrices, each with ng rows; includes coefficients bgibbs(Q*S columns), bgibbsUn (unstandardized for x), sensitivity fgibbs (Q1 columns), and fbgibbs (Q1 columns, where Q1 = Q - 1, unless there are multilevel factors); covariance sgibbs has $S*(S + 1)/2$ columns (REDUCT == F) or N*r columns (REDUCT == T).

<code>fit</code>	list of diagnostics (DIC, rmspeAll, rmspeBySpec, xscore, yscore).
<code>inputs</code>	list of input summaries, including <code>breakMat</code> (partition matrix), <code>classBySpec</code> (interval assignment), <code>designTable</code> (summary of design matrix), <code>[factorBeta, interBeta, intMat, lin]</code> (factor and interaction information), <code>other, notOther</code> (response columns to exclude and not), <code>[standMat, standRows, standX]</code> means and variances to standardize x, <code>[x, xdata, y]</code> cleaned versions of data.
<code>missing</code>	list of missing objects, including locations for predictors <code>xmiss</code> and responses <code>ymiss</code> in <code>xdata</code> and <code>ydata</code> , respectively, predictor means <code>xmissMu</code> and standard errors <code>xmissSe</code> , response means <code>ymissMu</code> and standard errors <code>ymissSe</code> .
<code>modellist</code>	list of model specifications from input <code>modellist</code> .
<code>parameters</code>	list of parameter estimates, including coefficient matrices on standardized ( <code>betaMu, betaSe</code> ), unstandardized ( <code>betaMuUn, betaSeUn</code> ), and dimensionless ( <code>fBetaMu, fBetaSd</code> ) scales; correlation ( <code>corMu, corSe</code> ) and covariance ( <code>sigMu, sigSe</code> ) matrices; sensitivities to predictors ( <code>fmatrix, fMu, fSe</code> ); environmental response matrix ( <code>ematrix</code> ), with locations of zero elements, conditionally ( <code>whConZero</code> ) and marginally ( <code>whichZero</code> ), set at probability level <code>modellist\$ematAlpha</code> ; and latent variables ( <code>wMu, wSd</code> ).
<code>prediction</code>	list of predicted values, including species richness (responses predicted > 0); inverse predicted x ( <code>xpredMu, xpredSd</code> ) and predicted y ( <code>ypredMu, ypredSd</code> ) matrices.

If **traits** are modeled, then parameters will additionally include `betaTraitMu, betaTraitSe` (coefficients), `sigmaTraitMu, sigmaTraitSe` (covariance). `prediction` will additionally include `tMuOrd` (ordinal trait means), `tMu, tSe` (trait predictions).

### Author(s)

James S Clark, <jimclark@duke.edu>

### References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs*, 87, 34-56.

### See Also

[gjamSimData](#) simulates data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

website '<http://sites.nicholas.duke.edu/clarklab/code/>'.

### Examples

```
## Not run:
## combinations of scales
types <- c('DA', 'DA', 'OC', 'OC', 'OC', 'OC', 'CON', 'CON', 'CON', 'CON', 'CON', 'CA', 'CA', 'PA', 'PA')
f <- gjamSimData(S = length(types), typeNames = types)
```

```

m1 <- list(ng = 500, burnin = 50, typeNames = f$typeNames)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)
summary(out)

# repeat with ng = 5000, burnin = 500, then plot data:
p1 <- list(trueValues = f$trueValues)
gjamPlot(out, plotPars = p1)

## discrete abundance with heterogeneous effort
S <- 5
n <- 1000
eff <- list( columns = 1:S, values = round(runif(n,.5,5),1) )
f <- gjamSimData(n, S, typeNames='DA', effort=eff)
m1 <- list(ng = 500, burnin = 50, typeNames = f$typeNames, effort = eff)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)
summary(out)

# repeat with ng = 2000, burnin = 500, then plot data:
p1 <- list(trueValues = f$trueValues)
gjamPlot(out, plotPars = p1)

## End(Not run)

```

---

gjamCensorY

*Censor gjam response data*


---

## Description

Returns a list with censored values, intervals, and censored response matrix *y*.

## Usage

```
gjamCensorY(values, intervals, y, type='CA', whichcol = c(1:ncol(y)))
```

## Arguments

values	Values in <i>y</i> that are censored, specified by intervals
intervals	matrix having two rows and one column for each value in values. The first row holds lower bounds. The second row holds upper bounds. See <b>Examples</b> .
<i>y</i>	Response matrix, <i>n</i> rows by <i>S</i> columns. All values within intervals will be replaced with values
type	Response type, see typeNames in <a href="#">gjam</a>
whichcol	Columns in <i>y</i> that are censored (often not all responses are censored)

## Details

Any values in *y* that fall within censored intervals are replaced with censored values. The example below simulates data collected on an 'octave scale': 0, 1, 2, 4, 8, ..., an approach to accelerate data collection with approximate bins.

**Value**

Returns a list containing two elements.

y	n by S matrix updated with censored values substituted for those falling within intervals.
censor	list containing \$columns that are censored and \$partition, a matrix with 3 rows used in <code>gjam</code> and <code>gjamPlot</code> , one column per censor interval. Rows are values, followed by lower and upper bounds.

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

`gjamSimData` simulates data `gjam` analyzes data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

website '<http://sites.nicholas.duke.edu/clarklab/code/>'.

