

# Package ‘BGmix’

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**Type** Package

**Title** Bayesian models for differential gene expression

**Version** 1.54.0

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**Description** Fully Bayesian mixture models for differential gene expression

**License** GPL-2

**Depends** R (>= 2.3.1), KernSmooth

**biocViews** Microarray, DifferentialExpression, MultipleComparison

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## R topics documented:

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|               |                                                                                                                                                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| BGmix-package | <i>BGmix fits a variety of Bayesian hierarchical models for finding differential gene expression between 2 or more experimental conditions.</i> |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------|

---

## Description

BGmix uses a C++ routine to fit the chosen model via an MCMC algorithm. Files are written to a sub-directory in the working directory. The package includes R functions for reading the results into R, and several plotting functions and functions for estimating error rates.

## Details

|          |            |
|----------|------------|
| Package: | BGmix      |
| Type:    | Package    |
| Version: | 1.0        |
| Date:    | 2007-02-01 |
| License: | GPL        |

See Vignette for details of how to use this package (use `openVignette()`).

## Author(s)

Alex Lewin and Natalia Bochkina

Maintainer: Alex Lewin <a.m.lewin@imperial.co.uk>

## References

Lewin, A., Bochkina, N. and Richardson, S. (2007), Fully Bayesian mixture model for differential gene expression: simulations and model checks. <http://www.bgx.org.uk/publications.html>

## Examples

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
```

```

outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1,trace.pred=1)

## Basic plot of parameters
params <- ccParams(outdir)
plotBasic(params,ybar,ss)

## plots of FDR and related quantities
fdr <- calcFDR(params)
par(mfrow=c(1,2))
plotFDR(fdr)

## plots of Bayesian p-values
## for predictive checks of mixture prior
pred <- ccPred(outdir,q.trace=TRUE)
plotPredChecks(pred$pval.ybar.mix2,params$pc,probz=0.5)

## plots of predictive density superimposed on data
plotMixDensity(params,pred,ybar,ss)

```

---

BGmix

*Fit the BGmix differential expression model.*


---

## Description

This is the main function of the BGmix package. It calls the C++ code which performs the MCMC to fit the BGmix model.

## Usage

