Package ‘SMAP’

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**Title**  
A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling

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**Description** Functions and classes for DNA copy number profiling of array-CGH data

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**License** GPL-2

**LazyLoad** true

**Collate**  
AllClasses.R AllGenerics.R methods-SMAPHMM.R  
methods-SMAPObservations.R methods-SMAPProfile.R  

**biocViews** Microarray, TwoChannel, CopyNumberVariation

**NeedsCompilation** yes

**R topics documented:**

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GBM Glioblastoma multiforme array CGH data

Description

Array CGH data measurements of glioblastoma multiforme sample G24460.

Usage

data(GBM)

Source

Genome wide array CGH data from Diaz de Stahl, T., et al. (2005).

References


See Also

smap

Examples

```r
data(GBM)
observations <- SMAPObservations(value=as.numeric(GBM[,2]),
  chromosome=as.character(GBM[,3]),
  startPosition=as.numeric(GBM[,4]),
 :endPosition=as.numeric(GBM[,5]),
  name="G24460",
  reporterId=as.character(GBM[,1]))
plot(observations)
```

smap

*smap*: A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling

Description

This function fits a Hidden Markov Model (HMM) to a set of observed microarray intensity ratios and outputs the most plausible state sequence in the HMM through segmental a posteriori maximization.

Briefly, given an HMM with initial parameter settings \( \lambda \) and a set of observations \( O \), the method alternates maximization of the joint posterior probability of the state sequence \( Q \) and \( \lambda \) given \( O \), \( p(Q, \lambda | O) \), over \( Q \) (using a modified Viterbi algorithm) and \( \lambda \) (using a gradient descent scheme with individual learning rate adaptation).
Usage

smap(x, Obs, sd.min=0.05, mean.sd=0.05,
     max.iters=Inf, gd.max.iters=Inf, tau=0.05,
     eta=0.01, e.change=0.5, e.same=1.2,
     e.min=0.0001, e.max=0.5, adaptive=TRUE,
     overlap=TRUE, distance=TRUE, chrom.wise=FALSE,
     verbose=1, L=5000000)

Arguments

x An object of class SMAPHMM-class.
Obs An object of class SMAPObservations-class.
sd.min The minimum allowed standard deviation of state associated Gaussian distributions (numeric).
mean.sd Prior standard deviation of state associated Gaussian means (numeric).
max.iters Maximum number of iterations in the SMAP algorithm (numeric).
gd.max.iters Maximum number of iterations in the gradient descent algorithm per SMAP iteration (numeric).
tau Minimum log probability improvement required in the SMAP and gradient descent optimization (numeric).
eta Initial learning rate in the gradient descent optimization (numeric).
e.change Multiplier for individual learning rate adaptation if the sign of partial derivative changes (numeric). Only used if adaptive == TRUE.
e.same Multiplier for individual learning rate adaptation if the sign of partial derivative stays the same (numeric). Only used if adaptive == TRUE.
e.min Minimum allowed learning rate (numeric).
e.max Maximum allowed learning rate (numeric).
adaptive If TRUE, individual learning rate adaptation according to Algorithm 1 in Bagos et al. (2004) is used in the gradient descent optimization.
overlap If TRUE, genomic overlap of clones is considered in the optimization.
distance If TRUE, genomic distance between clones is considered in the optimization, in terms of distance based transition probabilities.
chrom.wise If TRUE, the observations are analyzed chromosome-wise rather than genome-wise.
verbose Specifies the amount of output produced; 0 means no information and 3 a lot of information (numeric).
L A positive length parameter that controls the convergence of distance based transition probabilities towards 1 / noStates(x) (numeric).

Details

sd.min, mean.sd, and eta must all be greater than 0. tau must be greater than 0 if max.iters or gd.max.iters are infinite, and can be 0 otherwise. If adaptive is TRUE, then e.change is required to be in the interval (0,1], e.same must be greater than or equal to 1, and e.max must be greater than 0.
Value

The method returns an object of class `SMAPProfile-class` or `SMAPProfiles-class` if `chrom.wise` is set to `FALSE` or `TRUE`, respectively.

