Package ‘reb’

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Title  Regional Expression Biases
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Description  A set of functions to identify regional expression biases
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**absMax**  
*Absolute Maxima*

**Description**

Returns the absolute maxima of the input values.

**Usage**

```
absMax(x)
```

**Arguments**

- `x` numeric argument

**Value**

`absMax` returns the absolute maximum of all the values present in the arguments as double preserving the sign. Essentially `max(abs(x), na.rm=T)`.

**Author(s)**

Karl A. Dykema and Kyle A. Furge

**Examples**

```
absMax(c(1,2,3,4))
absMax(c(-1,-2,-3,-4))
```

---

**buildChromCytoband**  
*Construct a chromLocation object from a cytoband environment*

**Description**

Construct a chromLocation object from a cytoband environment. Human, Rat, and Mouse are currently possible.

**Usage**

```
buildChromCytoband(organism = "h")
```

**Arguments**

- `organism` character, "h" for human, "m" for mouse, and "r" for rat.

**Value**

a chromLocation object

**Author(s)**

Karl J. Dykema, <karl.dykema@vai.org> Kyle A. Furge, <kyle.furge@vai.org>
buildChromMap

See Also

buildChromLocation

Examples

humanBands <- buildChromCytoband("h")
humanBands@chromLocs[["1"]]

Description

This function will take the name of a data package and build a chromLocation object representing regions of the genomes.

Usage

buildChromMap(dataPkg, regions)

Arguments

dataPkg The name of the data package to be used (a.k.a generated by AnnBuilder or downloaded from Bioconductor web site
regions a character vector of genome regions to be generated

Details

This function is related to the buildChromLocation function found in the 'annotate' library. However, this function can be used to build specialized chromLocation objects based on gene mapping information. For example, a chromLocation object can be build specifically for human chromosome 1 by supplying chromosomal band information, such as c("1p1", "1p2", "1p3", "1q1", "1q2", "1q3", "1q4"). Genes that map to these regions are isolated and a chromLocation object is returned. Note that genes are isolated by ‘grep’ing genome mapping information. Therefore the number of genes that are able to placed into a defined genetic region (i.e. 1q4) is dependent on the quality of the mapping information in the annotation data source.

Unfortunately, not too many pre-built annotation packages are available for spotted arrays off the Bioconductor Metadata web set. Use AnnBuilder to make one or get one from your core.

Value

A 'chromLocation' object representing the specified genomic regions and annotation data source

Author(s)

Kyle A. Furge <kyle.furge@vai.org

See Also

buildChromLocation
Examples

```r
##
## NOTE: This requires an annotation package to work, it is provided for info only.
##

#if (require(hu6800)) {

# library(Biobase)
# library(annotate)

## Build a specific chrom arm
# chr1q <- buildChromMap("hu6800",c("1q1","1q2","1q3","1q4"))

## Build human data based on chrom arms
# data(Hs.arms)
# map <- buildChromMap("hu6800",Hs.arms)
#}
```

**cset2band**

cset2band

description

This function will summarize gene expression data by cytogenetic band

**Usage**

cset2band(exprs, genome, chr = "ALL", organism = NULL, FUN = isAbnormal, ...)

**Arguments**

- **exprs**: matrix of gene expression data or similar. The rownames must contain the gene identifiers
- **genome**: an associated chromLoc annotation object
- **chr**: a character vector specifying the chromosomes to analyze
- **organism**: character, "h" for human, "m" for mouse, and "r" for rat.; defaults to NULL - loads from chromLocation object
- **FUN**: function by which to aggregate/summarize each cytogenetic band
- **...**: extra arguments passed on to the aggregate/summary function

**Details**

This function loops through each band for a given organism and summarizes the data for genes that lie within each cytogenetic band based upon the input function. For example, a matrix of gene expression values could be used and the mean expression of each band be determined by passing the mean function. Alternative, DNA copy number gains or losses could be predicted using the reb function and regions of likely gain or losses be summarized by cytogenetic band using the isAbnormal function.
Value

a matrix with rows representing cytogenetic bands, and columns representing individual samples.

