

Package ‘VanillaICE’

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Title A Hidden Markov Model for high throughput genotyping arrays

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Description Hidden Markov Models for characterizing chromosomal alterations in
high throughput SNP arrays

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'functions.R' 'help.R' 'hmm-methods.R' 'methods-ArrayViews.R'
'methods-CopyNumScanParams.R' 'methods-EmissionParam.R'
'methods-FilterParam.R' 'methods-HMM.R' 'methods-HMMList.R'
'methods-HmmGRanges.R' 'methods-HmmParam.R'
'methods-HmmTrellisParam.R' 'methods-IdiogramParams.R'
'methods-LogLik.R' 'methods-SnpArrayExperiment.R'
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Local Variables

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End

R topics documented:

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ArrayViews-class	<i>ArrayViews class, constructor, and methods</i>
------------------	---

Description

ArrayViews provides views to the low-level data – log R ratios, B allele frequencies, and genotypes that are stored in parsed files on disk, often scaled and coerced to an integer. Accessors to the low-level data are provided that extract the marker-level summaries from disk, rescaling when appropriate.

Usage

```
ArrayViews(class = "ArrayViews", colData, rowData = GRanges(),
  sourcePaths = character(), scale = 1000, sample_ids,
  parsedPath = getwd())
```

```
## S4 method for signature ArrayViews,ANY,ANY,ANY
x[i, j, ..., drop = FALSE]
```

```
colnames(x) <- value
```

```
## S4 method for signature ArrayViews
show(object)
```

```
## S4 method for signature ArrayViews
sapply(X, FUN, ..., simplify = TRUE,
  USE.NAMES = TRUE)
```

```
## S4 method for signature ArrayViews
ncol(x)
```

```
## S4 method for signature ArrayViews
```

```
nrow(x)

## S4 method for signature ArrayViews
dim(x)

## S4 method for signature ArrayViews
start(x)
```

Arguments

class	character string
colData	DataFrame
rowData	GRanges object
sourcePaths	character string provide complete path to plain text source files (one file per sample) containing log R ratios and B allele frequencies
scale	log R ratios and B allele frequencies can be stored as integers on disk to increase IO speed. If scale =1, the raw data is not transformed. If scale = 1000 (default), the log R ratios and BAFs are multiplied by 1000 and coerced to an integer.
sample_ids	character vector indicating how to name samples
parsedPath	character vector indicating where parsed files should be saved
x	a ArrayViews object
i	numeric vector or missing
j	numeric vector or missing
...	additional arguments to FUN
drop	ignored
value	a character-string vector
object	a ArrayViews object
X	a ArrayViews object
FUN	a function to apply to each column of X
simplify	logical indicating whether result should be simplified
USE.NAMES	whether the output should be a named vector

Slots

colData A character string

rowData A DataFrame

index A GRanges object

sourcePaths A character string providing complete path to source files (one file per sample) containing low-level summaries (Log R ratios, B allele frequencies, genotypes)

scale A length-one numeric vector

parsedPath A character string providing full path to where parsed files should be saved

See Also

[CopyNumScanParams](#) [parseSourceFile](#)

Examples

```
ArrayViews()
## From unit test
require(BSgenome.Hsapiens.UCSC.hg18)
require(data.table)
extdir <- system.file("extdata", package="VanillaICE", mustWork=TRUE)
features <- suppressWarnings(fread(file.path(extdir, "SNP_info.csv")))
fgr <- GRanges(paste0("chr", features$Chr), IRanges(features$Position, width=1),
              isSnp=features[["Intensity Only"]]==0)
fgr <- SnpGRanges(fgr)
names(fgr) <- features[["Name"]]
seqlevels(fgr) <- seqlevels(BSgenome.Hsapiens.UCSC.hg18)[seqlevels(BSgenome.Hsapiens.UCSC.hg18) %in% seqlevels
seqinfo(fgr) <- seqinfo(BSgenome.Hsapiens.UCSC.hg18)[seqlevels(fgr),]
fgr <- sort(fgr)
files <- list.files(extdir, full.names=TRUE, recursive=TRUE, pattern="FinalReport")
ids <- gsub(".rds", "", gsub("FinalReport", "", basename(files)))
views <- ArrayViews(rowData=fgr,
                    sourcePaths=files,
                    sample_ids=ids)
```

baumWelchUpdate

Function for updating parameters for emission probabilities

Description

This function is not meant to be called directly by the user. It is exported in the package NAMESPACE for internal use by other BioC packages.

Usage

```
baumWelchUpdate(param, assay_list)
```

Arguments

param	A container for the HMM parameters
assay_list	list of log R ratios and B allele frequencies

calculateEmission *Calculate the emission probabilities for the 6-state HMM*

Description

Given the data and an object containing parameters for the HMM, this function computes emission probabilities. This function is not intended to be called by the user and is exported for internal use by other BioC packages.

Usage

```
calculateEmission(x, param = EmissionParam())
```

Arguments

x	list of low-level data with two elements: a numeric vector of log R ratios and a numeric vector of B allele frequencies
param	parameters for the 6-state HMM

Value

A matrix of emission probabilities. Column correspond to the HMM states and rows correspond to markers on the array (SNPs and nonpolymorphic markers)

See Also

baumWelchUpdate

cnvFilter *Filter the HMM-derived genomic ranges for copy number variants*

Description

The HMM-derived genomic ranges are represented as a GRanges-derived object. cnvFilter returns a GRanges object using the filters stipulated in the filters argument.