**Examples**

```
## Not run:
# data in octaves
v <- up <- c(0, 2^c(0:4), Inf)
dn <- c(-Inf, v[-length(v)])
i <- rbind( dn, up ) # intervals

f <- gjamSimData(n = 2000, S = 15, Q = 3, typeNames='CA')
y <- f$y
cc <- c(3:6) # censored columns
g <- gjamCensorY(values = v, intervals = i, y = y, whichcol = cc)
y[,cc] <- g$y # replace columns
ml <- list(ng = 50, burnin = 10, censor = g$censor, typeNames = f$typeNames)
output <- gjam(f$formula, xdata = f$xdata, ydata = y, modelList = ml)

#repeat with ng = 2000, burnin = 500, then:
pl <- list(trueValues = f>trueValues, width = 3, height = 3)
gjamPlot(output, pl)

# upper detection limit
up <- 5
v <- up
i <- matrix(c(up,Inf),2)
```



```

rownames(i) <- c('down','up')

f <- gjamSimData(typeNames='CA')
g <- gjamCensorY(values = v, intervals = i, y = f$y)
ml <- list(ng = 50, burnin = 10, censor = g$censor, typeNames = f$typeNames)
out <- gjam(f$formula, xdata = f$xdata, ydata = g$y, modelList = ml)

#repeat with ng = 2000, burnin = 500, then:
pl <- list(trueValues = f$trueValues, width = 3, height = 3)
gjamPlot(out, pl)

# lower detection limit
lo <- .001
values <- upper <- lo
intervals <- matrix(c(-Inf,lo),2)
rownames(intervals) <- c('lower','upper')

## End(Not run)

```

---

gjamConditionalParameters

*Parameters for gjam conditional prediction*


---

## Description

Conditional parameters quantify the direct effects of predictors including those that come through other species.

## Usage

```
gjamConditionalParameters(output, conditionOn, nsim = 2000)
```

## Arguments

output	object of <code>class</code> "gjam".
conditionOn	a character vector of responses to condition on (see <b>Details</b> ).
nsim	number of draws from the posterior distribution.

## Details

Responses in `ydata` are random with a joint distribution that comes through the residual covariance having mean matrix parameters\$`sigMu` and standard error matrix parameters\$`sigSe`. Still, it can be desirable to use some responses, along with covariates, as predictors of others. The responses (columns) in `ydata` are partitioned into two groups, a group to condition on (the names included in character vector `conditionOn`) and the remaining columns. `conditionOn` gives the names of response variables (column names for `ydata`). The conditional distribution is parameterized as the sum of effects that come directly from predictors in `xdata`, in a matrix `C`, and from the other responses, i.e., those in `conditionOn`, a matrix `A`. A third matrix `P` holds the conditional covariance.

See examples below.

**Value**

Amu	posterior mean for matrix A.
Ase	standard error for matrix A.
Atab	parameter summary for matrix A.
Cmu	posterior mean for matrix C.
Cse	standard error for matrix C.
Ctab	parameter summary for matrix C.
Pmu	posterior mean for matrix P.
Pse	standard error for matrix P.
Ptab	parameter summary for matrix P.

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Qiu, T., S. Shubhi, C. W. Woodall, and J.S. Clark. 2021. Niche shifts from trees to fecundity to recruitment that determine species response to climate change. *Frontiers in Ecology and Evolution* 9, 863. <https://www.frontiersin.org/article/10.3389/fevo.2021.719141>.

**See Also**

[gjamSimData](#) simulates data

[gjam](#) fits the model

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site ['http://sites.nicholas.duke.edu/clarklab/code/'](http://sites.nicholas.duke.edu/clarklab/code/).

**Examples**

```
## Not run:
f <- gjamSimData(n = 200, S = 10, Q = 3, typeNames = 'CA')
m1 <- list(ng = 5000, burnin = 5, typeNames = f$typeNames, holdoutN = 10)
output <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)

# condition on three species
gjamConditionalParameters( output, conditionOn = c('S1','S2','S3') )

## End(Not run)
```

---

gjamDeZero	<i>Compress (de-zero) gjam data</i>
------------	-------------------------------------

---

**Description**

Returns a de-zeroed (sparse matrix) version of matrix `yamat` with objects needed to re-zero it.

**Usage**

```
gjamDeZero(yamat)
```

**Arguments**

<code>yamat</code>	n by S response matrix
--------------------	------------------------

**Details**

Many abundance data sets are mostly zeros. [gjamDeZero](#) extracts non-zero elements for storage.

**Value**

Returns a list containing the de-zeroed `yamat` as a vector `yvec`.

<code>yvec</code>	non-zero elements of <code>yamat</code>
<code>n</code>	no. rows of <code>yamat</code>
<code>S</code>	no. cols of <code>yamat</code>
<code>index</code>	index for non-zeros
<code>ynames</code>	column names of <code>yamat</code>

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjamReZero](#) to recover `yamat`  
`browseVignettes('gjam')`  
website `'http://sites.nicholas.duke.edu/clarklab/code/'`.

**Examples**

```
## Not run:
library(repmis)
source_data("https://github.com/jimclarkatduke/gjam/blob/master/fungEnd.RData?raw=True")

ymat <- gjamReZero(fungEnd$yDeZero) # OTUs stored without zeros
length(fungEnd$yDeZero$yvec)       # size of stored version
length(ymat)                       # full size
yDeZero <- gjamDeZero(ymat)
length(yDeZero$yvec)               # recover de-zeroed vector

## End(Not run)
```

---

`gjamFillMissingTimes` *Fill out data for time series (state-space) gjam*

---

**Description**

Fills in predictor, response, and effort matrices for time series data where there are multiple multi-variate time series. Time series gjam is still under development.