```

BGmix(ybar, ss, nreps, neffects = 2, xx = matrix(c(1, 1, -0.5, 0.5),
ncol = 2, byrow = T), ntau = NULL, indtau = NULL, jstar = 1, niter =
10000, nburn = 10000, nthin = 10, seed = 12345, move.choice.bz = 4,
move.choice.aa = 1, move.choice.lam = 0, move.choice.tau = 1,
move.choice.eta = 1, trace.out = 1, trace.pred = 0, sig.aa = 0.1,
tau.eps = 50, lambda.up.init=1.5, lambda.down.init=1.5,
datafilename.ybar = NULL, xfilename = NULL, itfilename =
NULL, rundir=".")

```

## Arguments

|          |                                                                                                                                                             |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ybar     | matrix no. genes x no. experimental conditions. Mean log gene expression for each gene in each condition.                                                   |
| ss       | matrix no. genes x no. experimental conditions. Sample variance of log gene expression for each gene in each condition.                                     |
| nreps    | vector containing the number of replicate arrays in each experimental condition                                                                             |
| neffects | number of effect parameters per gene (eg. 2 for unpaired differential expression)                                                                           |
| xx       | design matrix: no. effects x no. experimental conditions. See Vignette for specification of design matrix. Default is for unpaired differential expression. |

|                                |                                                                                                                                                                           |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>ntau</code>              | number of variances per gene                                                                                                                                              |
| <code>indtau</code>            | label for each condition indicating which variance grouping that condition belongs to. See Vignette for more detail.                                                      |
| <code>jstar</code>             | Label of the effect parameter which has the mixture prior. Labels start at 0, as in C++. If no parameter has a mixture prior, set <code>jstar=-1</code> .                 |
| <code>niter</code>             | no. MCMC iterations after burn-in. This must be at least 100 for the function to work (or else set to zero).                                                              |
| <code>nburn</code>             | no. MCMC iterations for burn-in. This must be at least 100 for the function to work (or else set to zero).                                                                |
| <code>nthin</code>             | thinning parameter for MCMC iterations                                                                                                                                    |
| <code>seed</code>              | initial value for random seed                                                                                                                                             |
| <code>move.choice.bz</code>    | indicates choice of mixture prior: 1 for point mass null + Uniform alternatives, 4 for point mass null + Gamma alternatives, 5 for small Normal null + Gamma alternatives |
| <code>move.choice.aa</code>    | if this is 1, hyperparameter $a$ for gene variances is updated, if this is 0 it is fixed.                                                                                 |
| <code>move.choice.lam</code>   | if this is 1, hyperparameter $\lambda$ for mixture prior is updated, if this is 0 it is fixed.                                                                            |
| <code>move.choice.tau</code>   | indicates choice of prior on gene variances: 1 for Inverse Gamma, 2 for log Normal.                                                                                       |
| <code>move.choice.eta</code>   | if this is 1, hyperparameter $\eta$ for mixture prior is updated, if this is 0 it is fixed.                                                                               |
| <code>trace.out</code>         | if this is 1, output trace of model parameters, if this is 0, no output.                                                                                                  |
| <code>trace.pred</code>        | if this is 1, output trace of predictive quantities, if this is 0, no output.                                                                                             |
| <code>sig.aa</code>            | step-size in random walk update for $a$ (hyperparameter for gene variances distribution)                                                                                  |
| <code>tau.eps</code>           | Value of epsilon used in the small Normal null mixture component.                                                                                                         |
| <code>lambda.up.init</code>    | init or fixed value of $\lambda_+$ (parameter of Gamma mixture component)                                                                                                 |
| <code>lambda.down.init</code>  | init or fixed value of $\lambda_-$ (parameter of Gamma mixture component)                                                                                                 |
| <code>datafilename.ybar</code> | character. Name describing the data set (by default this is taken from the name of the <code>ybar</code> argument).                                                       |
| <code>xfilename</code>         | character. Name describing the design matrix.                                                                                                                             |
| <code>itfilename</code>        | character. Name describing the <code>indtau</code> parameter.                                                                                                             |
| <code>rundir</code>            | character. Path for saving output files. A new sub-directory is created in the <code>rundir</code> directory.                                                             |

## Details

The C++ code writes a count down on the screen, to give an indication of how long the code has to run. Output is written to a sub-directory of the working directory. This sub-directory is created automatically, and its name is printed by the C++ code to the screen.

**Value**

The output directory is returned (character).

**Author(s)**

Alex Lewin

**References**

Lewin, A., Bochkina, N. and Richardson, S. (2007), Fully Bayesian mixture model for differential gene expression: simulations and model checks. <http://www.bgx.org.uk/publications.html>

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
BGmix(ybar, ss, c(8,8), nburn=0, niter=1000, nthin=1)
```

---

|         |                                                                                         |
|---------|-----------------------------------------------------------------------------------------|
| calcFDR | <i>Estimate the FDR (false discovery rate) and related quantities for BGmix output.</i> |
|---------|-----------------------------------------------------------------------------------------|

---

**Description**

Given a threshold on the posterior probabilities, genes are declared as null or differentially expressed. For any given threshold, the FDR (false discovery rate) and FNR (false non-discovery rate) can be estimated using the posterior probabilities. Estimated numbers of false positives and false negatives are also output.

**Usage**

```
calcFDR(res, pcut = seq(0.01,0.5,0.01), true.z = NULL, q.print = F)
```

**Arguments**

|         |                                                                                             |
|---------|---------------------------------------------------------------------------------------------|
| res     | list object output from ccParams (this includes the posterior classification probabilities) |
| pcut    | scalar or vector of thresholds for which to estimate FDR etc.                               |
| true.z  | vector of true classifications (if known, eg. for simulated data)                           |
| q.print | Print FDR etc. when pcut is a vector?                                                       |

**Details**

If the true classification is known, it can be given as true.z, and the true FDR etc. for the threshold probability can be calculated.