Usage

```
cnvFilter(object, filters = FilterParam())
```

```
cnvSegs(object, filters = FilterParam(state = c("1", "2", "5", "6")))
```

```
duplication(object, filters = FilterParam(state = c("5", "6")))
```

```
deletion(object, filters = FilterParam(state = c("1", "2")))
```

```
hemizygous(object, filters = FilterParam(state = "2"))  
homozygous(object, filters = FilterParam(state = "1"))  
  
## S4 method for signature HMM  
cnvSegs(object, filters = FilterParam(state =  
  as.character(c(1, 2, 5, 6))))  
  
## S4 method for signature HMMList  
cnvSegs(object, filters = FilterParam(state =  
  as.character(c(1, 2, 5, 6))))  
  
## S4 method for signature HMMList  
cnvFilter(object, filters = FilterParam())  
  
## S4 method for signature HMMList  
segs(object)  
  
## S4 method for signature HMMList  
hemizygous(object)  
  
## S4 method for signature HMMList  
homozygous(object)  
  
## S4 method for signature HMMList  
duplication(object)  
  
## S4 method for signature HmmGRanges  
cnvSegs(object, filters = FilterParam(state =  
  as.character(c(1, 2, 5, 6))))
```

Arguments

object	see showMethods(cnvFilter)
filters	a FilterParam object

See Also

[FilterParam](#)

Examples

```
data(snp_exp)  
fit <- hmm2(snp_exp)  
segs(fit) ## all intervals  
cnvSegs(fit)  
filter_param <- FilterParam(probability=0.95, numberFeatures=10, state=c("1", "2"))  
cnvSegs(fit, filter_param)
```

```
hemizygous(fit)
homozygous(fit)
duplication(fit)
filter_param <- FilterParam(probability=0.5, numberFeatures=2, state=c("1", "2"))
cnvSegs(fit, filter_param)
```

cn_means

A parameter class for computing Emission probabilities

Description

Parameters for computing emission probabilities for a 6-state HMM, including starting values for the mean and standard deviations for log R ratios (assumed to be Gaussian) and B allele frequencies (truncated Gaussian), and initial state probabilities.

Constructor for EmissionParam class

This function is exported primarily for internal use by other BioC packages.

Usage

```
cn_means(object)
```

```
cn_sds(object)
```

```
baf_means(object)
```

```
baf_sds(object)
```

```
baf_means(object) <- value
```

```
baf_sds(object) <- value
```

```
cn_sds(object) <- value
```

```
cn_means(object) <- value
```

```
EmissionParam(cn_means = CN_MEANS(), cn_sds = CN_SDS(),
  baf_means = BAF_MEANS(), baf_sds = BAF_SDS(), initial = rep(1/6, 6),
  EMupdates = 5L, CN_range = c(-5, 3), temper = 1, p_outlier = 1/100,
  modelHomozygousRegions = FALSE)
```

```
EMupdates(object)
```

```
## S4 method for signature EmissionParam
```

```
show(object)
```


Arguments

object	see showMethods("EMupdates")
value	numeric vector
cn_means	numeric vector of starting values for log R ratio means (order is by copy number state)
cn_sds	numeric vector of starting values for log R ratio standard deviations (order is by copy number state)
baf_means	numeric vector of starting values for BAF means ordered. See example for details on how these are ordered.
baf_sds	numeric vector of starting values for BAF means ordered. See example for details on how these are ordered.
initial	numeric vector of initial state probabilities
EMupdates	number of EM updates
CN_range	the allowable range of log R ratios. Log R ratios outside this range are thresholded.
temper	Emission probabilities can be tempered by $\text{emit}^{\text{temper}}$. This is highly experimental.
p_outlier	probability that an observation is an outlier (assumed to be the same for all markers)
modelHomozygousRegions	logical. If FALSE (default), the emission probabilities for BAFs are modeled from a mixture of truncated normals and a Unif(0,1) where the mixture probabilities are given by the probability that the SNP is heterozygous. See Details below for a discussion of the implications.

Details

The log R ratios are assumed to be emitted from a normal distribution with a mean and standard deviation that depend on the latent copy number. Similarly, the BAFs are assumed to be emitted from a truncated normal distribution with a mean and standard deviation that depends on the latent number of B alleles relative to the total number of alleles (A+B).

Value

numeric vector

Details

When modelHomozygousRegions is FALSE (the default in versions $\geq 1.28.0$), emission probabilities for B allele frequencies are calculated from a mixture of a truncated normal densities and a Unif(0,1) density with the mixture probabilities given by the probability that a SNP is homozygous. In particular, let p denote a 6 dimensional vector of density estimates from a truncated normal distribution for the latent genotypes 'A', 'B', 'AB', 'AAB', 'ABB', 'AAAB', and 'ABBB'. The probability that a genotype is homozygous is estimated as

$$prHom = (p["A"] + p["B"])/sum(p)$$

and the probability that the genotype is heterozygous (any latent genotype that is not 'A' or 'B') is given by

$$prHet = 1 - prHom$$

Since the density of a Unif(0,1) is 1, the 6-dimensional vector of emission probability at a SNP is given by

$$emit = prHet * p + (1 - prHet)$$

The above has the effect of minimizing the influence of BAFs near 0 and 1 on the state path estimated by the Viterbi algorithm. In particular, the emission probability at homozygous SNPs will be virtually the same for states 3 and 4, but at heterozygous SNPs the emission probability for state 3 will be an order of magnitude greater for state 3 (diploid) compared to state 4 (diploid region of homozygosity). The advantage of this parameterization are fewer false positive hemizygous deletion calls. [Log R ratios tend to be more sensitive to technical sources of variation than the corresponding BAFs/ genotypes. Regions in which the log R ratios are low due to technical sources of variation will be less likely to be interpreted as evidence of copy number loss if heterozygous genotypes have more 'weight' in the emission estimates than homozygous genotypes.] The trade-off is that only states estimated by the HMM are those with copy number alterations. In particular, copy-neutral regions of homozygosity will not be called.

By setting `modelHomozygousRegions = TRUE`, the emission probabilities at a SNP are given simply by the `p` vector described above and copy-neutral regions of homozygosity will be called.

Examples

```
ep <- EmissionParam()
cn_means(ep)
ep <- EmissionParam()
cn_sds(ep)
ep <- EmissionParam()
baf_means(ep)
ep <- EmissionParam()
baf_sds(ep)
ep <- EmissionParam()
baf_means(ep) <- baf_means(ep)
ep <- EmissionParam()
baf_sds(ep) <- baf_sds(ep)
ep <- EmissionParam()
cn_sds(ep) <- cn_sds(ep)
ep <- EmissionParam()
cn_means(ep) <- cn_means(ep)
ep <- EmissionParam()
show(ep)
cn_means(ep)
cn_sds(ep)
baf_means(ep)
baf_sds(ep)
```

constrainMu2	<i>Constraints for updating the means of the copy number states</i>
--------------	---

Description

Constraints for updating the means of the copy number states
 Constraints for updating the standard deviations of the BAFs
 Restricted range for CN values

Usage

```
constrainMu2(mu)
constrainSd2(sigma)
copyNumberLimits(is.log)
```

Arguments

mu	numeric vector of means
sigma	numeric vector of standard deviations (non-negative)
is.log	whether copy number estimates are on log scale

Value

numeric vector of means
 constrained standard deviations
 numeric vector giving the lower and upper values of the restricted range

Examples

```
copyNumberLimits(is.log=TRUE)
copyNumberLimits(is.log=FALSE)
```

CopyNumScanParams-class

Parameters for parsing source files containing SNP-array processed data, such as GenomeStudio files for the Illumina platform

Description

Raw SNP array processed files have headers and variable labels that may depend the software, how the output files was saved, the software version, and other factors. The purpose of this container is to collect the parameters relevant for reading in the source files for a particular project in a single container. This may require some experimentation as the example illustrates. The function `fread` in the `data.table` package greatly simplifies this process.