**Usage**

```
gjamFillMissingTimes(xdata, ydata, edata, groupCol, timeCol, groupVars = groupCol,
                    FILLMEANS = FALSE, typeNames = NULL, missingEffort = .1)
```

**Arguments**

<code>xdata</code>	<code>n</code> by <code>Q</code> data.frame holding predictor variables
<code>ydata</code>	<code>n</code> by <code>S</code> matrix holding response variables
<code>edata</code>	<code>n</code> by <code>S</code> matrix holding effort
<code>groupCol</code>	column name in <code>xdata</code> for group variable, i.e., observations part of the same time series
<code>timeCol</code>	column name in <code>xdata</code> for time index
<code>groupVars</code>	character vector of column names in <code>xdata</code> having values that are fixed for a value of <code>groupCol</code> , i.e., they do not change with time index in <code>timeCol</code>
<code>FILLMEANS</code>	fill new rows in <code>ydata</code> with mean for <code>groupCol</code> times <code>missingEffort</code> ; otherwise NA
<code>typeNames</code>	typenames current limited to 'DA' for discrete counts
<code>missingEffort</code>	effort assigned to missing values of <code>edata</code> and <code>ydata</code>

## Details

Missing times in the data occur where there are gaps in `timeCol` column of `xdata` and the initial time 0 for each sequence. New versions of the data have NA (`xdata`) or prior values with appropriate weight (`ydata`). Missing times are filled in `xdata`, `ydata`, `edata`, including a time 0 which serves as a prior mean for `ydata` for time code 1. The group and time indices in columns `groupCol` and `timeCol` of `xdata` reference the time for a given time series. Missing values in the columns `groupVars` of `xdata` are filled automatically. This assumes that values for these variables are fixed for the group. If `FILLMEANS`, the missing values in `ydata` are filled with means for the group and given a low weight specified in `missingEffort`.

## Value

A list containing the following:

<code>xdata</code>	filled version of <code>xdata</code>
<code>ydata</code>	filled version of <code>ydata</code>
<code>edata</code>	filled version of <code>edata</code>
<code>timeList</code>	time indices used for computation, including, <code>timeZero</code> (row numbers in new data where each time series begins, with times = 0), <code>timeLast</code> (row numbers in new data where each time series ends), <code>rowInserts</code> (row numbers for all inserted rows), <code>noEffort</code> (rows for which effort in <code>edata</code> is filled with <code>missingEffort</code> )

## Author(s)

James S Clark, <jimclark@duke.edu>

## References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs*, 87, 34-56.

## See Also

[gjam](#) for more on `xdata`, `ydata`, and effort.

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site '<http://sites.nicholas.duke.edu/clarklab/code/>'.

gjamIIE

*Indirect effects and interactions for gjam data***Description**

Evaluates direct, indirect, and interactions from a `gjam` object. Returns a list of objects that can be plotted by `gjamIIEplot`.

**Usage**

```
gjamIIE(output, xvector, MEAN = T, keepNames = NULL, omitY = NULL,
        sdScaleX = T, sdScaleY = F)
```

**Arguments**

<code>output</code>	object of <code>class</code> inheriting from "gjam".
<code>xvector</code>	vector of predictor values, with names, corresponding to columns in <code>output\$x</code> .
<code>MEAN</code>	logical, if false, then median used.
<code>omitY</code>	character vector of columns in <code>output\$y</code> to omit from calculations.
<code>keepNames</code>	character vector of columns in <code>output\$y</code> . If omitted, all columns used.
<code>sdScaleX</code>	standardize coefficients to X scale.
<code>sdScaleY</code>	standardize coefficients to correlation scale.

**Details**

For plotting or recovering effects. The list `fit$IIE` has matrices for main effects (`mainEffect`), interactions (`intEffect`), direct effects (`dirEffect`), indirect effects (`indEffectTo`), and standard deviations for each. The direct effects are the sum of main effects and interactions. The indirect effects include main effects and interactions that come through other species, determined by covariance matrix `sigma`.

If `sdScaleX = T` effects are standardized from the Y/X to Y scale. This is the typical standardization for predictor variables. If `sdScaleY = T` effects are given on the correlation scale. If both are true effects are dimensionless. See the `gjam` vignette on dimension reduction.

**Value**

A list of objects for plotting by `gjamIIEplot`.

**Author(s)**

James S Clark, <jimclark@duke.edu>

## References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

## See Also

[gjamIIEplot](#) plots output from `gjamIIE`

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site '<http://sites.nicholas.duke.edu/clarklab/code/>'.

## Examples

```
## Not run:
sim <- gjamSimData(S = 12, Q = 5, typeNames = 'CA')
m1 <- list(ng = 50, burnin = 5, typeNames = sim$typeNames)
out <- gjam(sim$formula, sim$xdata, sim$ydata, modelList = m1)

xvector <- colMeans(out$inputs$xStand) #predict at mean values for data
xvector[1] <- 1

fit <- gjamIIE(output = out, xvector)

gjamIIEplot(fit, response = 'S1', effectMu = c('main','ind'),
            effectSd = c('main','ind'), legLoc = 'topleft')

## End(Not run)
```

---

`gjamIIEplot`

*Plots indirect effects and interactions for gjam data*

---

## Description

Using the object returned by `gjamIIEplot` generates a plot for a response variable.

## Usage

```
gjamIIEplot(fit, response, effectMu, effectSd = NULL,
            ylim = NULL, col='black', legLoc = 'topleft', cex = 1)
```

## Arguments

<code>fit</code>	object from <code>gjamIIE</code> .
<code>response</code>	name of a column in <code>fit\$y</code> to plot.
<code>effectMu</code>	character vector of mean effects to plot, can include 'main', 'int', 'direct', 'ind'.

effectSd	character vector can include all or some of effectMu.
ylim	vector of two values defines vertical axis range.
col	vector of colors for barplot.
legLoc	character for legend location.
cex	font size.

### Details

For plotting direct effects, interactions, and indirect effects from an object `fit` generated by `gjamIIE`. The character vector supplied as `effectMu` can include main effects ('main'), interactions ('int'), main effects plus interactions ('direct'), and/or indirect effects ('ind'). The list `effectSd` draws 0.95 predictive intervals for all or some of the effects listed in `effectMu`. Bars are contributions of each effect to the response.

For factors, effects are plotted relative to the mean over all factor levels.

### Author(s)

James S Clark, <jimclark@duke.edu>

### References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

### See Also

[gjamIIE](#) generates output for `gjamIIEplot`

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site '<http://sites.nicholas.duke.edu/clarklab/code/>'.