**Value**

|                    |                                                                                       |
|--------------------|---------------------------------------------------------------------------------------|
| fdr.est, fnr.est   | scalars or vectors of estimated FDR, FNR                                              |
| fp.est, fn.est     | scalars or vectors of estimated no. false positives, no. false negatives              |
| fdr.true, fnr.true | scalars or vectors of true FDR, FNR                                                   |
| fp.true, fn.true   | scalars or vectors of true no. false positives, no. false negatives                   |
| npos, nneg         | scalars or vectors of no. declared positives, no. declared negatives                  |
| prob.class         | posterior classification probabilities (from the 'res' object input to this function) |
| true.z             | argument to function is output                                                        |
| pcut               | argument to function is output                                                        |

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
params <- ccParams(outdir)
fdr <- calcFDR(params)
```

---

ccParams

---

*Read posterior means and classification probabilities from BGmix*


---

**Description**

Reads output files containing posterior means from BGmix AND reads posterior probabilities of each gene being classified in the null mixture component.

**Usage**

```
ccParams(filedir, q.beta = T, q.sig = T, q.z = T, quiet = T)
```

**Arguments**

|         |                                                                                                    |
|---------|----------------------------------------------------------------------------------------------------|
| filedir | character. The name of the output directory created by BGmix.                                      |
| q.beta  | logical. Read beta values?                                                                         |
| q.sig   | logical. Read gene variance parameters?                                                            |
| q.z     | logical. Read z values?                                                                            |
| quiet   | logical. Parameter passed to 'scan'. (If false, 'scan' prints details of number of items read in.) |

**Value**

|         |                                                                                                                                 |
|---------|---------------------------------------------------------------------------------------------------------------------------------|
| mbeta   | matrix no. genes x no. effects. Posterior means of gene effect parameters (usually gene means and log fold changes).            |
| msig2   | matrix no. genes x no. variances. Posterior means of gene variances.                                                            |
| mbb     | vector of hyperparameters (b) for gene variances (posterior means).                                                             |
| maa     | vector of hyperparameters (a) for gene variances (posterior means).                                                             |
| mtau    | matrix no. genes x no. conditions. Posterior means of gene precisions.                                                          |
| mwtc    | vector of posterior mean mixture weights                                                                                        |
| mzg     | vector of posterior mean allocation for each gene                                                                               |
| meta    | vector of mixture parameters (eta)                                                                                              |
| mlambda | vector of mixture parameters (lambda)                                                                                           |
| pc      | matrix no. genes x no. mixture components. Posterior probability for each gene of being classified into each mixture component. |

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
params <- ccParams(outdir)
```

---

ccPred

---

*Read predictive quantities output from BGmix.*


---

**Description**

Reads predictive p-values from files output from BGmix. Also (optionally) reads posterior predictive distributions of data.

**Usage**

```
ccPred(filedir, q.partial = T, q.trace = F, quiet = T)
```

**Arguments**

|           |                                                                                                    |
|-----------|----------------------------------------------------------------------------------------------------|
| filedir   | character. The name of the output directory created by BGmix.                                      |
| q.partial | logical. Read partial predictive p-values?                                                         |
| q.trace   | logical. Read posterior predictive distributions of data?                                          |
| quiet     | logical. Parameter passed to 'scan'. (If false, 'scan' prints details of number of items read in.) |

**Value**

|                |                                                                                                                              |
|----------------|------------------------------------------------------------------------------------------------------------------------------|
| pval.ss.post   | matrices no. genes x no. conditions. Posterior predictive p-values for sum of squares for each gene in each condition.       |
| pval.ss.mix    | matrices no. genes x no. conditions. Mixed predictive p-values for sum of squares for each gene in each condition.           |
| pval.ss.part   | matrices no. genes x no. conditions. Partial predictive p-values for sum of squares for each gene in each condition.         |
| pval.ybar.post | matrices no. genes x no. mixture components. Posterior predictive p-values for ybar for each gene in each mixture component. |
| pval.ybar.mix2 | matrices no. genes x no. mixture components. Mixed predictive p-values for ybar for each gene in each mixture component.     |
| pval.ybar.part | matrices no. genes x no. mixture components. Partial predictive p-values for ybar for each gene in each mixture component.   |
| ybar.pred1     | Posterior predictive distribution of ybar.                                                                                   |
| ybar.pred3     | Mixed predictive distribution of ybar.                                                                                       |
| ss.pred1       | Posterior predictive distribution of sums of squares.                                                                        |
| ss.pred2       | Mixed predictive distribution of sums of squares.                                                                            |

**Note**

Additional output: pval.ybar.mix1 and pval.ybar.mix3 are alternative versions of mixed predictive p-values (currently not used). Also, ybar.pred2 and ybar.pred4 are the corresponding alternative mixed predictive distributions for ybar.