Usage

```
CopyNumScanParams(cnvar = "Log R Ratio", bafvar = "B Allele Freq",
  gtvar = c("Allele1 - AB", "Allele2 - AB"), index_genome = integer(),
  select = integer(), scale = 1000, row.names = 1L)
```

```
## S4 method for signature CopyNumScanParams
show(object)
```

Arguments

cnvar	length-one character vector providing name of variable for log R ratios
bafvar	length-one character vector providing name of variable for B allele frequencies
gtvar	length-one character vector providing name of variable for genotype calls
index_genome	integer vector indicating which rows of the of the source files (e.g., GenomeStudio) to keep. By matching on a sorted GRanges object containing the feature annotation (see example), the information on the markers will also be sorted.
select	integer vector specifying indicating which columns of the source files to import (see examples)
scale	length-one numeric vector for rescaling the raw data and coercing to class integer. By default, the low-level data will be scaled and saved on disk as integers.
row.names	length-one numeric vector indicating which column the SNP names are in
object	a CopyNumScanParams object

Slots

```
index_genome
cnvar the column label for the log R ratios
bafvar the column label for the B allele frequencies
gtvar the column label(s) for the genotypes
scale length-one numeric vector indicating how the low-level data should be scaled prior to saving
on disk
select numeric vector indicating which columns to read
row.names length-one numeric vector indicating which column the SNP names are in
```

See Also

[ArrayViews parseSourceFile](#)

Examples

```
CopyNumScanParams() ## empty container
```

doUpdate	<i>Helper function to determine whether to update the HMM parameters via the Baum-Welch algorithm</i>
----------	---

Description

This function is not intended to be called directly by the user, and is exported only for internal use by other BioC packages.

Usage

```
doUpdate(param)
```

Arguments

param	An object containing parameters for the HMM
-------	---

See Also

[HmmParam](#)

dropDuplicatedMapLocs	<i>Drop markers on the same chromosome having the same genomic coordinates</i>
-----------------------	--

Description

If there are multiple markers on the same chromosome with the same annotated position, only the first is kept.

Usage

```
dropDuplicatedMapLocs(object)
```

Arguments

object	a container for which the methods seqnames and start are defined
--------	--

Value

an object of the same class with duplicated genomic positions removed

Examples

```

data(snp_exp)
g <- rowData(snp_exp)
## duplicate the first row
g[length(g)] <- g[1]
rowData(snp_exp) <- g
snp_exp2 <- dropDuplicatedMapLocs(snp_exp)

```

dropSexChrom *Filter sex chromosomes*

Description

Removes markers on chromosomes X and Y.

Usage

```
dropSexChrom(object)
```

Arguments

object an object for which the methods seqnames and rowData are defined.

Value

an object of the same class as the input

emission *Methods to set and get emission probabilities*

Description

Get or set a matrix of emission probabilities. This function is exported primarily for internal use by other BioC packages.

Usage

```
emission(object)
```

```
emission(object) <- value
```

Arguments

object see showMethods(emission)
value a matrix of emission probabilities

Value

matrix

emissionParam	<i>Accessor for parameters used to compute emission probabilities</i>
---------------	---

Description

Parameters for computing emission probabilities include the starting values for the Baum Welch update and initial state probabilities.

Usage

```
emissionParam(object)

emissionParam(object) <- value
```

Arguments

object	an object of class EmissionParam
value	an object of class EmissionParam

Value

[EmissionParam](#) instance

Examples

```
hparam <- HmmParam()
emissionParam(hparam)
ep <- EmissionParam()
cn_means(ep) <- log2(c(.1/2, 1/2, 2/2, 2/2, 3/2, 4/2))
emissionParam(hparam) <- ep
```

fileName	<i>Accessor for parsed file(s) containing low level summaries for copy number analysis</i>
----------	--

Description

These accessors are not meant to be called directly by the user. They are exported in the package NAMESPACE for internal use by other BioC packages.

Usage

```

fileName(object, label)

lrrFile(object, label = "lrr")

bafFile(object, label = "baf")

gtFile(object, label = "gt")

## S4 method for signature ArrayViews
lrrFile(object, label = "lrr")

## S4 method for signature ArrayViews
bafFile(object, label = "baf")

## S4 method for signature ArrayViews
gtFile(object, label = "gt")

```

Arguments

object	An array views-type container
label	character string to be incorporated as part of the file name for parsed BAFs

Examples

```

views <- ArrayViews(parsedPath=tempdir())
sourcePaths(views)
lrrFile(views)
bafFile(views)
gtFile(views)

```

FilterParam-class	<i>Container for the common criteria used to filtering genomic ranges</i>
-------------------	---

Description

The maximum a posteriori estimate of the trio copy number state for each genomic range is represented in a [GRanges](#)-derived class. Ultimately, these ranges will be filtered based on the trio copy number state (e.g., *de novo* deletions), size, number of features (SNPs), or chromosome. `FilterParam` is a container for the parameters commonly used to filter the genomic ranges.