Author(s)

Karl Dykema

Examples

data(mcr.eset)
data(idiogramExample)

## Create a vector with the index of normal samples
norms <- grep("MNC", colnames(mcr.eset@exprs))

## Smooth the data using the default 'movbin' method,
## with the normal samples as reference and median centering
ct <- reb(mcr.eset@exprs, vai.chr, ref=norms, center=TRUE)

## Mask the result to remove noise
exprs <- ct[, -norms]
exprs[abs(exprs) < 1.96] <- NA

## Starting data
midiogram(exprs, vai.chr, method="i", col=.rwb, dlim=c(-4,4))

## Summarize each cytogenetic band
banded <- cset2band(exprs, vai.chr, FUN=mean, na.rm=TRUE)

## Create chromLocation object based on human cytobands
h.cyto <- buildChromCytoband(organism = "h")

## Plot all data using mideogram
midiogram(banded, h.cyto, method="i", col=.rwb, dlim=c(-4,4))

---

fromRevIsh

**Convert from revish strings to a matrix**

Description

This function will convert two lists of revish style strings to a matrix format.

Usage

fromRevIsh(enhList, dimList, chr, organism = "h")

Arguments

<table>
<thead>
<tr>
<th>enhList</th>
<th>list of enhanced bands on each individual sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimList</td>
<td>list of diminished bands on each individual sample</td>
</tr>
<tr>
<td>chr</td>
<td>chromosome to examine</td>
</tr>
<tr>
<td>organism</td>
<td>character, &quot;h&quot; for human, &quot;m&quot; for mouse, and &quot;r&quot; for rat.</td>
</tr>
</tbody>
</table>
Value

A matrix is returned. The rownames of this matrix correspond to the major bands located on that chromosome, and the columns correspond to the sample names.

Author(s)

Karl J. Dykema, <karl.dykema@vai.org> Kyle A. Furge, <kyle.furge@vai.org>

References

MCR eset data was obtained with permission. See PMID: 15377468

See Also

reb,revish

Examples

```r
mb.chr <- buildChromCytoband("h")
data(mcr.eset)
data(idiogramExample)
## Create a vector with the index of normal samples
norms <- grep("MNC", colnames(mcr.eset@exprs))
## Smooth the data using the default 'movbin' method, with the normal samples as reference and median centering
withinRange <- function(x, y, range = range(x, na.rm = TRUE)) { return(which(y >= range[1] & y <= range[2])) }
cset <- reb(mcr.eset@exprs, vai.chr, ref=norms, center=TRUE)
## Mask the cset to remove noise
exprs <- cset[, -norms]
exprs[abs(exprs) < 1.96] <- NA
## Extract the aberrations on the 5th chromosome
revish <- revish(exprs, vai.chr, "5")
## Convert back to matrix
reconverted <- fromRevIsh(revish[[1]], revish[[2]], "5")
layout(cbind(1, 2))
idiogram(cset[, -norms], vai.chr, "5", method="i", dlim=c(-2, 2), col=.rwb, main="chr 5 reb results")
idiogram(reconverted, mb.chr, "5", method="i", dlim=c(-1, 1), col=.rwb, main="chr 5 converted \n and re-converted")
```

Description

The data set gives the human chromosomal arms.

Usage

data(Hs.arms)
isAbnormal

Format
The format is: chr [1:48] "1p" "1q" "2p" "2q" "3p" "3q" "4p" "4q" "5p" "5q" "6p" "6q" "7p" "7q" "8p" "8q" "9p" ...

Source
International System of Human Cytogenetic Nomenclature (ISCN)

<table>
<thead>
<tr>
<th>isAbnormal</th>
<th>Is a band 'abnormal'?</th>
</tr>
</thead>
</table>

Description
Returns 1 or -1 indicating a chromosomal change based upon an input percentage.

Usage

```r
isAbnormal(x, percent = 0.5)
```

Arguments

- `x` : genomic data, can contain NA's
- `percent` : numeric argument - a fraction or percentage

Details
This simple function is used by cset2band.

Author(s)
Karl Dykema

See Also
cset2band

Examples

```r
# Not abnormal
isAbnormal(c(1,NA))
# Abnormal; +
isAbnormal(c(1,NA,1))
# Abnormal; -
isAbnormal(c(1,NA,-1,-1,-1))
```
Description

An example exprSet and a chromLocation object generated from an gene expression profiling experiment of leukemic and normal blood cells. Profiling was done on custom pin-printed cDNA arrays.