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
pred <- ccPred(outdir)
```

---

ccSummary

---

*Read summary of BGmix output*


---

**Description**

Reads the summary.txt file output by BGmix, containing information about data sets used and model options. This function is called by ccParams, ccTrace and ccPred, therefore users will not in general need to call it directly.



**Usage**

```
ccSummary(filedir)
```

**Arguments**

`filedir` character. The name of the output directory created by BGmix.

**Value**

A list of scalar values, as follows:

`ngenes, nconds, neffects, ncomps, ntau`

nos. genes, conditions, effects, mixture components, gene variances

`jstar` label of effect with mixture prior (labels start at 0)

`move.choice.bz, move.choice.cut, move.choice.aa, move.choice.eta, move.choice.lam, move.choice.tau`, like model choice options (see [BGmix](#) help for details)

`lambda.up.init, lambda.down.init, eta.up.init, eta.down.init`

inital values for eta and lambda (parameters of mixture components)

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar, ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
summ <- ccSummary(outdir)
```

---

ccTrace

*Read trace files from BGmix*


---

**Description**

Reads output files containing whole posterior distributions from BGmix. Also calls 'ccSummary', and outputs model options.

**Usage**

```
ccTrace(filedir, q.beta = T, q.sig = T, q.z = T, quiet = T)
```

**Arguments**

|                      |                                                                                                    |
|----------------------|----------------------------------------------------------------------------------------------------|
| <code>filedir</code> | character. The name of the output directory created by BGmix.                                      |
| <code>q.beta</code>  | logical. Read beta values?                                                                         |
| <code>q.sig</code>   | logical. Read gene variances?                                                                      |
| <code>q.z</code>     | logical. Read z values?                                                                            |
| <code>quiet</code>   | logical. Parameter passed to 'scan'. (If false, 'scan' prints details of number of items read in.) |

**Value**

|                     |                                                                                                    |
|---------------------|----------------------------------------------------------------------------------------------------|
| <code>summ</code>   | list object output by 'ccSummary'                                                                  |
| <code>eta</code>    | matrix (no. components -1) x no. MCMC samples. Posterior of mixture component parameters (eta).    |
| <code>lambda</code> | matrix (no. components -1) x no. MCMC samples. Posterior of mixture component parameters (lambda). |
| <code>aa</code>     | matrix no. MCMC samples x no. variances. Posterior of variance hyperparameters (a).                |
| <code>bb</code>     | matrix no. MCMC samples x no. variances. Posterior of variance hyperparameters (b).                |
| <code>wtc</code>    | matrix no. MCMC samples x no. mixture components. Posterior of mixture weights.                    |
| <code>beta</code>   | matrix no. effects x no. genes x no. MCMC samples. Posterior of gene effects.                      |
| <code>sig2</code>   | matrix no. variances x no. genes x no. MCMC samples. Posterior of gene variances.                  |
| <code>zg</code>     | matrix no. MCMC samples x no. genes. Posterior of gene allocations.                                |

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
tr <- ccTrace(outdir)
```

---

|             |                                                              |
|-------------|--------------------------------------------------------------|
| EstimatePi0 | <i>Proportion of the variables under the null hypothesis</i> |
|-------------|--------------------------------------------------------------|

---

**Description**

Estimate of the proportion of the variables under the null hypothesis using tail posterior probabilities

**Usage**

```
EstimatePi0(tpp, pp0, plot = T)
```

**Arguments**

|      |                                                                                  |
|------|----------------------------------------------------------------------------------|
| tpp  | observed tail posterior probability                                              |
| pp0  | a vector of tail posterior probability under H0                                  |
| plot | if True, estimated pi0 at different locations and the median estimate is plotted |

**Details**

Use Storey (2002) approach to estimate pi0

**Value**

estimate of pi0 = proportion of non-differentially expressed genes

**Author(s)**

Natalia Bochkina

**References**

Bochkina N., Richardson S. (2007) Tail posterior probability for inference in pairwise and multi-class gene expression data. Biometrics (in press).

**See Also**

[TailPP](#), [FDRplotTailPP](#), [histTailPP](#)

**Examples**