### Examples

```
## Not run:
f <- gjamSimData(S = 10, Q = 6, typeNames = 'OC')
m1 <- list(ng = 50, burnin = 5, typeNames = f$typeNames)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)

xvector <- colMeans(out$inputs$xStand) #predict at mean values for data, standardized x
xvector[1] <- 1

fit <- gjamIIE(out, xvector)

gjamIIEplot(fit, response = 'S1', effectMu = c('main','ind'),
            effectSd = c('main','ind'), legLoc = 'topleft')

## End(Not run)
```



---

gjamOrdination	<i>Ordinate gjam data</i>
----------------	---------------------------

---

**Description**

Ordinate data from a gjam object using correlation corresponding to response matrix E.

**Usage**

```
gjamOrdination(output, specLabs = NULL, col = NULL, cex = 1,
               PLOT=T, method = 'PCA')
```

**Arguments**

output	object of <code>class</code> "gjam".
specLabs	character vector of variable names in <code>colnames(output\$y)</code> .
col	character vector of columns in <code>output\$y</code> to label in plots.
cex	text size in plot.
PLOT	logical, if true, draw plots.
method	character variable can specify 'NMDS'.

**Details**

Ordinates the response correlation matrix contained in `output$parameterTables`. If `method = 'PCA'` returns eigenvalues and eigenvectors. If `method = 'PCA'` returns three NMDS dimensions. If `PLOT`, then plots will be generated. Uses principle components analysis or non-metric multidimensional scale (NMDS).

**Value**

eVecs	$S \times S$ or, if there is an other response variable to be excluded, $S-1 \times S-1$ matrix of eigenvectors for species (rows) by eigenvectors (columns).
eValues	If <code>method = 'PCA'</code> returns length- $S$ or, there is an other response variable to be excluded, length- $S-1$ vector of eigenvalues. If <code>method = 'NMDS'</code> this variable is <code>NULL</code> .

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyedsrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjam](#) fits the data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

website ['http://sites.nicholas.duke.edu/clarklab/code/'](http://sites.nicholas.duke.edu/clarklab/code/).

**Examples**

```
## Not run:
f      <- gjamSimData(S = 30, typeNames = 'CA')
m1     <- list(ng = 30, burnin = 5, typeNames = f$typeNames, holdoutN = 10)
output <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)
ePCA   <- gjamOrdination(output, PLOT=TRUE)
eNMDS  <- gjamOrdination(output, PLOT=TRUE, method='NMDS')

## End(Not run)
```

---

gjamPlot

*Plot gjam analysis*


---

**Description**

Constructs plots of posterior distributions, predictive distributions, and additional analysis from output of [gjam](#).

**Usage**

```
gjamPlot(output, plotPars)
```

**Arguments**

output	object of <code>class</code> "gjam"
plotPars	list having default values described in <b>Details</b>

**Details**

plotPars a list that can contain the following, listed with default values:

PLOTY = T	plot predicted y.
PLOTX = T	plot inverse predicted x.
PREDICTX = T	inverse prediction of x; does not work if PREDICTX = F in <code>link{gjam}</code> .
ncluster	number of clusters to highlight in cluster diagrams, default based on S.
CORLINES = T	draw grid lines on grid plots of R and E.
cex = 1	text size for grid plots, see <a href="#">par</a> .
BETAGRID = T	draw grid of beta coefficients.
PLOTALLY = F	an individual plot for each column in y.
SMALLPLOTS = T	avoids plot margin error on some devices, better appearance if FALSE.

GRIDPLOTS = F	cluster and grid plots derived from parameters; matrices R and E are discussed in Clark et al. (
SAVEPLOTS = F	plots saved in pdf format.
outfolder = 'gjamOutput'	folder for plot files if SAVEPLOTS = T.
width, height = 4	can be small values, in inches, to avoid plot margin error on some devices.
specColor = 'black'	color for posterior box-and-whisker plots.
ematAlpha = .95	prob threshold used to infer that a covariance value in Emat is not zero.
ncluster = 4	number of clusters to identify in ematrix.

The 'plot margin' errors mentioned above are device-dependent. They can be avoided by specifying small width, height (in inches) and by omitting the grid plots (GRIDPLOTS = F). If plotting does not produce a 'plot margin error', better appearance is obtained with SMALLPLOTS = F.

Names will not be legible for large numbers of species. Specify specLabs = F and use a character vector for specColor to identify species groups (see the gjam vignette on dimension reduction).

Box and whisker plots bound 0.68 and 0.95 credible and predictive intervals.

## Value

Summary tables of parameter estimates are:

betaEstimates	Posterior summary of beta coefficients.
clusterIndex	cluster index for responses in grid/cluster plots.
clusterOrder	order for responses in grid/cluster plots.
eComs	groups based on clustering ematrix.
ematrix	S X S response correlation matrix for E.
eValues	eigenvalues of ematrix.
eVecs	eigenvectors of ematrix.
fit	list containing DIC, score, and rmspe.

## Author(s)

James S Clark, <jimclark@duke.edu>

## References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. Ecological Monographs 87, 34-56.

## See Also

[gjam](#) A more detailed vignette is can be obtained with:  
 browseVignettes('gjam')  
 website 'http://sites.nicholas.duke.edu/clarklab/code/.'

**Examples**

```
## Not run:
## ordinal data
f <- gjamSimData(S = 15, Q = 3, typeNames = 'OC')
ml <- list(ng = 500, burnin = 50, typeNames = f$typeNames, holdoutN = 10)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = ml)

# repeat with ng = 2000, burnin = 500, then plot data here:
pl <- list(trueValues = f>trueValues, width=3, height=2)
fit <- gjamPlot(output = out, plotPars = pl)

## End(Not run)
```

gjamPoints2Grid

*Incidence point pattern to grid counts***Description**

From point pattern data in  $(x, y)$  generates counts on a lattice supplied by the user or specified by lattice size or density. For analysis in [gjam](#) as counts (known effort) or count composition (unknown effort) data.