Author(s)

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References


See Also

`SMAPHMM`, `SMAPObservations`

Examples

```r
## Load Glioblastoma multiforme data
data(GBM)
observations <- SMAPObservations(value=as.numeric(GBM[,2]),
                                  chromosome=as.character(GBM[,3]),
                                  startPosition=as.numeric(GBM[,4]),
                                  endPosition=as.numeric(GBM[,5]),
                                  name="G24460",
                                  reporterId=as.character(GBM[,1]))
plot(observations, ylim=c(0,2))
## Initiate HMM
init.means <- c(0.4, 0.7, 1, 1.3, 1.6, 3)
init.sds <- rep(0.1, 6)
phi <- cbind(init.means, init.sds)
hmm <- SMAPHMM(6, phi, initTrans=0.02)
hmm
## RUN SMAP:
profile <- smap(hmm, observations, verbose=2)
## genome profile
plot(profile, ylim=c(0,2))
## chromosome 9 profile
ids <- which(chromosome(observations) == "9")
plot(profile[ids], ylim=c(0,2), main="chromosome 9")
## output results for chromosome 9
#cbind(reporterId(observations[ids]), Q(profile[ids]))
```
SMAPHMM

Constructor for "SMAPHMM" objects

Description

A constructor for SMAPHMM-class objects.

Usage

SMAPHMM(noStates, Phi, A=NULL, 
Pi=rep(1/noStates,noStates), 
initTrans=0.2/(noStates - 1))

Arguments

noStates: The number of hidden states in the HMM (numeric).

Phi: A Gaussian distribution parameter matrix (numeric).

A: A noStates * noStates matrix of transition probabilities between the hidden states (numeric).

Pi: A vector of initial probabilities of starting in a certain state (numeric).

initTrans: Specifies the transition probability between non-equal states (numeric).

Details

Phi is a noStates * 2 matrix that specifies the parameters of Gaussian distributions associated with each hidden state. The first column specifies standard deviations, the second specifies means.

If A == NULL, initTrans specifies the transition probability between states i and j in 1:noStates, such that i != j. Only used if A == NULL. initTrans * noStates must be smaller than (or equal to) 1.

Value

An object of class SMAPHMM-class.

Author(s)

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References


See Also

smap, SMAPHMM-class, SMAPObservations-class
Class "SMAPHMM": A class to manage HMMs for the SMAP package

Description
Holds parameters for a Hidden Markov Model (HMM) used in the SMAP package.

Objects from the Class
Objects should not be created directly but via the constructor function SMAPHMM.

Slots
- \(A\): Object of class "matrix" The transition probability matrix between states.
- \(\Pi\): Object of class "numeric" The initial probabilities of starting in a certain state.
- \(\Phi\): Object of class "matrix" A matrix that specifies the parameters of Gaussian distributions associated with each hidden state. The first column specifies standard deviations, the second specifies means.
- \(\text{noStates}\): Object of class "numeric" The number of hidden states in the HMM.
- \(Z\): Object of class "matrix" Matrix of transition probabilities.
- \(Y\): Object of class "numeric" Vector of initial probabilities.
- \(\eta\): Object of class "ANY". Internal slot.
- \(\text{grad}\): Object of class "ANY". Internal slot.

Methods
- \(A\) signature(object = "SMAPHMM"): Returns the transition matrix.
- \(\Pi\) signature(object = "SMAPHMM"): Returns the initial probabilities.
- \(\Phi\) signature(object = "SMAPHMM"): Returns the distribution parameter matrix.
- \(\text{noStates}\) signature(object = "SMAPHMM"): Returns the number of hidden states in the HMM.

Author(s)
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References

See Also
smap, SMAPHMM
SMAPObservations

Constructor for "SMAPObservations" objects

Description

A constructor for SMAPObservations-class objects.

Usage

SMAPObservations(value, chromosome, startPosition, endPosition,
   name=character(0),
   reporterId=as.character(1:length(value)))

Arguments

value
A vector of microarray intensity ratios (numeric).

chromosome
A vector of chromosome annotations (character).

startPosition
A vector of start positions (numeric).

endPosition
A vector of end positions (numeric).

name
The name of the observation set (character).

reporterId
A vector of observation identifiers, e.g., probe ids (character).

Details

The vectors value, chromosome, startPosition, endPosition, and reporterId must be of equal length.

Value

An object of class SMAPObservations-class.

Author(s)

Robin Andersson, <robin.andersson@lcb.uu.se>

References


See Also

smap, SMAPObservations-class, SMAPHMM-class
Examples

```r
## Load Glioblastoma multiforme data
data(GBM)
observations <- SMAPObservations(value=as.numeric(GBM[,2]),
                                   chromosome=as.character(GBM[,3]),
                                   startPosition=as.numeric(GBM[,4]),
                                   endPosition=as.numeric(GBM[,5]),
                                   name="G24460",
                                   reporterId=as.character(GBM[,1]))

## plot observations
plot(observations, ylim=c(0,2))
## plot subset of observations (chromosome 9)
ids <- which(chromosome(observations) == "9")
plot(observations[ids])
```

SMAPObservations-class

Class "SMAPObservations": A class to manage microarray observations for the SMAP package

Description

Holds observed microarray intensity ratios and clone annotations for the SMAP package.