```
data(ybar, ss)
nreps <- c(8,8)

## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
outdir <- BGmix(ybar, ss, nreps, jstar=-1, nburn=0, niter=100, nthin=1)

params <- ccParams(outdir)
```

```
res <- ccTrace(outdir)

tpp.res <- TailPP(res, nreps, params, plots = FALSE)
pi0 <- EstimatePi0(tpp.res$tpp, tpp.res$pp0)
```

FDRforTailPP

*FDR for tail posterior probability***Description**

Calculate the false discovery rate (FDR) for the tail posterior probability

**Usage**

```
FDRforTailPP(tpp, a1, a2 = NULL, n.rep1, n.rep2 = NULL, prec = 0.05, p.cut = 0.7, N = 10000, pp0=NULL, plot=FALSE)
```

**Arguments**

|        |                                                                                                                                                                     |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| tpp    | vector of tail posterior probabilities                                                                                                                              |
| a1     | posterior mean of the shape parameter of the inverse gamma distribution - prior for the variance in condition 1                                                     |
| a2     | posterior mean of the shape parameter of the inverse gamma distribution - prior for the variance in condition 2                                                     |
| n.rep1 | number of replicates in condition 1                                                                                                                                 |
| n.rep2 | number of replicates in condition 2                                                                                                                                 |
| prec   | precision of the estimate of the cumulative distribution function of tail posterior probability under H0 (at points $1 - k \cdot \text{prec}$ , $k = 1, 2, \dots$ ) |
| p.cut  | to save time, calculate FDR only for cutoffs on tail posterior probability $> \text{p.cut}$                                                                         |
| N      | simulation size for tail posterior probability under H0                                                                                                             |
| pp0    | a vector of simulated tail posterior probabilities under H0                                                                                                         |
| plot   | if True, the estimated pi0 at different locations and the median estimate is plotted                                                                                |

**Value**

|     |                                                                    |
|-----|--------------------------------------------------------------------|
| pi0 | estimate of pi0 - proportion of non-differentially expressed genes |
| FDR | estimate of FDR for all (distinct) cutoffs $> \text{p.cut}$        |

**Author(s)**

Natalia Bochkina

**References**

Bochkina N., Richardson S. (2007) Tail posterior probability for inference in pairwise and multi-class gene expression data. Biometrics.

**See Also**

[TailPP](#), [FDRplotTailPP](#), [histTailPP](#), [EstimatePi0](#)

**Examples**

```
data(ybar, ss)
nreps <- c(8,8)

## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
outdir <- BGmix(ybar, ss, nreps, jstar=-1, nburn=0, niter=100, nthin=1)

params <- ccParams(outdir)
res <- ccTrace(outdir)

tpp.res <- TailPP(res, nreps, params, plots = FALSE)
FDR.res = FDRforTailPP(tpp.res$tpp, a1 = params$maa[1],
a2 = params$maa[2], n.rep1=nreps[1], n.rep2=nreps[2], p.cut = 0.8)
```

---

FDRplotTailPP

---

*Plot of FDR for tail posterior probability*


---

**Description**

Plots smoothed FDR vs tail posterior probability or vs the number of differentially expressed (DE) genes

**Usage**

```
FDRplotTailPP(tpp.res, nmax = sum(! is.na(tpp.res$FDR)), plot.TP = F)
```

**Arguments**

|         |                                                                                                                                     |
|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| tpp.res | output of TailPP                                                                                                                    |
| nmax    | maximum size of the list of DE genes                                                                                                |
| plot.TP | logical. If TRUE FDR is plotted, otherwise the number of false positives is plotted vs the number of differentially expressed genes |

**Author(s)**

Natalia Bochkina

**References**

Bochkina N., Richardson S. (2007) Tail posterior probability for inference in pairwise and multi-class gene expression data. *Biometrics*.

**See Also**

[TailPP](#), [histTailPP](#), [EstimatePi0](#)

**Examples**

```
data(ybar, ss)
nreps <- c(8,8)

## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
outdir <- BGmix(ybar, ss, nreps, jstar=-1, nburn=0, niter=100, nthin=1)

params <- ccParams(outdir)
res <- ccTrace(outdir)

tpp.res <- TailPP(res, nreps, params, plots = FALSE)
FDRplotTailPP(tpp.res, plot.TP = TRUE)
```

---

histTailPP

*Histogram plot for tail posterior probability*


---

**Description**

Plots a histogram of tail posterior probability with its density under the null hypothesis

**Usage**

```
histTailPP(tpp.res, bw=0.05, xlim=c(0,1),nc=10)
```

**Arguments**

|         |                                                   |
|---------|---------------------------------------------------|
| tpp.res | output of TailPP                                  |
| bw      | bandwidth for kernel estimate of the null density |
| xlim    | limits on the x axis                              |
| nc      | number of bins of the histogram                   |

**Author(s)**

Natalia Bochkina

**References**

Bochkina N., Richardson S. (2007) Tail posterior probability for inference in pairwise and multi-class gene expression data. *Biometrics*.

**See Also**

[TailPP](#), [FDRplotTailPP](#), [EstimatePi0](#)

**Examples**

```
data(ybar, ss)
nreps <- c(8,8)

## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
outdir <- BGmix(ybar, ss, nreps, jstar=-1, nburn=0, niter=100, nthin=1)

params <- ccParams(outdir)
res <- ccTrace(outdir)

tpp.res <- TailPP(res, nreps, params, plots = FALSE)
histTailPP(tpp.res, bw=0.04, xlim=c(0,1), nc=10)
```

---

plotBasic

*Basic plots of BGmix parameters and data.*


---

**Description**

Plots gene effects and variances versus their corresponding data sufficient statistics (to show the effect of smoothing and shrinkage). Also plots "volcano plots": posterior probabilities of being classified in each mixture component versus the log fold change parameters.

**Usage**

```
plotBasic(res, ybar, ss, q.mean = T, q.diff = T, q.sig = T, q.volcano = T)
```

**Arguments**

|           |                                                                          |
|-----------|--------------------------------------------------------------------------|
| res       | list object output from 'ccParams'                                       |
| ybar      | ybar data (see <a href="#">BGmix</a> help for details)                   |
| ss        | ss data (see <a href="#">BGmix</a> help for details)                     |
| q.mean    | logical. Include mean plot?                                              |
| q.diff    | logical. Include log fold change plot?                                   |
| q.sig     | logical. Include variance plot?                                          |
| q.volcano | logical. Include volcano plot (posterior classification v. fold change)? |

**Details**

Note this plotting function is designed for model output from the unpaired differential expression design.

**Value**

No value is returned to R. Results from BGmix model are output to files.

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
params <- ccParams(outdir)
plotBasic(params,ybar,ss)
```

---

plotCompare

*Scatter plot with equal axes.*


---

**Description**

Plots a scatter plot of two variables with equal scales for the axes.

**Usage**

```
plotCompare(var1, var2, limi = 0, xlab = substitute(var1), ylab = substitute(var2), log = "", title = "")
```

**Arguments**

|       |                                                                               |
|-------|-------------------------------------------------------------------------------|
| var1  | data to plot (x co-ordinate)                                                  |
| var2  | data to plot (y co-ordinate)                                                  |
| limi  | limits of axes. If not specified, axes limits are determined from input data. |
| xlab  | x-axis label                                                                  |
| ylab  | y-axis label                                                                  |
| log   | specifies if axes are on the log scale (as argument to 'par')                 |
| title | title of plot                                                                 |
| ...   | other parameters input to plot                                                |

**Value**

Outputs the limits used in the plot (the input 'limi' argument if specified).

**Author(s)**

Alex Lewin



**Examples**

```
x <- runif(100)
y <- rbeta(100,0.5,0.5)
plotCompare(x,y)
```

plotFDR

*Plot estimated FDR etc. for BGmix output.***Description**

Given a threshold on the posterior probabilities, genes are declared as null or differentially expressed. For any given threshold, the FDR (false discovery rate) and FNR (false non-discovery rate) can be estimated using the posterior probabilities. This function plots these quantities twice, once versus the threshold probabilities, and once versus the number of declared positives.