Usage

```

FilterParam(probability = 0.99, numberFeatures = 10,
  seqnames = paste0("chr", c(1:22, "X", "Y")), state = as.character(1:6),
  width = 1L)

```



```
## S4 method for signature FilterParam
probability(object)

## S4 method for signature FilterParam
state(object)

## S4 method for signature FilterParam
show(object)
```

Arguments

probability	minumum probability for the call
numberFeatures	minumum number of SNPs/nonpolymorphic features in a region
seqnames	the seqnames (character string or R1e to keep)
state	character: the HMM states to keep
width	the minimum widht of a region
object	a FilterParam object

Slots

probability a length-one numeric vector indicating the minimum posterior probability for the called state. Genomic intervals with posterior probabilities below probability will be filtered.

numberFeatures a positive integer indicating the minimum number of features in a segment

seqnames a character vector of seqnames to select (i.e., 'chr1' for only those intervals on chromosome 1)

width positive integer indicating the minimal width of genomic intervals

state character string indicating which hidden Markov model states to select

See Also

[cnvFilter](#) [cnvSegs](#) [hmm2](#)

Examples

```
fp <- FilterParam()
width(fp)
numberFeatures(fp)
seqnames(fp)
## To select CNV segments for which
## - the CNV call has a posterior probability of at least 0.95
## - the number of features is at least 10
## - the HMM states are 1 (homozygous deletion) or 2 (hemizygous deletion)
FilterParam(probability=0.95, numberFeatures=10, state=c("1", "2"))
```

filters	<i>Accessor for HMM filter parameters</i>
---------	---

Description

Accessor for HMM filter parameters

Usage

filters(object)

Arguments

object see showMethods(filters)

genotypes	<i>Accessor for SNP genotypes</i>
-----------	-----------------------------------

Description

Extract SNP genotypes. Genotypes are assumed to be represented as integers: 1=AA, 2=AB, 3=BB.

Usage

genotypes(object)

S4 method for signature ArrayViews
lrr(object)

S4 method for signature ArrayViews
baf(object)

S4 method for signature ArrayViews
genotypes(object)

S4 method for signature SnpArrayExperiment
baf(object)

S4 method for signature SnpArrayExperiment
copyNumber(object)

S4 method for signature SnpArrayExperiment
lrr(object)

S4 method for signature SnpArrayExperiment
genotypes(object)

Arguments

object see showMethods("genotypes")

See Also

copyNumber

getExampleSnpExperiment

Create an example SnpArrayExperiment from source files containing marker-level genomic data that are provided in this package

Description

Create an example SnpArrayExperiment from source files containing marker-level genomic data that are provided in this package

Usage

```
getExampleSnpExperiment()
```

Value

A [SnpArrayExperiment](#)

Examples

```
## Not run:  
snp_exp <- getExampleSnpExperiment()  
  
## End(Not run)
```

getHmmParams

Accessor for HMM model parameters

Description

Accessor for HMM model parameters

Usage

```
getHmmParams(object)
```

Arguments

object see showMethods(HmmParam)

Examples

```
hmm_object <- HMM()
getHmmParams(hmm_object)
```

hmm *Deprecated functions in the VanillaICE package*

Description

These functions have been deprecated. The functions are only provided only for compatability with older versions and will be defunct at the next release.

Usage

```
hmm(object, ...)

robustSds(x, takeLog = FALSE, ...)
```

Arguments

object	see <code>showMethods(hmm)</code> for a listing of classes for which this method is defined
...	additional arguments to <code>mad</code>
x	a numeric matrix
takeLog	whether to first <code>log2</code> transform the numeric matrix

Value

a matrix of the same dimension as the input. Within a column, the entries are identical

See Also

[mad](#)

HMM-class *Container for the segmented data and the 6-state HMM model parameters*

Description

Container for the segmented data and the 6-state HMM model parameters

The constructor `HMM` creates an object of class `HMM`. Not typically called directly by the user.

Usage

```
HMM(granges = GRanges(), param = HmmParam(), posterior = matrix(),
     filters = FilterParam())

## S4 method for signature HMM
state(object)

## S4 method for signature HMM
show(object)
```

Arguments

granges	a GRanges object
param	a HmmParam object
posterior	matrix of posterior probabilities
filters	an object of class FilterParam
object	a HMM object

Slots

granges	a GRanges object
param	a HmmParam object
posterior	a matrix of posterior probabilities
filters	a FilterParam object

See Also

[hmm2](#)

Examples

```
data(snp_exp)
hmm_list <- hmm2(snp_exp[,1])
resultsFirstSample <- hmm_list[[1]]
resultsFirstSample
HMM()
```

Description

This function is intended for estimating the integer copy number from germline or DNA of clonal origin using a 6-state HMM. The states are homozygous deletion, hemizygous deletion, diploid copy number, diploid region of homozygosity, single copy gain, and two+ copy gain. Because heterozygous markers are more informative for copy number than homozygous markers and regions of homozygosity are common in normal genomes, we currently computed a weighted average of the BAF emission matrix with a uniform 0,1 distribution by the probability that the marker is heterozygous, thereby downweighting the contribution of homozygous SNPs to the likelihood. In addition to making the detection of copy-neutral regions of homozygosity less likely, it also helps prevent confusing hemizygous deletions with copy neutral regions of homozygosity – the former would be driven mostly by the log R ratios. This is experimental and subject to change.

Usage

```
hmm2(object, emission_param = EmissionParam(),
      transition_param = TransitionParam(), ...)

## S4 method for signature SnpArrayExperiment
hmm2(object, emission_param = EmissionParam(),
      transition_param = TransitionParam(), ...)

## S4 method for signature oligoSnpSet
hmm2(object, emission_param = EmissionParam(),
      transition_param = TransitionParam(), ...)

## S4 method for signature ArrayViews
hmm2(object, emission_param = EmissionParam(),
      transition_param = TransitionParam(), tolerance = 2, verbose = FALSE,
      ...)
```

Arguments

object	A SnpArrayExperiment
emission_param	A EmissionParam object
transition_param	A TransitionParam object
...	currently ignored
tolerance	length-one numeric vector. When the difference in the log-likelihood of the Viterbi state path between successive models (updated by Baum Welch) is less than the tolerance, no additional model updates are performed.
verbose	logical. Whether to display messages indicating progress.

Details

The `hmm2` method allows parallelization across samples using the `foreach` paradigm. Parallelization is automatic when enabled via packages such as `snow/doSNOW`.

See Also

[EmissionParam](#) [TransitionParam](#)

Examples

```
tp <- TransitionParam()
TransitionParam(taup=1e12)
data(snp_exp)
emission_param <- EmissionParam(temper=1/2)
fit <- hmm2(snp_exp, emission_param)
unlist(fit)
## - the HMM states are 1 (homozygous deletion) or 2 (hemizygous deletion)
fp <- FilterParam(probability=0.5, numberFeatures=2, state=c("1", "2"))
cnvSegs(fit,fp)
## for parallelization
## Not run:
  library(snow)
  library(doSNOW)
  cl <- makeCluster(2, type = "SOCK")
  registerDoSNOW(cl)
  fit <- hmm2(snp_exp, emission_param)

## End(Not run)
```

HMMList

Constructor for HMMList class

Description

The constructor function for the HMMList class. The constructor is useful for representing a list of HMM objects.