**Usage**

```
gjamPoints2Grid(specs, xy, nxy = NULL, dxy = NULL,
               predGrid = NULL, effortOnly = TRUE)
```

**Arguments**

specs	character vector of species names or codes.
xy	matrix with rows = length(specs) and columns for $(x, y)$ .
nxy	length-2 numeric vector with numbers of points evenly spaced on $(x, y)$ .
dxy	length-2 numeric vector with distances for points evenly spaced on $(x, y)$ .
predGrid	matrix with 2 columns for $(x, y)$ .
effortOnly	logical to return only points where counts are positive (e.g., effort is unknown).

**Details**

For incidence data with species names specs and locations  $(x, y)$  constructs a lattice based a prediction grid predGrid, at a density of  $(dx, dy)$ , or with numbers of lattice points  $(nx, ny)$ . If effortOnly = T, returns only points with non-zero values.

A prediction grid predGrid would be passed when counts by locations of known effort are required or where multiple groups should be assign to the same lattice points.

The returned gridBySpec can be analyzed in [gjam](#) with known effort as count data "DA" or with unknown effort as count composition data "CC".



---

<code>gjamPredict</code>	<i>Predict gjam data</i>
--------------------------	--------------------------

---

## Description

Predicts data from a gjam object, including conditional and out-of-sample prediction.

## Usage

```
gjamPredict(output, newdata = NULL, y2plot = NULL, ylim = NULL,
            FULL = FALSE)
```

## Arguments

<code>output</code>	object of <code>class</code> "gjam".
<code>newdata</code>	a list of data for prediction, see <b>Details</b> .
<code>y2plot</code>	character vector of columns in <code>output\$y</code> to plot.
<code>ylim</code>	vector of lower and upper bounds for prediction plot
<code>FULL</code>	will return full chains for predictions as <code>output\$ychains</code>

## Details

If `newdata` is not specified, the response is predicted from `xdata` as an in-sample prediction. If `newdata` is specified, prediction is either conditional or out-of-sample.

Conditional prediction on a new set of `y` values is done if `newdata` includes the matrix `ycondData`, which holds columns to condition on. `ycondData` must be a matrix and have column names matching those in `y` that it will replace. `ycondData` must have at least one column, but fewer than `ncol(y)` columns. Columns not included in `ycondData` will be predicted conditionally. Note that conditional prediction can be erratic if the observations on which the prediction is conditioned are unlikely given the model.

Alternatively, the list `newdata` can include a new version of `xdata` for out-of-sample prediction. The version of `xdata` passed in `newdata` has the columns with the same names and variable types as `xdata` passed to `gjam`. Note that factor levels must also match those included when fitting the model. All columns in `y` will be predicted out-of-sample.

For count composition data the effort (total count) is 1000.

Because there is no out-of-sample effort for 'CC' data, values are predicted on the [0, 1] scale.

See examples below.

## Value

<code>x</code>	design matrix.
<code>sdList</code>	list of predictive means and standard errors includes <code>yMu</code> , <code>yPe</code> (predictive mean, SE), <code>wMu</code> , <code>wSe</code> (mean latent states and SEs)

piList	predictive intervals, only generated if <code>length(y) &lt; 10000</code> , includes <code>yLo, yHi</code> (0.025, 0.975) prediction interval, <code>wLo, wHi</code> (0.025, 0.975) for latent states
prPresent	<code>n x S</code> matrix of probabilities of presence
ematrix	effort
ychains	full prediction chains if <code>FULL = T</code>

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs*, 87, 34-56.

**See Also**

[gjamSimData](#) simulates data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site '<http://sites.nicholas.duke.edu/clarklab/code/>'.

**Examples**

```
## Not run:
S <- 10
f <- gjamSimData(n = 200, S = S, Q = 3, typeNames = 'CC')
m1 <- list(ng = 50, burnin = 5, typeNames = f$typeNames, holdoutN = 10)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = m1)

# predict data
cols <- c('#018571', '#a6611a')
par(mfrow=c(1,3),bty='n')
gjamPredict(out, y2plot = colnames(f$ydata)) # predict the data in-sample
title('full sample')

# out-of-sample prediction
xdata <- f$xdata[1:20,]
xdata[,3] <- mean(f$xdata[,3]) # mean for x[,3]
xdata[,2] <- seq(-2,2,length=20) # gradient x[,2]
newdata <- list(xdata = xdata, nsim = 50)
p1 <- gjamPredict(output = out, newdata = newdata)

# plus/minus 1 prediction SE, default effort = 1000
x2 <- p1$x[,2]
ylim <- c(0, max(p1$sedList$yMu[,1] + p1$sedList$yPe[,1]))
plot(x2, p1$sedList$yMu[,1], type='l', lwd=2, ylim=ylim, xlab='x2',
     ylab = 'Predicted', col = cols[1])
lines(x2, p1$sedList$yMu[,1] + p1$sedList$yPe[,1], lty=2, col = cols[1])
```

```

lines(x2, p1$sdList$yMu[,1] - p1$sdList$yPe[,1], lty=2, col = cols[1])

# upper 0.95 prediction error
lines(x2, p1$piList$yLo[,1], lty=3, col = cols[1])
lines(x2, p1$piList$yHi[,1], lty=3, col = cols[1])
title('SE and prediction, Sp 1')

# conditional prediction, assume first species is absent
ydataCond <- out$inputs$y[,1,drop=FALSE]*0 # set first column to zero
newdata <- list(ydataCond = ydataCond, nsim=50)
p0 <- gjamPredict(output = out, newdata = newdata)

ydataCond <- ydataCond + 10 # first column is 10
newdata <- list(ydataCond = ydataCond, nsim=50)
p1 <- gjamPredict(output = out, newdata = newdata)

s <- 4 # species chosen at random to compare
ylim <- range( p0$sdList$yMu[,s], p1$sdList$yMu[,s] )
plot(out$inputs$y[,s],p0$sdList$yMu[,s], cex=.2, col=cols[1],
     xlab = 'Observed', ylab = 'Predicted', ylim = ylim)
abline(0,1,lty=2)
points(out$inputs$y[,s],p1$sdList$yMu[,s], cex=.2, col=cols[2])
title('Cond. on 1st Sp')
legend( 'topleft', c('first species absent', 'first species = 10'),
       text.col = cols, bty = 'n')

# conditional, out-of-sample
n <- 1000
S <- 10
f <- gjamSimData(n = n, S = S, Q = 3, typeNameNames = 'CA')

holdOuts <- sort( sample(n, 50) )

xdata <- f$xdata[-holdOuts,] # fitted data
ydata <- f$ydata[-holdOuts,]

xx <- f$xdata[holdOuts,] # use for prediction
yy <- f$ydata[holdOuts,]

m1 <- list(ng = 2000, burnin = 50, typeNameNames = f$typeNames) # fit the non-holdouts
out <- gjam(f$formula, xdata, ydata, modelList = m1)

cdex <- sample(S, 4) # condition on 4 species
ndex <- c(1:S)[-cdex] # conditionally predict others

newdata <- list(xdata = xx, ydataCond = yy[,cdex], nsim = 200) # conditionally predict out-of-sample
p2 <- gjamPredict(output = out, newdata = newdata)

par(bty='n', mfrow=c(1,1))
plot( as.matrix(yy[,ndex]), p2$sdList$yMu[,ndex],
     xlab = 'Observed', ylab = 'Predicted', cex=.3, col = cols[1])
abline(0,1,lty=2)

