Package ‘flowBin’

March 22, 2017

Type Package
Title Combining multitube flow cytometry data by binning
Version 1.10.0
Date 2013-5-11
Author Kieran O’Neill
Maintainer Kieran O’Neill <koneill@bccrc.ca>
Description Software to combine flow cytometry data that has been multiplexed into multiple tubes with common markers between them, by establishing common bins across tubes in terms of the common markers, then determining expression within each tube for each bin in terms of the tube-specific markers.
License Artistic-2.0
LazyLoad yes
Imports class, limma, snow, BiocGenerics
Depends methods, flowCore, flowFP, R (>= 2.10)
Suggests parallel
biocViews CellBasedAssays, FlowCytometry
Collate 'AllClasses.R' 'AllGenerics.R' 'BinnedFlowSample-accessors.R'
  'checkQNorm.R' 'flowBin.R' 'flowFPBin.R'
  'FlowSample-accessors.R' 'getBinExpr.R' 'kMeansBin.R'
  'mapClustersKNN.R' 'quantileNormalise.R' 'removeSparseBins.R'
NeedsCompilation no

R topics documented:

  amlsample .................................................. 2
  BinnedFlowSample ......................................... 2
  checkQNorm ................................................. 2
  eventsInBins .............................................. 3
  flowBin ................................................... 3
  flowFPBin .................................................. 4
  FlowSample ................................................ 5
  getBinExpr .................................................. 5
  kMeansBin .................................................. 6
  mapBinsKNN ............................................... 7
Multitube AML sample as example data for flowBin

Multitube AML sample as example data for flowBin

a flowSample containing 7 tubes with 3 common parameters and 4 measure parameters per tube.

FlowRepository.org accession FR-FCM-ZZYA

A FlowSample, but with binning information for each tube

A FlowSample, but with binning information for each tube

clust.labels: list of cluster label vectors, one for each tube
Note: all slots can be get and set using accessor methods, for example bin.pars(myFlowSet) <- c(1,2,5)

Function to check the quantile normalisation of a FlowSample using flowFP

Function to check the quantile normalisation of a FlowSample using flowFP

object and normed.object are compared using flowFP binning, to assess the deviation in bin counts between the two.

list containing two matrices of standard deviations across bins (rows) vs tubes (columns) for before (sd.before) and after (sd.after).

data(aml.sample)
normed.sample <- quantileNormalise(aml.sample)
qnorm.check <- checkQNorm(aml.sample, normed.sample, do.plot=FALSE)
show(qnorm.check)
eventsInBins

Count number of events for each tube in each bin

Description

Useful for QA of bin mapping

flowBin

function to run the entire flowBin pipeline

Description

Takes a list of flowFrames representing tubes from a single flow cytometry sample, and combines them using binning of events in terms of common markers across tubes.

Usage

flowBin(tube.list, bin.pars, control.tubes = vector(),
measure.pars = NULL,
sample.name = "Unnamed Flow Expr Set",
bin.method = "kmeans", expr.method = "medianFI",
 sparse.bin.thresh = 0.001, dequantize = T,
 snow.cluster = NULL, n.bins = 128, scale.expr = F,
do.qnorm = T, return.bins = F)

Arguments

tube.list a list of flowFrames, one for each tube to combine
bin.pars a numerical vector indicating which flow parameters in the each flowFrame to use for combining tubes. These should be the same markers assayed across every tube.
control.tubes a vector indicating which tubes in tube.list to use for negative controls. May be empty.
measure.pars a list of which parameters to measure expression for, with one vector for each tube. If left NULL, this defaults to all parameters other than those specified as bin.pars
sample.name name of this flowSample, for convenience (defaults to 'Unnamed Flow Expr Set')
bin.method The method to use for creating bins. The two options are "kmeans" for k-means clustering and nearest-neighbour mapping of bins, or "flowFP" for flowFP binning and direct mapping of bin boundaries across tubes.
expr.method The method to use to compute bin expression across tubes. This defaults to MFI of the cells belonging to that bin in each tube. Other options are
sparse.bin.thresh Bins which contain fewer than this proportion of total events in any tube will be excluded as outliers. Defaults to 0.001
flowFPBin

**Description**

Bin sample using flowFP binning

**Arguments**

- **object**: flowSample to bin
- **n.bins=128**: number of bins to use. This should be a power of 2, and will be rounded down to the nearest power of 2 if not.
- **snow.cluster=** NULL: Optional snow cluster to use for parallel execution.
- **dequantize=T**: If TRUE, adds a small (region of 1e-8) value to flow data to help break ties when binning.

**Value**

a BinnedFlowSample

---

**Examples**

```r
data(amlsample)
tube.combined <- flowBin(aml.sample@tube.set,
  bin.pars=aml.sample@bin.pars,
  bin.method='flowFP',
  control.tubes=aml.sample@control.tubes,
  expr.method='medianFIDist', scale.expr=TRUE)
heatmap(tube.combined, scale='none')
```

---

**Value**

A matrix containing expression values for each bin in terms of each marker across all tubes. If return.bins is set TRUE, then a list containing a BinnedFlowExprSet followed by the expression matrix is returned.

---

**Arguments**

- **object**: flowSample to bin
- **n.bins=128**: number of bins to use. This should be a power of 2, and will be rounded down to the nearest power of 2 if not.
- **snow.cluster=** NULL: Optional snow cluster to use for parallel execution.
- **dequantize=T**: If TRUE, adds a small (region of 1e-8) value to flow data to help break ties when binning.