Usage

data(mcr.eset)

Source


Examples

data(mcr.eset)

str(mcr.eset)

---

movbin

Description

This function analyzes ordered data series to identify regional biases using an moving (running) approximated binomial test.

Usage

movbin(v, span=NULL, summarize=mean)

Arguments

v data vector

span numeric vector. Each element is used to define the number of points to include when the approximated binomial test is applied to v. While mixed for the defaults, the span can be specified as fraction of the observation or actual sizes, but not a mixture - defaults to: seq(25, length(v)*.3, by=5)

summarize function that is used to summarize the results from multiple spans. if NULL, a matrix with length(span) rows and length(v) columns is returned.
movt

Details

movbin applies a moving binomial test to sequential windows of elements of v. Within each span a z-score from an approximated binomial is computed such that 
\[ z = \frac{2r - n}{\sqrt{n}} \]
where \( r \) is the number of positive relative gene expression values and \( n \) is the number of non-zero values within each window.

For convenience, this function allows for the specification of multiple window sizes using the span argument. The result of a movbin call will generate a matrix with \( \text{length}(\text{span}) \) rows and \( \text{length}(v) \) columns. Each row of the matrix represents the data generated from each span. This matrix can be returned or the matrix from can be condensed to a single vector of length \( v \) by applying a summary function \text{summarize} to the matrix columns.

Value

Either a matrix or a vector containing the summarized z-scores from the applied binomial test.

Author(s)

Kyle A. Furge, Ph.D., <kyle.furge@vai.org> and Karl J. Dykema, <karl.dykema@vai.org>

Examples

```r
x <- c(rnorm(50,mean=1),rnorm(50,mean=-1),rnorm(100))
layout(1:2)
plot(x,type="h",ylim=c(-5,5))

## apply the approximated binomial with a single span
mb <- movbin(x,span=25,summarize=NULL)
lines(mb[1,])

## try a few different span ranges
mb <- movbin(x,span=c(10,25,50),summarize=NULL)
lines(mb[1,]) ## span of 10
lines(mb[2,]) ## span of 25
lines(mb[3,]) ## span of 50

## average the results from the different spans
plot(x,type="h",ylim=c(-5,5))
mb <- movbin(x,span=c(10,25,50),summarize=mean)
lines(mb,col="blue")

mb <- movbin(x,span=c(10,25,50),summarize=median)
lines(mb,col="red")
```

Description

This function analyzes ordered data series to identify regional biases using an moving (running) approximated t-test.
Usage

`movt(v, span=NULL, summarize=mean)`

Arguments

- `v`  
  data vector
- `span`  
  numeric vector. Each element is used to define the number of points to include when the approximated binomial test is applied to `v`. While mixed for the defaults, the span can be specified as fraction of the observation or actual sizes, but not a mixture - defaults to: `seq(25, length(v) * 0.3, by=5)`
- `summarize`  
  function that is used to summarize the results from multiple spans. If NULL, a matrix with `length(span)` rows and `length(v)` columns is returned.

Details

`movt` acts very similar to `movbin`

Value

Either a matrix or a vector containing the summarized z-scores from the applied t-test.

Author(s)

Kyle A. Furge, Ph.D., `<kyle.furge@vai.org>` and Karl J. Dykema, `<karl.dykema@vai.org>`

See Also

`movbin`

Examples

```r
x <- c(rnorm(50, mean=1), rnorm(50, mean=-1), rnorm(100))
layout(1:2)
plot(x, type="h", ylim=c(-5,5))

## apply the approximated binomial with a single span
mb <- movt(x, span=25, summarize=NULL)
lines(mb[1,])

## try a few different span ranges
mb <- movt(x, span=10:50, summarize=NULL)
lines(mb[1,]) ## span of 10
lines(mb[2,]) ## span of 25
lines(mb[3,]) ## span of 50

## average the results from the different spans
plot(x, type="h", ylim=c(-5,5))
mb <- movt(x, span=10:50, summarize=mean)
lines(mb, col="blue")

mb <- movt(x, span=10:50, summarize=median)
lines(mb, col="red")

mb <- movt(x, span=10:50, summarize=max)
```
naMean

lines(mb,col="green")

---

**naMean**

*Wrapper function for the arithmetic mean*

**Description**

Simple call to mean with the *na.rm* option set to TRUE.