Usage

```
HMMList(object)
```

Arguments

object a list. Each element of the list is an instance of the HMM class.

See Also

[HMMList](#) [HMM](#) [hmm2](#)

HMMList-class	<i>Class, constructor, and methods for representing HMM results from multiple samples</i>
---------------	---

Description

Each element of the HMMList contains the genomic intervals of the HMM segmentation (GRanges-derived object), parameters from the Baum-Welch, and a FilterParam object.

Usage

```
## S4 method for signature HMMList
show(object)

## S4 method for signature HMMList
unlist(x, recursive = TRUE, use.names = TRUE)
```

Arguments

object	a HMMList object
x	a HMMList object
recursive	logical; currently ignored
use.names	logical; currently ignored

Slots

.Data a list. Each element of the list should be a HMM object.

See Also

[HMM](#)

Examples

```
data(snp_exp)
fit <- hmm2(snp_exp)
class(fit)
identical(length(fit), ncol(snp_exp))
unlist(fit)
```

HmParam *Constructor for HmParam class*

Description

Contains emission probabilities, parameters for emission probabilities, and transition probabilities required for computing the most likely state path via the Viterbi algorithm

Usage

```
HmParam(emission = matrix(0, 0, 0), emission_param = EmissionParam(),
        transition = rep(0.99, nrow(emission)),
        chromosome = character(nrow(emission)), loglik = LogLik(),
        viterbi = Viterbi(), compute_posteriors = TRUE, verbose = FALSE)
```

```
## S4 method for signature HmParam
show(object)
```

```
## S4 method for signature HmParam
nrow(x)
```

```
## S4 method for signature HmParam
ncol(x)
```

Arguments

emission	A matrix of emission probabilities
emission_param	an object of class EmissionParam
transition	vector of transition probabilities whose length is N-1, where N is the number of markers. User should provide the probability that the state at marker j is the same as the state at marker j-1. It is assumed that the probability of transitioning to state_j from state_j-1 is the same for all states != state_j-1.
chromosome	character vector
loglik	an object of class LogLik
viterbi	an object of class Viterbi
compute_posteriors	logical
verbose	logical
object	a HmParam object
x	a HmParam object

Examples

```
HmParam()
```

hmmResults	<i>Example output from the hidden markov model</i>
------------	--

Description

The results of a 6-state HMM fit to simulated copy number and genotype data.

Format

a GRanges object

HmmTrellisParam	<i>Constructor for HmmTrellisParam class</i>
-----------------	--

Description

Constructor for HmmTrellisParam class

Usage

```
HmmTrellisParam(ylimits = list(c(0, 1), c(-3, 1)), expandfun = function(g) {
  width(g) * 50 })
```

Arguments

ylimits	length-two list of the y-axis limits for B allele frequencies and log R ratios, respectively
expandfun	a function that takes a length-one GRanges object as an argument and computes a width relative to the width of the GRanges object

icePlatforms	<i>List platforms for which ICE option is supported.</i>
--------------	--

Description

When processing genotypes with the **crImm**, confidence scores for the diallelic genotype calls are available. One can estimate the emission probabilities for the crImm diallelic genotypes using the confidence scores by setting the value of ICE to TRUE in the constructor for the HmmOptionList class. Currently, only certain platforms are supported for this option.

Usage

```
icePlatforms()
```

Value

A character vector of the annotation packages that are supported for the ICE option

References

Scharpf, RB et al., 2008, Annals of Applied Statistics

Examples

```
icePlatforms()
```

IdiogramParams	<i>Constructor for IdiogramParam objects</i>
----------------	--

Description

Parameters for plotting idiograms

Usage

```
IdiogramParams(seqnames = character(), seqlengths = numeric(),
  unit = "kb", genome = "hg19", box = list(color = "blue", lwd = 1))

## S4 method for signature IdiogramParams,ANY
plot(x, y, ...)
```

Arguments

seqnames	length-one character vector providing chromosome name
seqlengths	length-one numeric vector indicating size of chromosome
unit	character string indicating unit for genomic position
genome	character string indicating genome build
box	a list of parameters for plotting the box around the part of the idiogram that is plotted
x	an IdiogramParam object
y	ignored
...	ignored

Value

IdiogramParam object

IdiogramParams-class *Parameter class for plotting idiograms*

Description

Parameter class for plotting idiograms

Usage

```
## S4 method for signature IdiogramParams
show(object)
```

Arguments

object an IdiogramParam object

Slots

seqnames length-one character vector providing chromosome name
seqlengths length-one numeric vector indicating size of chromosome
unit character string indicating unit for genomic position (default is 'kb')
genome character string indicating genome build
box a list of parameters for plotting the box around the part of the idiogram that is plotted.

Examples

```
if(require(BSgenome.Hsapiens.UCSC.hg18) && require(grid)){
  si <- seqinfo(BSgenome.Hsapiens.UCSC.hg18)
  iparam <- IdiogramParams(seqnames="chr1",
                           genome="hg18",
                           seqlengths=seqlengths(si)["chr1"],
                           box=list(xlim=c(20e6L, 25e6L), color="blue", lwd=2))
  iparam
  idiogram <- plot(iparam)
  vp <- viewport(x=0.05, y=0.8, width=unit(0.9, "npc"), height=unit(0.2, "npc"),
                 name="vp1", just=c("left", "bottom"))
  grid.newpage()
  pushViewport(vp)
  print(idiogram, vp=vp, newpage=FALSE)
}
```

LogLik	<i>Constructor for LogLik class</i>
--------	-------------------------------------

Description

A container for the log likelihood of the Viterbi state path. Stores the log likelihood from successive updates of model parameters. When the difference between the log likelihoods at iteration i and $i-1$ is below the tolerance, no additional updates are performed.