---

**Value**

a BinnedFlowSample
Examples

data(aml.sample)  
normed.sample <- quantileNormalise(aml.sample)  
res <- flowFPBin(normed.sample)

FlowSample  
A class similar to flowSet, but with extra information needed by flowBin

Description

name: character string - name of the object

tube.set: list of flowFrames containing raw flow data.

control.tubes: Integer vector indicating which tubes in the list (if any) to use as negative controls. May be empty.

bin.pars: Integer vector indicating which parameters to use for binning. These must be in the same position in all tubes.

measure.pars: list of integer vectors indicating which parameters to use for measurement. These must be specified per tube. Note: all slots can be get and set using accessor methods, for example bin.pars(myFlowSet) <- c(1,2,5)

getBinExpr  
Calculate the expression of each bin in a BinnedFlowSample in terms of the measurement markers

Description

getBinExpr main function definition

Arguments

method  
Method to use to compute expression, passed as a string. Defaults to medianFI, which takes the simple median of each bin, and does not require control tubes. Other options available are medianFIDist, which uses medians with the median of the negative control subtracted out, and propPos which sets a threshold at the 98th percentile of the negative control and determines what proportion of cells lie above that.

include.bin.medians  
logical, specifies whether to compute the medians of each bin in terms of the binning markers and include them in the result or not. Defaults to T.

scale  
logical specifying whether to scale the results to the interval (0,1). If T (default), then all medians will be divided by the range for that marker as specified in the flowFrame.

Value

A numeric matrix containing expression values, with bins as rows and markers as columns
**Examples**

data(amlsample)
normed.sample <- quantileNormalise(aml.sample)
binned.sample <- flowFPBin(normed.sample)
binned.sample <- removeSparseBins(binned.sample, 0.001)
bin.expr <- getBinExpr(binned.sample)
heatmap(bin.expr, scale='none')

---

**kMeansBin**

*Bin sample using K-means binning*

**Description**

Bin sample using K-means binning

**Arguments**

- **object**
  - flowSample to bin
- **n.bins=128**
  - number of bins to use. This should be a power of 2, and will be rounded down to the nearest power of 2 if not.
- **n.neighbours=1**
  - number of neighbours to use for KNN mapping of bins from clustered tube
- **snow.cluster=NULL**
  - Optional snow cluster to use for parallel execution.
- **random.seed=101**
  - Random seed to set to make K-means clustering deterministic.
- **dequantize=T**
  - If TRUE, adds a small (region of 1e-8) value to flow data to help break ties when binning.

**Details**

Runs K-means clustering on the binning markers in the first tube of the data set. These clusters are then mapped to the other tubes using K-nearest neighbours.

**Value**

- a BinnedFlowSample

**Examples**

data(amlsample)
normed.sample <- quantileNormalise(aml.sample)
res <- kMeansBin(normed.sample)
mapBinsKNN

Internal function to map bins by KNN

Description

Internal function to map bins by KNN

Arguments

object
flowSample to map the bins of
tube.1.labels
integer vector of bin labels for the events in tube 1
n.neighbours=1
number of neighbours to use for KNN mapping of bins from clustered tube
snow.cluster=NULL
Optional snow cluster to use for parallel execution.
dequant=T
If TRUE, adds a small (region of 1e-8) value to flow data to help break ties when binning.

Details

Takes a FlowSample and labels for the events in tube 1, and maps these to all other tubes.

Value

a BinnedFlowSample

Examples

data(amlsample)
tube1.expr <- exprs(tube.set(aml.sample)[[1]])
kmeans.res <- kmeans(tube1.expr, 100)
kmeans.labels <- kmeans.res$cluster

#Now create a binnedFlowExprSet using the cluster labels for tube 1
clustered.sample <- mapBinsKNN(aml.sample, kmeans.labels)
sort(table(bin.labels(clustered.sample)[[3]]))

quantileNormalise

quantileNormalise normalise binning parameters across all tubes of a flowSample

Description

Since the binning parameters are the same across tubes, and samples each tube is an aliquot from the same sample, these should have the same underlying distribution. Hence, quantile normalisation can be used to force this to be so, removing technical variation.

Examples

data(amlsample)
normed.sample <- quantileNormalise(aml.sample)
qnorm.check <- checkQNorm(aml.sample, normed.sample, do.plot=FALSE)
show(qnorm.check)
**removeSparseBins**  
*Remove bins from a BinnedFlowSample with few events in them*

**Description**

Remove bins from a BinnedFlowSample with few events in them

**Arguments**

- `object`: the BinnedFlowSample to act on
- `cutoff.prop=NULL`: the minimum proportion that a bin must contain to be kept. If NULL, only bins with no events in at least one tube will be removed.

**Details**

This is important to do prior to calculating bin expression, as bins containing 2 or less events, for example, cannot have their median computed.

**Value**

a BinnedFlowSample with sparse bins removed

---

**show-methods**  
*Methods to view flowBin objects*

**Description**

Methods for function `show` in Package `flowBin`

**Methods**

- `signature(object = "BinnedFlowExprSet")`: Show number of bins and samples for a BinnedFlowExprSet.
- `signature(object = "CVResult")`: Show various statistics stored in a CVResult object.