**Usage**

`naMean(x)`

**Arguments**

- `x`: An R object

**Value**

The arithmetic mean of the values in `x`.

**Examples**

```r
mean(c(1,2,3,NA),na.rm=TRUE)
naMean(c(1,2,3,NA))
```

---

**regmap**

*Image function wrapper*

**Description**

A simple wrapper around the `image` function

**Usage**

`regmap(m,scale=c(-6,6),na.color=par("bg"),...)`

**Arguments**

- `m`: a matrix
- `scale`: Include a graph scale showing this range of values ‘image’ function
- `na.color`: the color to draw over NA values
- `...`: additional parameters to ‘image’
Details

A small wrapper around the ‘image’ function to display genome region summary statistics. Additional parameters will be passed along to the image function.

The scale argument is a two-element vector that provides a floor and ceiling for the matrix and allows a crude scale bar to be included on the lower portion of the graph.

For other colors consider using the geneplotter (dChip.colors) or marrayPlots (maPalette) library functions (i.e. regmap(m, col=dChipColors(50)))

Author(s)

Kyle A. Furge

See Also

image, summarizeByRegion

Examples

```r
m <- matrix(rnorm(6*4),ncol=6)
colnames(m) <- c(1:6)
rownames(m) <- c("1p","1q","2p","2q")
regmap(m,scale=c(-1,1))
```

**revish**

*Creation of CGH (reverse in situ hybridization) style character strings*

Description

This function returns a two lists of character strings. These two lists correspond to the enhanced and diminished chromosomal bands.

Usage

```r
revish(cset, genome, chr, organism = NULL)
```

Arguments

- `cset` expression set containing cytogenetic predictions, see `reb`
- `genome` chromLocation object containing annotation information
- `chr` chromosome to examine
- `organism` if NULL, determination of the host organism will be retrieved from the `organism` slot of the chromLocation object. Otherwise "h", "r", or "m" can be used to specify human, rat, or mouse chromosome information

Value

- `enh` list of enhanced bands on each individual sample
- `dim` list of diminished bands on each individual sample
Author(s)
Karl J. Dykema, <karl.dykema@vai.org> Kyle A. Furge, <kyle.furge@vai.org>

References
MCR eset data was obtained with permission. See PMID: 15377468

See Also
reb

Examples
data(idiogramExample)
ix <- abs(colo.eset) > .225
colo.eset[ix] <- NA
idiogram(colo.eset,ucsf.chr,"14",method="i",dlim=c(-1,1),col=.rwb)
revlist<- revish(colo.eset,ucsf.chr,"14")
str(revlist)

rmAmbigMappings

Remove genes that map to multiple chromosomes from a chromLocation object

Description
Due to the automated probe annotation, a subset of probes can be “confidently” mapped to multiple chromosomes on the genome.
This can cause some confusion if you are trying to perform certain types of data analysis.
This function examines a chromLocation object and removes probes that map to multiple chromosomes.

Usage
rmAmbigMappings(cl)

Arguments
cl an existing chromLocation object

Value
A chromLocation object

Author(s)
Kyle A. Furge
smoothByRegion

See Also

buildChromLocation

Examples

###
### NOTE: This requires an annotation package to work, it is provided for info only.
###

```r
#if (require(hu6800)) {
  # library(Biobase)
  # library(annotate)

  ## Build a specific chrom arm
  # cl <- buildChromLocation("hu6800")
  # cleanCL <- rmAmbigMappings(cl)
  #}
```

smoothByRegion  
reb

Description

This function "smooths" gene expression data to assist in the identification of regional expression biases.

Usage

 reb(eset, genome, chrom = "ALL", ref = NULL, center = FALSE, aggrfun=absMax, method = c("movbin", "supsmu", "lowess","movt"), ...)  

