Package ‘BHC’

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Type Package

Title Bayesian Hierarchical Clustering

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Description The method performs bottom-up hierarchical clustering, using a Dirichlet Process (infinite mixture) to model uncertainty in the data and Bayesian model selection to decide at each step which clusters to merge. This avoids several limitations of traditional methods, for example how many clusters there should be and how to choose a principled distance metric. This implementation accepts multinomial (i.e. discrete, with 2+ categories) or time-series data. This version also includes a randomised algorithm which is more efficient for larger data sets.

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NeedsCompilation yes

R topics documented:

bhc .......................................................... 1

Index 4

bhc Function to perform Bayesian Hierarchical Clustering on a 2D array of discretised (i.e. multinomial) data

Description

The method performs bottom-up hierarchical clustering, using a Dirichlet Process (infinite mixture) to model uncertainty in the data and Bayesian model selection to decide at each step which clusters to merge. This avoids several limitations of traditional methods, for example how many clusters there should be and how to choose a principled distance metric. This implementation accepts multinomial (i.e. discrete, with 2+ categories) or time-series data. This version also includes a randomised algorithm which is more efficient for larger data sets.
Usage

```
bhc(data, itemLabels, nFeatureValues, timePoints, dataType,
    noise, numReps, noiseMode, robust, numThreads, randomised, m, verbose)
```

Arguments

data : A 2D array containing discretised data. The dimensions of data should be
       nDataItems * nFeatures, and the algorithm will cluster the data items.

itemLabels : A character array containing nDataItems entries, one for each data item in the
             analysis. The leaf nodes of the output dendrogram will be labelled with these labels.

nFeatureValues : Deprecated. This is a legacy argument, retained for backwards compatibility.
                  Any value passed to it will have no effect.

timePoints : An array of length nFeatures, containing the time points of the measurements.

dataType : A string specifying the data type. Either 'multinomial', 'time-course',
            or 'cubicspline'.

noise : Noise term for each gene, required only if noiseMode=2. The noise term for
        each gene is calculated as
        \[ \sum (\text{residuals}^2) \\]
        \[ \frac{1}{(\text{number of observations for gene} - 1)(\text{number of replicates})} \]
        where (number of observations for gene) is typically (number of time points *
        number of replicates).

numReps : Number of replicates per observation.

noiseMode : Noise mode. If 0 then fitted noise; 2 estimated noise from replicates.

robust : 0 to use single Gaussian likelihood, 1 to use mixture likelihood.

numThreads : The BHC library has been parallelised using OpenMP (currently on UNIX sys-
             tems only). Specify here the number of threads to use (the default value is 1).

randomised : Set to TRUE if you wish to use the randomised algorithm.

m : If randomised is set to TRUE, then this is the dimension of the randomly chosen
    subset D_m in the randomised algorithm.

verbose : If set to TRUE, the algorithm will output some information to screen as it runs.

Details

Typical usage for the multinomial case:

```
bhc(data, itemLabels).
```

To use the squared-exponential covariance:

```
bhc(data, itemLabels, 0, timePoints, "time-course",
    noise, numReps, noiseMode),
```

and the cubic spline covariance:

```
bhc(data, itemLabels, 0, timePoints, "cubicspline",
    noise, numReps, noiseMode).
```

To use the randomised algorithm, simply include the following two arguments:

```
bhc(data, itemLabels, 0, timePoints, "time-course",
    noise, numReps, noiseMode, randomised=TRUE, m=10)
```
**Value**

A DENDROGRAM object (see the R stats package for details).

**Author(s)**

Rich Savage, Emma Cooke, Robert Darkins, and Yang Xu

**References**

Bayesian Hierarchical Clustering, Heller + Ghahramani, Gatsby Unit Technical Report GCNU-TR 2005-002 (2005); also see shorter version in ICML-2005; R/BHC: fast Bayesian hierarchical clustering for microarray data, Savage et al, BMC Bioinformatics 10:242 (2009); Bayesian hierarchical clustering for microarray time series data with replicates and outlier measurements, Cooke et al, currently under review

**See Also**

hclust

**Examples**

```r
## BUILD SAMPLE DATA AND LABELS
data <- matrix(0,15,10)
itemLabels <- vector("character",15)
data[1:5,] <- 1 ; itemLabels[1:5] <- "a"
data[6:10,] <- 2 ; itemLabels[6:10] <- "b"
timePoints <- 1:10 # for the time-course case

## DATA DIMENSIONS
nDataItems <- nrow(data)
nFeatures <- ncol(data)

## RUN MULTINOMIAL CLUSTERING
hc1 <- bhc(data, itemLabels, verbose=TRUE)
plot(hc1, axes=FALSE)

## RUN TIME-COURSE CLUSTERING
hc2 <- bhc(data, itemLabels, 0, timePoints, "time-course",
            numReps=1, noiseMode=0, numThreads=2, verbose=TRUE)
plot(hc2, axes=FALSE)

## OUTPUT CLUSTER LABELS TO FILE
WriteOutClusterLabels(hc1, "labels.txt", verbose=TRUE)

## FOR THE MULTINOMIAL CASE, THE DATA CAN BE DISCRETISED
newData <- data[] + rnorm(150, 0, 0.1);
percentiles <- FindOptimalBinning(newData, itemLabels, transposeData=TRUE, verbose=TRUE)
discreteData <- DiscretiseData(t(newData), percentiles=percentiles)
discreteData <- t(discreteData)
hc3 <- bhc(discreteData, itemLabels, verbose=TRUE)
plot(hc3, axes=FALSE)
```
Index

*Topic* cluster
  bhc, 1

bhc, 1

DiscretiseData (bhc), 1

FindOptimalBinning (bhc), 1

hclust, 3

WriteOutClusterLabels (bhc), 1