Usage

```
LogLik(loglik = numeric(), tolerance = 1L)
```

Arguments

loglik	length-one numeric vector for the log likelihood of the Viterbi state path
tolerance	if the difference in the log-likelihood of the Viterbi state path after the Baum-Welch update is less than the specified tolerance, no additional Baum-Welch updates are required

See Also

[LogLik](#)

LogLik-class	<i>Classes and methods for storing/getting log-likelihoods from Viterbi algorithm</i>
--------------	---

Description

Exported for internal use by other BioC packages

Usage

```
## S4 method for signature LogLik
length(x)
```

```
## S4 method for signature LogLik
show(object)
```

Arguments

x	object of class LogLik
object	a LogLik object

Slots

loglik a numeric vector
tolerance a numeric vector

See Also

[LogLik](#)

matrixOrNULL	<i>A class allowing matrix or NULL objects</i>
--------------	--

Description

Exported for internal use by other BioC packages

NA_filter	<i>Remove SNPs with NAs in any of the low-level estimates</i>
-----------	---

Description

Remove SNPs with NAs in any of the low-level estimates

Usage

```
NA_filter(x, i)
```

Arguments

x a container for SNP data ([SnpArrayExperiment](#))
i integer vector to subset

Value

An object of the same class

numberFeatures	<i>The number of SNP/nonpolymorphic probes contained in a genomic interval</i>
----------------	--

Description

The number of SNP/nonpolymorphic probes contained in a genomic interval

Usage

numberFeatures(object)

Arguments

object see showMethods(numberFeatures)

parsedPath	<i>Complete path to directory for keeping parsed files</i>
------------	--

Description

A character string indicating the complete path for storing parsed files.

Usage

parsedPath(object)

```
## S4 method for signature ArrayViews  
parsedPath(object)
```

Arguments

object a ArrayViews object

See Also

[parseSourceFile ArrayViews](#)

[ArrayViews](#)

parseSourceFile *Function for parsing GenomeStudio files*

Description

This function parses genome studio files, writing the low-level data for log R ratios, B allele frequencies, and genotypes to disk as integers (1 file per subject per data type).

Usage

```
parseSourceFile(object, param)

## S4 method for signature ArrayViews,CopyNumScanParams
parseSourceFile(object, param)
```

Arguments

object An [ArrayViews](#) object
 param An object of class [CopyNumScanParams](#)

See Also

[ArrayViews](#) [ArrayViews](#) [CopyNumScanParams](#)

Examples

```
require(BSgenome.Hsapiens.UCSC.hg18)
require(data.table)
extdir <- system.file("extdata", package="VanillaICE", mustWork=TRUE)
features <- suppressWarnings(fread(file.path(extdir, "SNP_info.csv")))
fgr <- GRanges(paste0("chr", features$Chr), IRanges(features$Position, width=1),
               isSnp=features[["Intensity Only"]]==0)
fgr <- SnpGRanges(fgr)
names(fgr) <- features[["Name"]]
seqlevels(fgr) <- seqlevels(BSgenome.Hsapiens.UCSC.hg18)[seqlevels(BSgenome.Hsapiens.UCSC.hg18) %in% seqlevels
seqinfo(fgr) <- seqinfo(BSgenome.Hsapiens.UCSC.hg18)[seqlevels(fgr),]
fgr <- sort(fgr)
files <- list.files(extdir, full.names=TRUE, recursive=TRUE, pattern="FinalReport")
views <- ArrayViews(rowData=fgr, sourcePaths=files, parsedPath=tempdir())
show(views)

## read the first file
dat <- fread(files[1])
## information to store on the markers
select <- match(c("SNP Name", "Allele1 - AB", "Allele2 - AB", "Log R Ratio", "B Allele Freq"), names(dat))
##
## which rows to keep in the MAP file. By matching on the sorted GRanges object
## containing the feature annotation, the low-level data for the log R ratios/
## B allele frequencies will also be sorted
```



```

##
index_genome <- match(names(fgr), dat[["SNP Name"]])
scan_params <- CopyNumScanParams(index_genome=index_genome, select=select)
##
## parse the source files
##
parseSourceFile(views, scan_params)
list.files(parsedPath(views))
##
## Inspecting source data through accessors defined on the views object
##
require(oligoClasses)
## log R ratios
r <- head(lrr(views))
## B allele frequencies
b <- head(baf(views))
g <- head(genotypes(views))

```

probability	<i>Accessor for probability filter</i>
-------------	--

Description

Accessor for probability filter

Usage

```
probability(object)
```

Arguments

object	a FilterParam object
--------	----------------------

rescale	<i>Rescale a numeric vector</i>
---------	---------------------------------

Description

Rescale a numeric vector

Usage

```
rescale(x, l, u)
```

Arguments

x	numeric vector
l	lower limit of rescaled x
u	upper limit of rescaled x

rowModes	<i>Robust statistics for matrices</i>
----------	---------------------------------------

Description

Compute the column-wide or row-wise mode of numeric matrices
Compute the median absolute deviation (MAD) for the rows of a matrix

Usage

```
rowModes(x)  
colModes(x)  
rowMAD(x, ...)
```

Arguments

x	matrix
...	additional arguments to rowMedians

Value

numeric vector

See Also

[mad](#)
[mad rowMedians](#)

Examples

```
X <- matrix(rnorm(100), 10, 10)  
rowMAD(X)
```

segs	<i>Accessor for the HMM segments</i>
------	--------------------------------------

Description

Accessor to obtain all segments from the HMM.

Usage

```
segs(object)
```

Arguments

object see showMethods(segs)

Value

a GRanges-derived object

show, Viterbi-method *Show method for objects of class Viterbi*

Description

Show method for objects of class Viterbi

Usage

```
## S4 method for signature Viterbi
show(object)
```

Arguments

object a Viterbi object

snpArrayAssays *Create an assays object from log R ratios and B allele frequencies*

Description

This function is exported primarily for internal use by other BioC packages.

Usage

```
snpArrayAssays(cn = new("matrix"), baf = new("matrix"), ...)
```

Arguments

cn matrix of log R ratios
baf matrix of B allele frequencies
... additional matrices of the same dimension, such as SNP genotypes.

