

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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Collate AllClasses.R AllGenerics.R methods-SMAPHMM.R
methods-SMAPObservations.R methods-SMAPProfile.R
methods-GaussParam.R methods-grad.R methods-eta.R

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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

Diaz de Stahl, T., et al. (2005) Chromosome 22 tiling-path array-CGH analysis identifies germline- and tumor-specific aberrations in patients with glioblastoma multiforme. *Genes Chromosomes Cancer* **44**(2), 161–169

See Also

[smap](#)

Examples

```
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	<i>smap: A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling</i>
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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

<code>x</code>	An object of class <code>SMAPHMM-class</code> .
<code>Obs</code>	An object of class <code>SMAPObservations-class</code> .
<code>sd.min</code>	The minimum allowed standard deviation of state associated Gaussian distributions (numeric).
<code>mean.sd</code>	Prior standard deviation of state associated Gaussian means (numeric).
<code>max.iters</code>	Maximum number of iterations in the SMAP algorithm (numeric).
<code>gd.max.iters</code>	Maximum number of iterations in the gradient descent algorithm per SMAP iteration (numeric).
<code>tau</code>	Minimum log probability improvement required in the SMAP and gradient descent optimization (numeric).
<code>eta</code>	Initial learning rate in the gradient descent optimization (numeric).
<code>e.change</code>	Multiplier for individual learning rate adaptation if the sign of partial derivative changes (numeric). Only used if <code>adaptive == TRUE</code> .
<code>e.same</code>	Multiplier for individual learning rate adaptation if the sign of partial derivative stays the same (numeric). Only used if <code>adaptive == TRUE</code> .
<code>e.min</code>	Minimum allowed learning rate (numeric).
<code>e.max</code>	Maximum allowed learning rate (numeric).


```

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)

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

References

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPHMM-class](#), [SMAPObservations-class](#)

SMAPHMM-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.

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.

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.

noStates signature(object = "SMAPHMM"): Returns the number of hidden states in the HMM.

Author(s)

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

References

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPHMM](#)

SMAPObservations	<i>Constructor for "SMAPObservations" objects</i>
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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

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPObservations-class](#), [SMAPHMM-class](#)

Examples

```
## 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.

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.
endPosition 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 = "SMAPPObservations"): Creates a new object of class SMAPObservations with extracted elements as specified by the indices provided.

Author(s)

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

References

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPObservations](#)

SMAPPProfile-class *Class "SMAPPProfile"*

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

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 = "SMAPPProfile"): Returns the log joint posterior probability.

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

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

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

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

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

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

Author(s)

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

References

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPPProfiles-class](#)

SMAPPProfiles-class *Class "SMAPPProfiles"*

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 [SMAPPProfile-class](#).

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

Extends

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

Methods

Q `signature(object = "SMAPPProfiles")`: Returns the optimal state sequence of the list elements.

observations `signature(object = "SMAPPProfiles")`: Returns the observations of the list elements.

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

plot `signature(x = "SMAPPProfiles", y = "missing")`: A plot method for the result profiles.

Author(s)

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

References

Andersson, R., Bruder, C. E. G., Piotrowski, A., Menzel, U., Nord, H., Sandgren, J., Hvidsten, T. R., Diaz de Stahl, T., Dumanski, J. P., Komorowski, J., A Segmental Maximum A Posteriori Approach to Array-CGH Copy Number Profiling, submitted

See Also

[smap](#), [SMAPPProfile-class](#)

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