Arguments

eset the expression set to analyze

genome an associated chromLoc annotation object

chrom a character vector specifying the chromosomes to analyze

ref a vector containing the index of reference samples from which to make comparisons. Defaults to NULL (internally referenced samples)

center boolean - re-center gene expression matrix columns. Helpful if ref is used

aggrfun a function to summarizes/aggregates gene expression values that map to the same locations. Defaults to the maximum absolute value absMax. If NULL, all values are included.

method smoothing function to use - either "supsmu","lowess","movbin" or "movt".

... additional parameters to pass along to the smoothing function
Details

reb returns an eset that contains predictions of regional expression bias using data smoothing approaches. The exprSet is separated into subsets based on the genome chromLocation object and the gene expression data within the subsets is organized by genomic location and smoothed. In addition, the approx function is used to estimate data between any missing values. This was implemented so the function follows the "principles of least astonishment".

Smoothing approaches are most straightforwardly applied by comparing a set of test samples to a set of control samples. For single color experiments, the control samples can be specified using the ref argument and the comparisons are generated internal to the reb function. This argument can also be used for two-color experiments provided both the test and control samples were run against a common reference.

If multiple clones map to the same genomic locus the aggrfun argument can be used to summarize the overlapping expression values to a single summarized value. This is can be helpful in two situations. First, the supsum and lowess smoothing functions do not allow for duplicate values. Currently, if duplicate values are found and these smoothing functions are used, the duplicate values are simply discard. Second, if 50 copies of the actin gene are present on a the array and actin changes expression under a given condition, it may appear as though a regional expression bias exists as 50 values within a region change expression. Summarizing the 50 expression values to a single value can partially correct for this effect.

The idiogram package can be used to plot the regional expression bias.

Value

An exprSet

Author(s)

Kyle A. Furge, <kyle.furge@vai.org> Karl J. Dykema, <karl.dykema@vai.org>

References


MCR eset data was obtained with permission. See PMID: 15377468

See Also

movbin,idiogram

Examples

# The mcr.eset is a two-color gene expression exprSet
# with cytogenetically complex (MCR) and normal
# control (MNC) samples which are a pooled-cell line reference.

data("mcr.eset")
data(idiogramExample)

## Create a vector with the index of normal samples
norms <- grep("MNC",colnames(mcr.eset@exprs))
## Smooth the data using the default 'movbin' method,
## with the normal samples as reference

cset <- reb(mcr.eset@exprs,vai.chr,ref=norms,center=TRUE)

## Display the results with midiogram
midiogram(cset@exprs[-norms],vai.chr,method="i",dlim=c(-5,5),col=.rwb)

summarizeByRegion

### Compute Summary Statistics of Genome Regions

**Description**

Splits the data into subsets based on genome mapping information, computes summary statistics for each region, and returns the results in a convenient form. (cgma stands for Comparative Genomic Microarray Analysis)

This function supplies a t.test function at the empirically derived significance threshold (p.value = 0.005)

**Usage**

cgma(eset, genome, chrom="ALL",ref=NULL,center=TRUE,aggrfun=NULL, p.value=0.005, FUN=t.test, verbose=TRUE, explode=FALSE, ...)

**Arguments**

eset: an exprSet object

genome: an chromLocation object, such as on produced by buildChromLocation or buildChromMap

chrom: a character vector specifying the chromosomes to analyze

ref: a vector containing the index of reference samples from which to make comparisons. Defaults to NULL (internally referenced samples)

center: boolean - re-center gene expression matrix columns. Helpful if ref is used

aggrfun: a function to summarizes/aggregates gene expression values that map to the same locations. If NULL, all values are included. Also see absMax

p.value: p.value cutoff, NA for all results, or TRUE for all t.stats and p.values

FUN: function by which to summarize the data

verbose: boolean - print verbose output during execution?

explode: boolean - explode summary matrix into a full expression set?

...: further arguments pass to or used by the function

**Details**

Gene expression values are separated into subsets that based on the 'chromLocation' object argument. For example, buildChromMap can be used to produce a 'chromLocation' object composed of the genes that populate human chromosome 1p and chromosome 1q. The gene expression values from each of these regions are extracted from the 'exprSet' and a summary statistic is computed for each region.
summarizeByRegion

cgma is most straightforwardly used to identify regional gene expression biases when comparing a test sample to a reference sample. For example, a number of simple tests can be used to determine if a genomic region contains a disproportionate number of positive or negative log transformed gene expression ratios. The presence of such a regional expression bias can indicates an underlying genomic abnormality.