Objects from the Class

Objects can be created by calls of the form `new("SMAPObservations", value, chromosome, startPosition,endPosition,...)`.

Values for internal slots (see below) are not intended to be passed upon construction. You can also use the convenience function `SMAPObservations`.

Slots

- `value`: Object of class "numeric" Microarray intensity ratios.
- `chromosome`: Object of class "character" Associated chromosomes for the observations.
- `startPosition`: Object of class "numeric" Associated start positions for the observations.
- `endPosition`: Object of class "numeric" Associated end positions for the observations.
- `reporterId`: Object of class "character" Identifiers of the observations, e.g., probe ids.
- `name`: Object of class "character" An identifier of the observation set.
- `noObservations`: Object of class "numeric" The number of observations in the set.
- `chrom.start`: Object of class "numeric". Internal slot.
- `chroms`: Object of class "character". Internal slot.
- `distance`: Object of class "numeric". Internal slot.
- `noOverlaps`: Object of class "numeric". Internal slot.
- `overlaps`: Object of class "numeric". Internal slot.
- `overlapIds`: Object of class "numeric". Internal slot.
- `startOverlaps`: Object of class "numeric". Internal slot.
SMAPProfile-class

Methods

value signature(object = "SMAPObservations"): Returns the values of the observations.

chromosome signature(object = "SMAPObservations"): Returns the chromosome annotations of the observations.

startPosition signature(object = "SMAPObservations"): Returns the start positions of the observations.

dateTime signature(object = "SMAPObservations"): Returns the end positions of the observations.

reporterId signature(object = "SMAPObservations"): Returns the identifiers of the observations.

name signature(object = "SMAPObservations"): Returns the name of the observation set.

noObservations signature(object = "SMAPObservations"): Returns the number of observations in the set.

initialize signature(.Object = "SMAPObservations"): Creates an instance.

plot signature(x = "SMAPObservations", y = "missing"): A plot method for the observations.

[ signature(x = "SMAPProfile"): Creates a new object of class SMAPObservations with extracted elements as specified by the indices provided.

Author(s)

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References


See Also

smap, SMAPObservations

SMAPProfile-class

Class "SMAPProfile"

Description

Holds results from running smap.

Objects from the Class

Objects are not intended to be created directly but as a result from running smap.
SMAPProfiles-class

Slots

HMM: Object of class "SMAPHMM"

observations: Object of class "SMAPObservations"

P: Object of class "numeric" The log joint posterior probability of the state sequence Q and parameters of HMM given the observations.

Q: Object of class "numeric" The optimal state sequence (path) in the HMM.

name: Object of class "character" The name of the object.

Methods

P signature(object = "SMAPProfile"): Returns the log joint posterior probability.

Q signature(object = "SMAPProfile"): Returns the optimal state sequence.

HMM signature(object = "SMAPProfile"): Returns the optimized HMM.

name signature(object = "SMAPProfile"): Returns the name of the profile.

observations signature(object = "SMAPProfile"): Returns the observations.

plot signature(x = "SMAPProfile", y = "missing"): A plot method for the result profile.

[ signature(x = "SMAPProfile"): Creates a new object of class SMAPProfile with extracted elements as specified by the indices provided.

Author(s)

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References


See Also

smap, SMAPProfiles-class

SMAPProfiles-class Class "SMAPProfiles"

Description

Holds results from running smap.

Objects from the Class

Objects are not intended to be created directly but as a result from running smap.

Slots

.Data: Object of class "list" A list of objects of class SMAPProfile-class.

name: Object of class "character" The name of the object.
SMAPProfiles-class

Extends
Class "list", from data part. Class "vector", by class "list".

Methods

  Q signature(object = "SMAPProfiles"): Returns the optimal state sequence of the list elements.
  observations signature(object = "SMAPProfiles"): Returns the observations of the list elements.
  name signature(object = "SMAPProfiles"): Returns the name of the profile.
  plot signature(x = "SMAPProfiles", y = "missing"): A plot method for the result profiles.

Author(s)
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References

See Also
smap, SMAPProfile-class
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