**Usage**

```
plotFDR(res, ylim = NULL, q.plotfnr = F, q.plotpcut = T, q.plotnpos = T, ...)
```

**Arguments**

|            |                                                                          |
|------------|--------------------------------------------------------------------------|
| res        | list object output from 'calcFDR'                                        |
| ylim       | optional argument specifying limit for y-axis                            |
| q.plotfnr  | Include FNR in plots?                                                    |
| q.plotpcut | Include the plot of error rates v. threshold on posterior probabilities? |
| q.plotnpos | Include the plot of error rates v. no. positives.                        |
| ...        | arguments passed to 'plot'                                               |

**Value**

No value is returned to R. Results from BGmix model are output to files.

**Author(s)**

Alex Lewin

**Examples**

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
params <- ccParams(outdir)
fdr <- calcFDR(params)
par(mfrow=c(1,2))
plotFDR(fdr)
```

---

|                |                                         |
|----------------|-----------------------------------------|
| plotMixDensity | <i>Plot predictive density of data.</i> |
|----------------|-----------------------------------------|

---

## Description

Plot predictive density of data superimposed on histograms of observed data. Separate plots for ybar and sums of squares.

## Usage

```
plotMixDensity(res, predres, ybar, ss)
```

## Arguments

|         |                                                               |
|---------|---------------------------------------------------------------|
| res     | list object output from 'ccParams'                            |
| predres | list object output from 'ccPred' (need q.trace=T in 'ccPred') |
| ybar    | ybar data (see <a href="#">BGmix</a> help for details)        |
| ss      | ss data (see <a href="#">BGmix</a> help for details)          |

## Details

Note that this function is written for the unpaired differential expression design.

## Author(s)

Alex Lewin

## Examples

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar,ss,c(8,8),niter=100,nburn=0,nthin=1,trace.pred=1)
pred <- ccPred(outdir,q.trace=TRUE)
params <- ccParams(outdir)
plotMixDensity(params,pred,ybar,ss)
```

---

|                |                                                      |
|----------------|------------------------------------------------------|
| plotPredChecks | <i>Plots of predictive checks for mixture prior.</i> |
|----------------|------------------------------------------------------|

---

## Description

Histograms and q-q plots of predictive p-values for the mixture prior. Separate plots are given for each mixture component, using only genes with high posterior probability of being classified into the relevant component.

## Usage

```
plotPredChecks(pvals, pc, probz = 0.8, label = "", breaks = 20)
```

## Arguments

|        |                                                                                                                                         |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------|
| pvals  | matrix of predictive p-values output by 'ccPred' (NB, not the whole list object, just the matrix of p-values)                           |
| pc     | matrix of posterior classification probabilities output by 'ccParams' (NB, not the whole list object, just the matrix of probabilities) |
| probz  | threshold on posterior probabilities for including genes in each mixture component plot                                                 |
| label  | title used on histograms                                                                                                                |
| breaks | argument input to histogram                                                                                                             |

## Author(s)

Alex Lewin

## Examples

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
params <- ccParams(outdir)
pred <- ccPred(outdir)
plotPredChecks(pred$pval.ybar.mix2,params$pc,probz=0.5)
```

---

|           |                                      |
|-----------|--------------------------------------|
| plotTrace | <i>Trace plots for BGmix output.</i> |
|-----------|--------------------------------------|

---

### Description

Trace plots are plotted for all scalar parameters. Optionally, traces are plotted for parameters indexed by genes, but for selected genes only.

### Usage

```
plotTrace(res, q.beta = T, q.sig = T, q.z = T, ind.genes = (1:3))
```

### Arguments

|           |                                                       |
|-----------|-------------------------------------------------------|
| res       | list object output from 'ccTrace'                     |
| q.beta    | logical. Plot trace of beta (gene effect) parameters? |
| q.sig     | logical. Plot trace of gene variances?                |
| q.z       | logical. Plot trace of gene allocation parameters?    |
| ind.genes | indices of genes for which to plot gene parameters.   |

### Author(s)

Alex Lewin

### Examples