If multiple clones map to the same genomic locus the aggregate.by.loc argument can be used to include a summary value for the overlapping expression values rather then include all of the individual gene expression values. For example, if 50 copies of the actin gene are on a particular array and actin changes expression under a given condition, it may appear as though a regional expression bias exists as 50 values in a small region change expression.

regmap is usually the best way to plot results of this function. idiogram can also be used if you set the "explode" argument to TRUE.

buildChromLocation.2 can be used to create a chromLocation object in which the genes can be divided a number of different ways. Separating the data by chromosome arm was the original intent. If you use buildChromLocation.2 with the "arms" argument to build your chromLocation object, set the "chrom" argument to "arms" in this function.

Value

m A matrix of summary statistics

Author(s)

Kyle A. Furge

References


See Also

buildChromMap,tBinomTest,regmap,buildChromLocation.2

Examples

## Not run:
##
## NOTE: This requires an annotation package to work.
## In this example packages "hu6800" and "golubEsets" are used.
## They can be downloaded from http://www.bioconductor.org
## "hu6800" is under MetaData, "golubEsets" is under Experimental Data.

if(require(hu6800) && require(golubEsets)) {
  data(Golub_Train)
  cloc <- buildChromMap("hu6800",c("1p","1q","2p","2q","3p","3q"))

  ## For one-color expression data
  ## compare the ALL samples to the AML samples
  ## not particularly informative in this example

  aml.ix <- which(Golub_Train$"ALL.AML" == "AML")
  bias <- cgma(eset=Golub_Train,ref=aml.ix,genome=cloc)
  regmap(bias,col=.rwb)
A more interesting example

The mcr.eset is a two-color gene expression exprSet
where cytogenetically complex (MCR),
cytogenetically simple (CN) leukemia samples
and normal control (MNC) samples were profiled against
a pooled-cell line reference

The MCR eset data was obtained with permission. See PMID: 15377468

Notice the diminished expression on chromosome 5 in the MCR samples
and the enhanced expression on chromosome 11
This reflects chromosome gains and losses as validated by CGH

```r
data("mcr.eset")
data(idiogramExample)
norms <- grep("MNC", colnames(mcr.eset@exprs))
bias <- cgma(mcr.eset@exprs, vai.chr, ref=norms)
regmap(bias, col=topo.colors(50))
```

## End(Not run)

---

### tBinomTest

**binomial t-test**

#### Description

Binomial t-test

#### Usage

```r
tBinomTest(x, trim=.1)
```

#### Arguments

- `x`: numeric argument
- `trim`: trim at?

#### Value

bla bla bla

#### Author(s)

Karl A. Dykema and Kyle A. Furge

#### Examples

```r
cat("this is an example")
```
writeGFF3

Output of a GFF compliant table describing the enhanced and diminished chromosomal bands.

Description

This function writes out a GFF compliant tab delimited file for integration with genome browsers.

Usage

writeGFF3(cset, genome, chr, file.prefix = "temp.gff", organism = NULL)

Arguments

cset expression set containing cytogenetic predictions, see reb
genome chromLocation object containing annotation information
chr chromosome to examine
file.prefix character string - name of the output file, defaults to "temp.gff"
organism if NULL, determination of the host organism will be retrieved from the organism slot of the chromLocation object. Otherwise "h", "r", or "m" can be used to specify human, rat, or mouse chromosome information

Value

writeGFF3 returns an invisible list of character vectors.

Author(s)

Karl J. Dykema, <karl.dykema@vai.org> Kyle A. Furge, <kyle.furge@vai.org>

References

MCR eset data was obtained with permission. See PMID: 15377468

See Also

reb

Examples

data(idiogramExample)
ix <- abs(colo.eset) > .225
colo.eset[ix] <- NA
idiogram(colo.eset, ucsf.chr, "14", method="i", dlim=c(-1,1), col=.rwb)
gffmat <- writeGFF3(colo.eset, ucsf.chr, "14", NULL)
gffmat[1:4,]
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