Examples

```
data(snp_exp)
r <- lrr(snp_exp)
b <- baf(snp_exp)
s1 <- snpArrayAssays(cn=r, baf=b)
```

SnpArrayExperiment-class

A SummarizedExperiment-derived class of marker-level SNP array data for copy number inference

Description

A SummarizedExperiment-derived class of marker-level SNP array data for copy number inference

Constructor for SnpArrayExperiment

Usage

```
SnpArrayExperiment(cn, baf, rowData = GRanges(), colData = DataFrame(),
  isSnp = logical(), ...)

## S4 method for signature missing
SnpArrayExperiment(cn, baf, rowData = GRanges(),
  colData = DataFrame(), isSnp = logical(), ...)

## S4 method for signature matrix
SnpArrayExperiment(cn, baf, rowData = GRanges(),
  colData = DataFrame(row.names = colnames(cn)), isSnp = logical(), ...)
```

Arguments

cn	matrix of copy number estimates (e.g., log R ratios)
baf	matrix of B allele frequencies
rowData	GRanges object for SNPs/nonpolymorphic markers
colData	DataFrame containing sample-level covariates
isSnp	logical vector indicating whether marker is a SNP
...	additional arguments passed to initialization method for SummarizedExperiment

Examples

```
SnpArrayExperiment()
data(snp_exp) # example
SnpArrayExperiment(cn=lrr(snp_exp), baf=baf(snp_exp),
  rowData=rowData(snp_exp))
```

SnpExperiment	<i>Constructor for SnpArrayExperiment</i>
---------------	---

Description

A single-argument generic function to construct a SnpArrayExperiment.

Usage

```
SnpExperiment(object)

## S4 method for signature ArrayViews
SnpExperiment(object)
```

Arguments

object see showMethods(SnpExperiment) for a list of supported objects

Examples

```
view <- ArrayViews()
SnpExperiment(view)
```

SnpGRanges-class	<i>An extension to GRanges for representing SNPs</i>
------------------	--

Description

An extension to GRanges for representing SNPs

Constructor for SnpGRanges class

Usage

```
SnpGRanges(object = GRanges(), isSnp, ...)

## S4 method for signature missing
SnpGRanges(object, isSnp)

## S4 method for signature GRanges
SnpGRanges(object, isSnp)
```

Arguments

object	A GRanges object
isSnp	A logical vector. Each genomic interval in the GRanges container corresponds to a marker on the genotyping array. isSnp is FALSE for nonpolymorphic markers such as those included on the Affymetrix 6.0 chips.
...	ignored

Slots

elementMetadata a SnpDataFrame

Examples

```
SnpGRanges()
g <- GRanges("chr1", IRanges(15L, 15L))
SnpGRanges(g, isSnp=TRUE)
```

snp_exp	<i>An example SnpArrayExperiment</i>
---------	--------------------------------------

Description

A container for low-level summaries used for downstream copy number estimation, including log R ratios, B allele frequencies, and genotypes

Format

a SnpArrayExperiment object

sourcePaths	<i>Accessor for file paths containing SNP-level summaries</i>
-------------	---

Description

Files containing SNP-level summaries for log R ratios, B allele frequencies, and genotypes – one sample per subject – are required.

Usage

```
sourcePaths(object)
```

Arguments

object	an ArrayViews object
--------	----------------------

Examples

```
sourcePaths(ArrayViews())
```

start,oligoSnpSet-method

Retrieve genomic location of SNPs

Description

Retrieve genomic location of SNPs

Usage

```
## S4 method for signature oligoSnpSet
start(x)
```

Arguments

x a oligoSnpSet object

state,HmmGRanges-method

Accessor for copy number state

Description

Extract the copy number state for each genomic interval.

Usage

```
## S4 method for signature HmmGRanges
state(object)
```

Arguments

object a HmmGRanges object

state-methods	<i>Accessor for the Viterbi state path</i>
---------------	--

Description

The states are represented as integers: 1=homozygous deletion, 2=hemizygous deletion, 3=diploid normal heterozygosity, 4=diploid region of homozygosity, 5=single copy gain, 6=two or more copy gain.

Usage

```
## S4 method for signature Viterbi
state(object)
```

Arguments

object	a Viterbi object
--------	------------------

sweepMode	<i>Sweep the modal log R ratio (by row or column) from a matrix of log R ratios</i>
-----------	---

Description

This function simplifies the process of sweeping the modal log R ratio from the rows or columns of a SnpArrayExperiment object. It is most useful when a large number of samples (more than 10) are available and the dataset is a collection of germline samples. We assume that the samples are from a single batch and that the modal value will be a robust estimate of the mean log R ratio for diploid copy number. Variation in the modal estimates between markers is presumed to be attributable to probe effects (e.g., differences hybridization efficiency/PCR do to sequence composition). For sex chromosomes, one should apply this function separately to men and women and then recenter the resulting matrix according to the expected copy number.

Usage

```
sweepMode(x, MARGIN)

## S4 method for signature SnpArrayExperiment
sweepMode(x, MARGIN)
```

Arguments

x	see showMethods(sweepMode)
MARGIN	integer indicating which margin (1=rows, 2=columns) to sweep the mode

Value

an object of the same class as x

Examples

```
data(snp_exp)
snp_exp_rowcentered <- sweepMode(snp_exp, 1)
snp_exp_colcentered <- sweepMode(snp_exp, 2)
x <- lrr(snp_exp)
x_rowcentered <- sweep(x, 1, rowModes(x))
all.equal(lrr(snp_exp_rowcentered), x_rowcentered)
```

threshold	<i>Threshold numeric values</i>
-----------	---------------------------------

Description

Threshold numeric values according to user-specific limits. The thresholded values can also be jittered near the limits.

Usage

```
threshold(x, lim = c(-Inf, Inf), amount = 0)
```

Arguments

x	numeric matrix or vector
lim	limit at which to threshold entries in x
amount	see jitter

See Also

[jitter](#)

Examples

```
x <- rnorm(1000, 0, 3)
y <- threshold(x, c(-5,5))
range(y)
```

TransitionParam *Constructor for TransitionParam class*

Description

Contains parameters for computing transition probabilities

Usage

```
TransitionParam(taup = 1e+10, taumax = 1 - 5e+06)
```

```
## S4 method for signature TransitionParam
show(object)
```

Arguments

taup	length-one numeric vector
taumax	The maximum probability that the current state is the same as the preceding state. See details
object	a TransitionParam object

Details

Diagonal elements of the transition probability matrix are computed as $e^{-2*d/taup}$, where d is the distance between markers i and $i-1$ and $taup$ is typically in the range of $1e10$. This probability is constrained to be no larger than $taumax$. The probabilities on the off-diagonal elements are the same and are subject to the constraint that the rows of the transition probability matrix sum to 1.

Examples

```
TransitionParam()
## higher values of taup make transitions between states less likely
TransitionParam(taup=1e12)
```

updateHmmParams *Run the Baum-Welch algorithm to update HMM parameters*

Description

This function is not intended to be called directly by the user. It is exported in the package NAMESPACE for internal use by other BioC packages.