```



```

title('RMSPE')
mspeC <- sqrt( mean( (as.matrix(yy[,ndex]) - p2$sdList$yMu[,ndex])^2 ) )

#predict unconditionally, out-of-sample
newdata <- list(xdata = xx, nsim = 200 )
p1 <- gjamPredict(out, newdata = newdata)

points( as.matrix(yy[,ndex]), p1$sdList$yMu[,ndex], col=cols[2], cex = .3)
mspeU <- sqrt( mean( (as.matrix(yy[,ndex]) - p1$sdList$yMu[,ndex])^2 ) )

e1 <- paste( 'cond, out-of-sample =', round(mspeC, 2) )
e2 <- paste( 'uncond, out-of-sample =', round(mspeU, 2) )

legend('topleft', c(e1, e2), text.col = cols, bty = 'n')

## End(Not run)

```

---

gjamPriorTemplate      *Prior coefficients for gjam analysis*

---

## Description

Constructs coefficient matrices for low and high limits on the uniform prior distribution for beta.

## Usage

```
gjamPriorTemplate(formula, xdata, ydata, lo = NULL, hi = NULL)
```

## Arguments

formula	object of class formula, starting with ~, matches the formula passed to gjam
xdata	n x Q observation by predictor data.frame
ydata	n x Q observation by response data.frame
lo	list of lower limits
hi	list of upper limits

## Details

The prior distribution for a coefficient  $\beta_{[q, s]}$  for predictor  $q$  and response  $s$ , is  $\text{dunif}(\text{lo}[q, s], \text{hi}[q, s])$ . `gjamPriorTemplate` generates these matrices. The default values are  $(-\text{Inf}, \text{Inf})$ , i.e., all values in `lo` equal to  $-\text{Inf}$  and `hi` equal to  $\text{Inf}$ . These templates can be modified by changing specific values in `lo` and/or `hi`.

Alternatively, desired lower limits can be passed as the list `lo`, assigned to names in `xdata` (same limit for all species in `ydata`), in `ydata` (same limit for all predictors in `xdata`), or both, separating names in `xdata` and `ydata` by `"_"`. The same convention is used for upper limits in `hi`.

These matrices are supplied in as list `betaPrior`, which is included in `modelList` passed to `gjam`. See examples and `browseVignettes('gjam')`.

Note that the informative prior slows computation.

**Value**

A list containing two matrices. `lo` is a  $Q \times S$  matrix of lower coefficient limits. `hi` is a  $Q \times S$  matrix of upper coefficient limits. Unless specified in `lo`, all values in `lo` = `-Inf`. Likewise, unless specified in `hi`, all values in `hiBeta` = `-Inf`.

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjam](#)

**Examples**

```
## Not run:
library(repmis)
source_data("https://github.com/jimclarkatduke/gjam/blob/master/forestTraits.RData?raw=True")

xdata      <- forestTraits$xdata
plotByTree <- gjamReZero(forestTraits$treesDeZero) # re-zero
traitTypes <- forestTraits$traitTypes
specByTrait <- forestTraits$specByTrait

tmp <- gjamSpec2Trait(pbys = plotByTree, sbyt = specByTrait,
                    tTypes = traitTypes)
tTypes <- tmp$traitTypes
traity <- tmp$plotByCWM
censor <- tmp$censor

formula <- as.formula(~ temp + deficit)
lo <- list(temp_ring = 0, deficit_drought = 0) # positive combinations
b <- gjamPriorTemplate(formula, xdata, ydata = traity, lo = lo)
bp <- list(loBeta = b$lo, hiBeta = b$hi)

m1 <- list(ng=4000, burnin=1000, typeNames = tTypes, censor = censor,
          betaPrior = bp)
out <- gjam(formula, xdata, ydata = traity, modelList = m1)

S <- ncol(traity)
sc <- rep('black', S)
sc[colnames(traity)]
pl <- list(SMALLPLOTS=F, specColor=sc)
gjamPlot(output = out, plotPars = pl)
```

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

---

gjamReZero	<i>Expand (re-zero) gjam data</i>
------------	-----------------------------------

---

## Description

Returns a re-zeroed matrix `y` from the de-zeroed vector, a sparse matrix.

## Usage

```
gjamReZero( yDeZero )
```

## Arguments

`yDeZero` list created by [gjamReZero](#) containing number of rows `n`, number of columns `S`, index for non-zeros `index`, the vector of non-zero values `yvec`, and the column names `yname`s.

## Details

Many abundance data sets are mostly zeros. `gjamReZero` recovers the full matrix from de-zeroed list `yDeZero` written by [gjamDeZero](#)

## Value

`yamat` re-zeroed `n` by `S` matrix.