```
## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
data(ybar,ss)
outdir <- BGmix(ybar, ss, c(8,8), nburn=0, niter=100, nthin=1)
tr <- ccTrace(outdir)
plotTrace(tr)
plotTrace(tr,q.beta=TRUE,q.sig=FALSE,q.z=FALSE,ind.genes=1)
plotTrace(tr,q.beta=FALSE,q.sig=FALSE,q.z=TRUE,ind.genes=sample(1:1000,5))
```

---

|         |                                                           |
|---------|-----------------------------------------------------------|
| readBGX | <i>Reads output from BGX package, for input to BGmix.</i> |
|---------|-----------------------------------------------------------|

---

### Description

Reads posterior mean parameters from BGX, and outputs objects suitable for input to BGmix.

### Usage

```
readBGX(path)
```

**Arguments**

path                      directory containing BGX output

**Value**

ybar                      ybar object (see [BGmix](#) help for details)  
ss                        ss object (see [BGmix](#) help for details)  
...

**Author(s)**

Ernest Turro

---

Simulated example data

*Mean log gene expression under two conditions*

---

**Description**

Simulated gene expression data. 2500 genes under 2 experimental conditions, with 8 replicate arrays for each condition. The data is presented as mean and sum of squares of the log gene expression, in each condition. ybar is the matrix containing the means in each condition.

**Usage**

data(ybar)

**Format**

matrix no. genes x no. experimental conditions

---

Simulated gene expression data

*Sample variance of log gene expression under two conditions*

---

**Description**

Simulated gene expression data. 2500 genes under 2 experimental conditions, with 8 replicate arrays for each condition. The data is presented as mean and sum of squares of the log gene expression, in each condition. ss is the matrix containing the sample variances in each condition.

**Usage**

data(ss)

**Format**

matrix no. genes x no. experimental conditions

---

|        |                                                     |
|--------|-----------------------------------------------------|
| TailPP | <i>Tail posterior probability for BGmix output.</i> |
|--------|-----------------------------------------------------|

---

**Description**

For differential expression models with unstructured priors (no mixture prior), calculates tail posterior probability and FDR, and plots a histogram. Uses whole posterior distributions of likelihood parameters (found by 'ccTrace') and posterior means of hyperparameters (found by 'ccParams').

**Usage**

```
TailPP(res, nreps, params, paired=F, alpha=0.05, N = 5000, prec=0.05, p.cut = 0.7, plots = T, plot.pi0=F)
```

**Arguments**

|          |                                                                                                               |
|----------|---------------------------------------------------------------------------------------------------------------|
| res      | list object output from 'ccTrace'                                                                             |
| nreps    | vector length 2 containing the number of replicates in each condition                                         |
| params   | list object output from 'ccParams'                                                                            |
| paired   | logical. TRUE for paired design, FALSE for unpaired.                                                          |
| alpha    | parameter of the tail posterior probability (1-alpha/2 quantile)                                              |
| N        | simulation size for tail posterior probability under H0                                                       |
| prec     | parameter used when estimating CDF of tail posterior probability under H0                                     |
| p.cut    | calculate FDR only for cutoffs on tail posterior probability > p.cut                                          |
| plots    | logical. if TRUE, makes plots of the histogram of tail posterior probability with the null density and of FDR |
| plot.pi0 | logical. if TRUE, diagnostic plot of the estimated pi0 at different locations and the median estimate         |

**Value**

|     |                                                                           |
|-----|---------------------------------------------------------------------------|
| tpp | vector of tail posterior probabilities with parameter alpha, one per gene |
| FDR | (smoothed) estimate of FDR for all (distinct) cutoffs > p.cut             |
| pi0 | estimated proportion of observations under the null                       |
| pp0 | simulations under the null                                                |

**Author(s)**

Natalia Bochkina

**References**

Bochkina N., Richardson S. (2007) Tail posterior probability for inference in pairwise and multi-class gene expression data. Biometrics. <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1541-0420.2006.00807.x>

**See Also**

[FDRplotTailPP](#), [histTailPP](#), [EstimatePi0](#)

**Examples**

```
data(ybar, ss)
nreps <- c(8,8)

## Note this is a very short MCMC run!
## For good analysis need proper burn-in period.
outdir <- BGmix(ybar, ss, nreps, jstar=-1, nburn=0, niter=100, nthin=1)

params <- ccParams(outdir)
res <- ccTrace(outdir)

tpp.res <- TailPP(res, nreps, params, plots = FALSE)
histTailPP(tpp.res)
FDRplotTailPP(tpp.res, plot.TP = TRUE)
```

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