Usage

```
updateHmmParams(object, emission_param = EmissionParam(),
  transition_param = TransitionParam())
```

Arguments

object a [SnpArrayExperiment](#) object
emission_param a [EmissionParam](#) object
transition_param
a [TransitionParam](#) object

VanillaICE	<i>A hidden markov model for detection of germline copy number variants from arrays</i>
------------	---

Description

A hidden markov model for detection of germline copy number variants from arrays

viewports	<i>Default viewports for plotting CNV data with lattice-style graphics</i>
-----------	--

Description

Default viewports for plotting CNV data with lattice-style graphics

Usage

```
viewports()
```

Value

list

See Also

[xyplotList](#) [xygrid](#)

Examples

```
vps <- viewports()
```

viterbi2Wrapper

Wrapper function for fitting the viterbi algorithm

Description

The viterbi algorithm, implemented in C, estimates the optimal state path as well as the forward and backward variables that are used for updating the mean and variances in a copy number HMM. The function `viterbi2Wrapper` should not be called directly by the user. Rather, users should fit the HMM by passing an appropriate container to the method `hmm`. We document the `viterbi2Wrapper` arguments as several of the arguments can be modified from their default value when passed from the `hmm` method through the `...`. In particular, `nupdates`, `p.hom`, and `prOutlierBaf`.

Usage

```
viterbi2Wrapper(index.samples, cnStates, prOutlierBAF = list(initial = 1e-05,
  max = 0.001, maxROH = 1e-05), p.hom = 0.05, is.log, limits,
  normalIndex = 3L, nupdates = 10, tolerance = 5, computeLLR = TRUE,
  returnEmission = FALSE, verbose = FALSE, grFun, matrixFun, snp.index,
  anyNP)
```

Arguments

<code>index.samples</code>	Index for the samples that are to be processed.
<code>cnStates</code>	numeric vector for the initial copy number state means.
<code>prOutlierBAF</code>	A list with elements 'initial', 'max', and 'maxROH' corresponding to the initial estimate of the probability that a B allele frequency (BAF) is an outlier, the maximum value for this parameter over states that do not involve homozygous genotypes, and the maximum value over states that assume homozygous genotypes. This parameter is experimental and could be used to fine tune the HMM for different platforms. For example, the BAFs for the Affy platform are typically more noisy than the BAFs for Illumina. One may want to set small values of these parameters for Illumina (e.g, 1e-5, 1e-3, and 1e-5) and larger values for Affy (e.g., 1e-3, 0.01, 1e-3).
<code>p.hom</code>	numeric: weight for observing homozygous genotypes. For value 0, homozygous genotypes / B allele frequencies have the same emission probability in the 'normal' state as in the states hemizygous deletion and in copy-neutral region of homozygosity. Regions of homozygosity are common in normal genomes. For small values of <code>p.hom</code> , hemizygous deletions will only be called if the copy number estimates show evidence of a decrease from normal.
<code>is.log</code>	logical: Whether the copy number estimates in the <code>r</code> matrix are on the log-scale.
<code>limits</code>	numeric vector of length two specifying the range of the copy number estimates in <code>r</code> . Values of <code>r</code> outside of this range are truncated. See <code>copyNumberLimits</code> .

normalIndex	integer specifying the index for the normal state. Note that states must be ordered by the mean of the copy number state. E.g., state 1 is homozygous deletion (0 copies), state 2 is hemizygous deletion (1 copy), normal (2 copies), ... In a 6-state HMM, normalIndex should be 3.
nupdates	integer specifying the maximum number of iterations for reestimating the mean and variance for each of the copy number states. The number of iterations may be fewer than nupdates if the difference in the log-likelihood between successive iterations is less than tolerance.
tolerance	numeric value for indicating convergence of the log-likelihood. If the difference in the log-likelihood of the observed data given the HMM model at iteration i and $i-1$ is less than tolerance, no additional updates of model parameters using the EM algorithm is needed.
computeLLR	Logical. Whether to compute a log likelihood ratio (LLR) comparing the predicted state to the normal state. This is calculated post-hoc and is not precisely the likelihood estimated from the Viterbi algorithm. When FALSE, the LLR is not calculated and the algorithm is slightly faster.
returnEmission	Logical. If TRUE, an array of emission probabilities are returned. The dimensions of the array are SNPs, samples, and copy number states.
verbose	Logical. Whether to print some of the details of the processing.
grFun	An R function for coercing the state-path from the HMM to a GRanges object. Takes advantage of lexical scope.
matrixFun	An R function for subsetting the assay data (takes advantage of lexical scope).
snp.index	The SNP indices
anyNP	An indicator for whether any of the markers are nonpolymorphic, and therefore BAFs / genotypes are ignored

Value

A GRanges object if returnEmission is FALSE. Otherwise, an array of emission probabilities is returned.

xyplotList *Lattice-style plots for granges and SnpArrayExperiment objects*

Description

Data for the graphic is generated by a call to grangesData.

Usage

```
xyplotList(granges, se, param = HmmTrellisParam())
```

```
## S4 method for signature HmmGRanges,SnpArrayExperiment
xyplotList(granges, se,
```

```

param = HmmTrellisParam()

## S4 method for signature GRangesList,SnpArrayExperiment
xyplotList(granges, se,
  param = HmmTrellisParam())

xygrid(trellis_plot, viewports, granges)

```

Arguments

granges	a HmmGRanges object
se	a SnpArrayExperiment
param	trellis parameters for plotting HMM
trellis_plot	an object of class trellis
viewports	a list of viewports as provided by the viewports function

See Also

[viewports](#)

Examples

```

snp_exp <- getExampleSnpExperiment()
seqlevels(snp_exp, force=TRUE) <- "chr22"
fit <- hmm2(snp_exp)
g <- reduce(hemizygous(fit), min.gapwidth=500e3)
trellis_param <- HmmTrellisParam()
fig <- xyplotList(g, snp_exp, trellis_param)
vps <- viewports()
xygrid(fig[[1]], vps, g)

```

[[,oligoSetList,ANY,ANY-method
Subset method for deprecated oligoSetList

Description

The oligoSetList class is deprecated. Use [SnpArrayExperiment](#) instead.

Usage

```

## S4 method for signature oligoSetList,ANY,ANY
x[[i, j, ..., exact = TRUE]]

```

Arguments

x	a oligoSetList object
i	A length-one numeric vector specifying which chromosome to extract
j	A numeric vector specifying samples to extract (optional)
...	Ignored
exact	Ignored

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