## Author(s)

James S Clark, <jimclark@duke.edu>

## References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

## See Also

[gjamDeZero](#) to de-zero `yamat`

`browseVignettes('gjam')`

website: `'http://sites.nicholas.duke.edu/clarklab/code/'`.

**Examples**

```
## Not run:
library(repmis)
source_data("https://github.com/jimclarkatduke/gjam/blob/master/fungEnd.RData?raw=True")
ymat <- gjamReZero(fungEnd$yDeZero) # OTUs stored without zeros
length(fungEnd$yDeZero$yvec)      # size of stored version
length(ymat)                      # full size

## End(Not run)
```

---

gjamSensitivity      *Sensitivity coefficients for gjam*

---

**Description**

Evaluates sensitivity coefficients for full response matrix or subsets of it. Uses output from [gjam](#). Returns a matrix of samples by predictors.

**Usage**

```
gjamSensitivity(output, group = NULL, nsim = 100, PERSPECIES = TRUE)
```

**Arguments**

output	object fitted with gjam.
group	character vector of response-variable names from output\$inputs\$y.
nsim	number of samples from posterior distribution.
PERSPECIES	divide variance by number of species in the group

**Details**

Sensitivity to predictors of entire response matrix or a subset of it, identified by the character string group. The equations for sensitivity are given here:

```
browseVignettes('gjam')
```

**Value**

Returns a nsim by predictor matrix of sensitivities to predictor variables, evaluated by draws from the posterior. Because sensitivities may be compared across groups represented by different numbers of species, PERSPECIES = TRUE returns sensitivity on a per-species basis.

**Author(s)**

James S Clark, <jimclark@duke.edu>

## References

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs*, 87, 34-56.

## See Also

[gjamSimData](#) simulates data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

website ['http://sites.nicholas.duke.edu/clarklab/code/'](http://sites.nicholas.duke.edu/clarklab/code/).

## Examples

```
## Not run:
## combinations of scales
types <- c('DA','DA','OC','OC','OC','OC','CC','CC','CC','CC','CC','CA','CA','PA','PA')
f <- gjamSimData(S = length(types), typeNames = types)
ml <- list(ng = 50, burnin = 5, typeNames = f$typeNames)
out <- gjam(f$formula, f$xdata, f$ydata, modelList = ml)

ynames <- colnames(f$y)
group <- ynames[types == 'OC']

full <- gjamSensitivity(out)
cc <- gjamSensitivity(out, group)

nt <- ncol(full)

ylim <- range(rbind(full, cc))

boxplot( full, boxwex = 0.25, at = 1:nt - .21, col='blue', log='y',
         ylim = ylim, xaxt = 'n', xlab = 'Predictors', ylab='Sensitivity')
boxplot( cc, boxwex = 0.25, at = 1:nt + .2, col='forestgreen', add=T,
         xaxt = 'n')
axis(1,at=1:nt,labels=colnames(full))
legend('bottomleft',c('full response','CC data'),
      text.col=c('blue','forestgreen'))

## End(Not run)
```

---

gjamSimData

*Simulated data for gjam analysis*

---

## Description

Simulates data for analysis by [gjam](#).

**Usage**

```
gjamSimData(n = 1000, S = 10, Q = 5, x = NULL, nmiss = 0, typeNames, effort = NULL)
```

**Arguments**

n	Sample size
S	Number of response variables (columns) in y, typically less than n
Q	Number of predictors (columns) in design matrix $x \ll n$
x	design matrix, if supplied n and Q will be set to <code>nrow(x)</code> and <code>ncol(x)</code> , respectively
nmiss	Number of missing values to in $x \ll n$
typeNames	Character vector of data types, see <b>Details</b>
effort	List containing 'columns' specifying columns to which effort applies, and 'values', a length-n vector of effort per observation.

**Details**

Generates simulated data and parameters for analysis by [gjam](#). Because both parameters and data are stochastic, not all simulations will give good results.

`typeNames` can be 'PA' (presenceAbsence), 'CA' (continuous), 'DA' (discrete), 'FC' (fractional composition), 'CC' (count composition), 'OC' (ordinal counts), and 'CAT' (categorical levels). If more than one 'CAT' is included, each defines a multilevel categorical response. One additional type, 'CON' (continuous), is not censored at zero by default.

If defined as a single character value `typeNames` applies to all columns in y. If not, `typeNames` is length-S character vector, identifying each response by column in y. If a column 'CAT' is included, a random number of levels will be generated, a, b, c, . . .

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

website ['http://sites.nicholas.duke.edu/clarklab/code/'](http://sites.nicholas.duke.edu/clarklab/code/).

**Value**

formula	R formula for model, e.g., $\sim x_1 + x_2$
xdata	data.frame includes columns for predictors in the design matrix
ydata	data.frame for the simulated response
y	response as a n by S matrix as assembled in <a href="#">gjam</a> .
w	n by S latent states
typeY	vector of data types corresponding to columns in y, see <b>Details</b>
typeNames	vector of data types corresponding to columns in ydata
trueValues	list containing true parameter values beta (regression coefficients), sigma (covariance matrix), corSpec (correlation matrix corresponding to sigma), and cuts (partition matrix for ordinal data).
effort	see <b>Arguments</b> .

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2016. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjam](#)

**Examples**

```
## Not run:
## ordinal data, show true parameter values
sim <- gjamSimData(S = 5, typeNames = 'OC')
sim$ydata[1:5,]           # example data
sim$trueValues$cuts      # simulated partition
sim$trueValues$beta      # coefficient matrix

## continuous data censored at zero, note latent w for obs y = 0
sim <- gjamSimData(n = 5, S = 5, typeNames = 'CA')
sim$w
sim$y

## continuous and discrete data
types <- c(rep('DA',5), rep('CA',4))
sim <- gjamSimData(n = 10, S = length(types), Q = 4, typeNames = types)
sim$typeNames
sim$ydata

## composition count data
sim <- gjamSimData(n = 10, S = 8, typeNames = 'CC')
totalCount <- rowSums(sim$ydata)
cbind(sim$ydata, totalCount) # data with sample effort

## multiple categorical responses - compare matrix y and data.frame ydata
types <- rep('CAT',2)
sim <- gjamSimData(S = length(types), typeNames = types)
head(sim$ydata)
head(sim$y)

## discrete abundance, heterogeneous effort
S <- 5
n <- 1000
ef <- list( columns = 1:S, values = round(runif(n,.5,5),1) )
sim <- gjamSimData(n, S, typeNames = 'DA', effort = ef)
sim$effort$values[1:20]

## combinations of scales, partition only for 'OC' columns
```

```

types <- c('OC', 'OC', 'OC', 'CC', 'CC', 'CC', 'CC', 'CC', 'CA', 'CA', 'PA', 'PA')
sim <- gjamSimData(S = length(types), typeNames = types)
sim$typeNames
head(sim$data)
sim$trueValues$cuts

## End(Not run)

```

---

gjamSpec2Trait

*Ecological traits for gjam analysis*


---

### Description

Constructs community-weighted mean-mode (CWMM) trait matrix for analysis with [gjam](#) for  $n$  observations,  $S$  species,  $P$  traits, and  $M$  total trait levels.

### Usage

```
gjamSpec2Trait(pbyn, sbyn, tTypes)
```

### Arguments

pbyn	$n \times S$ plot by species matrix (presence-absence, abundance)
sbyn	$S \times P$ species by trait matrix
tTypes	$P$ data types for trait columns

### Details

Generates the objects needed for a trait response model (TRM). As inputs the sbyn data.frame has  $P$  columns containing numeric values, ordinal scores, and categorical variables, identified by data type in tTypes. Additional trait columns can appear in the  $n \times M$  output matrix plotByCWMM, because each level of a category becomes a new 'FC' column as a CWMM. Thus,  $M$  can exceed  $P$ , depending on the number of factors in sbyn. The exception is for categorical traits with only two levels, which can be treated as (0, 1) censored 'CA' data.

As output, the CWMM data types are given in traitTypes.

The list censor = NULL unless some data types are censored. In the example below there are two censored columns.

A detailed vignette on trait analysis is obtained with:

```
browseVignettes('gjam')
```

### Value

plotByCWM	$n \times M$ matrix of community-weight means (numeric) or modes (ordinal)
traitTypes	character vector of data types for traits
specByTrait	$S \times M$ matrix translates species to traits
censor	list of censored columns, values, and intervals; see <a href="#">gjamCensorY</a>



**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S. 2016. Why species tell us more about traits than traits tell us about species: Predictive models. *Ecology* 97, 1979-1993.

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjam](#), [gjamCensorY](#)

**Examples**

```
## Not run:
library(repmis)
source_data("https://github.com/jimclarkatduke/gjam/blob/master/forestTraits.RData?raw=True")

xdata      <- forestTraits$xdata
plotByTree <- gjamReZero(forestTraits$treesDeZero) # re-zero
traitTypes <- forestTraits$traitTypes
specByTrait <- forestTraits$specByTrait

tmp <- gjamSpec2Trait(pbys = plotByTree, sbyt = specByTrait,
                    tTypes = traitTypes)
tTypes <- tmp$traitTypes
traity <- tmp$plotByCWM
censor <- tmp$censor

m1 <- list(ng=2000, burnin=500, typeNames = tTypes, censor = censor)
out <- gjam(~ temp + stdage + deficit, xdata, ydata = traity, modellist = m1)
gjamPlot( output = out )

## End(Not run)
```

---

gjamTrimY

*Trim gjam response data*

---

**Description**

Returns a list that includes a subset of columns in *y*. Rare species can be aggregated into a single class.

**Usage**

```
gjamTrimY(y, minObs = 2, maxCols = NULL, OTHER = TRUE)
```

**Arguments**

<code>y</code>	n by S numeric response matrix
<code>minObs</code>	minimum number of non-zero observations
<code>maxCols</code>	maximum number of response variables
<code>OTHER</code>	logical or character string. If <code>OTHER = TRUE</code> , rare species are aggregated in a new column 'other'. A character vector contains the names of columns in <code>y</code> to be aggregated with rare species in the new column 'other'.

**Details**

Data sets commonly have many responses that are mostly zeros, large numbers of rare species, even singletons. Response matrix `y` can be trimmed to include only taxa having `> minObs` non-zero observations or to `<= maxCol` total columns. The option `OTHER` is recommended for composition data ('CC', 'FC'), where the 'other' column is taken as the reference class. If there are unidentified species they might be included in this class. [See [gjamSimData](#) for `typeName` codes].

**Value**

Returns a list containing three elements.

<code>y</code>	trimmed version of <code>y</code> .
<code>colIndex</code>	length-S vector of indices for new columns in <code>y</code> .
<code>nobs</code>	number of non-zero observations by column in <code>y</code> .

**Author(s)**

James S Clark, <jimclark@duke.edu>

**References**

Clark, J.S., D. Nemergut, B. Seyednasrollah, P. Turner, and S. Zhang. 2017. Generalized joint attribute modeling for biodiversity analysis: Median-zero, multivariate, multifarious data. *Ecological Monographs* 87, 34-56.

**See Also**

[gjamSimData](#) simulates data [gjam](#) analyzes data

A more detailed vignette is can be obtained with:

```
browseVignettes('gjam')
```

web site 'http://sites.nicholas.duke.edu/clarklab/code/'

**Examples**

```
## Not run:
library(repmis)
source_data("https://github.com/jimclarkatduke/gjam/blob/master/forestTraits.RData?raw=True")

y <- gjamReZero(fungEnd$yDeZero)    # re-zero data
dim(y)
y <- gjamTrimY(y, minObs = 200)$y   # species in >= 200 observations
dim(y)
tail(colnames(y))    # last column is 'other'

## End(Not run)
```

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