Package ‘Signac’

December 8, 2021

Title  Analysis of Single-Cell Chromatin Data
Version 1.5.0
Date 2021-12-07
Description  A framework for the analysis and exploration of single-cell chromatin data. The 'Signac' package contains functions for quantifying single-cell chromatin data, computing per-cell quality control metrics, dimension reduction and normalization, visualization, and DNA sequence motif analysis.
Depends  R (>= 4.0.0), methods
License MIT + file LICENSE
Encoding UTF-8
LazyData true
RoxygenNote 7.1.2
BugReports https://github.com/timoast/signac/issues
LinkingTo Rcpp
Imports GenomeInfoDb, GenomicRanges, IRanges, Matrix, Rsamtools, S4Vectors, Seurat (>= 4.0.0), SeuratObject (>= 4.0.0), data.table, dplyr (>= 1.0.0), future, future.apply, ggplot2, ggseqlogo, irlba, pbapply, tidyr, patchwork, stats, utils, BiocGenerics, ggrepel, stringi, fastmatch, lsa, RcppRoll, scales, Rcpp, ggforce, qclMatrix, grid
Collate 'RcppExports.R' 'data.R' 'differential_accessibility.R'
 'generics.R' 'dimension_reduction.R' 'footprinting.R'
 'fragments.R' 'genomeinfodb-methods.R' 'granges-methods.R'
 'iranges-methods.R' 'links.R' 'mtos.R' 'motifs.R' 'objects.R'
 'peaks.R' 'preprocessing.R' 'quantification.R' 'utilities.R'
 'visualization.R' 'zzz.R'
Suggests testthat (>= 2.1.0), chromVAR, SummarizedExperiment,
TFBSTools, motifmatchr, BSgenome, shiny, miniUI, rtracklayer,
birovizBase, Biostats
NeedsCompilation: yes

Author: Tim Stuart [aut, cre] (<https://orcid.org/0000-0002-3044-0897>),
Avi Srivastava [aut] (<https://orcid.org/0000-0001-9798-2079>),
Paul Hoffman [ctb] (<https://orcid.org/0000-0002-7693-8957>),
Rahul Satija [ctb] (<https://orcid.org/0000-0001-9448-8833>)

Maintainer: Tim Stuart <tstuart@nygenome.org>

Repository: CRAN

Date/Publication: 2021-12-08 17:40:06 UTC

R topics documented:

- Signac-package ................................................................. 4
- AccessiblePeaks ................................................................. 5
- AddChromatinModule ........................................................... 6
- AddMotifs .......................................................... 6
- AggregateTiles ................................................................. 7
- AlleleFreq .......................................................... 9
- Annotation ........................................................... 10
- AnnotationPlot ............................................................... 11
- as.ChromatinAssay .......................................................... 11
- atac_small ................................................................. 12
- AverageCounts ............................................................... 13
- BigwigTrack .............................................................. 14
- BinarizeCounts ............................................................... 15
- blacklist_ce10 ............................................................... 16
- blacklist_ce11 ............................................................... 16
- blacklist_dm3 ............................................................... 17
- blacklist_dm6 ............................................................... 17
- blacklist_hg19 ............................................................... 18
- blacklist_hg38 ............................................................... 18
- blacklist_hg38_unified ..................................................... 19
- blacklist_mm10 ............................................................... 19
- CallPeaks ............................................................... 20
- Cells.Fragment ............................................................. 23
- Cells<- ................................................................. 23
- CellsPerGroup ........................................................... 24
- ChromatinAssay-class ...................................................... 24
- ClosestFeature ............................................................. 25
- ClusterClonotypes .......................................................... 25
- CombineTracks .............................................................. 26
- ConnectionsToLinks ........................................................ 27
- ConvertMotifID .............................................................. 28
- CountFragments ............................................................ 29
- CountsInRegion ............................................................. 29
- coverage.ChromatinAssay-method ...................................... 30
- CoverageBrowser .......................................................... 31
### R topics documented:

- CoveragePlot ................................................. 32
- CreateChromatinAssay ...................................... 35
- CreateFragmentObject ...................................... 37
- CreateMotifMatrix ......................................... 38
- CreateMotifObject ......................................... 39
- DepthCor .................................................... 40
- DownsampleFeatures ....................................... 41
- ExpressionPlot .............................................. 41
- Extend ....................................................... 42
- FeatureMatrix .............................................. 43
- FilterCells .................................................. 44
- FindClonotypes ............................................. 45
- FindMotifs .................................................. 46
- findOverlaps-methods ...................................... 47
- FindTopFeatures ............................................ 50
- Footprint .................................................... 51
- FractionCountsInRegion .................................... 53
- Fragment-class ............................................. 54
- FragmentHistogram ......................................... 54
- Fragments .................................................... 55
- FRiP .......................................................... 56
- GeneActivity .................................................. 57
- GenomeBinMatrix ............................................ 58
- GetCellsInRegion .......................................... 59
- GetFootprintData ............................................ 60
- GetFragmentData ............................................ 60
- GetGRangesFromEnsDb ...................................... 61
- GetIntersectingFeatures ................................... 61
- GetLinkedGenes ............................................. 62
- GetLinkedPeaks ............................................. 63
- GetMotifData ................................................ 63
- GetTSSPositions .......................................... 64
- granges-methods .......................................... 65
- GRangesToString ............................................ 66
- head.Fragment .............................................. 66
- IdentifyVariants .......................................... 67
- InsertionBias ............................................... 68
- inter-range-methods ....................................... 69
- IntersectMatrix ............................................. 71
- Jaccard ...................................................... 72
- LinkPeaks .................................................... 72
- LinkPlot ..................................................... 74
- Links ........................................................ 75
- LookupGeneCoords ......................................... 76
- MatchRegionStats .......................................... 76
- Motif-class .................................................. 77
- MotifPlot .................................................... 78
- Motifs ....................................................... 79
Signac-package

Description


Author(s)

Maintainer: Tim Stuart <tstuart@nygenome.org> (ORCID)

Authors:

- Avi Srivastava <asrivastava@nygenome.org> (ORCID)

Other contributors:

- Paul Hoffman <phoffman@nygenome.org> (ORCID) [contributor]
- Rahul Satija <rsatija@nygenome.org> (ORCID) [contributor]
AccessiblePeaks

See Also

Useful links:

- https://github.com/timoast/signac
- https://satijalab.org/signac
- Report bugs at https://github.com/timoast/signac/issues

| AccessiblePeaks | Accessible peaks |

Description

Find accessible peaks in a set of cells

Usage

AccessiblePeaks(
  object,
  assay = NULL,
  idents = NULL,
  cells = NULL,
  min.cells = 10
)

Arguments

| object | A Seurat object |
| assay  | Name of assay to use |
| idents | A set of identity classes to find accessible peaks for |
| cells  | A vector of cells to find accessible peaks for |
| min.cells | Minimum number of cells with the peak accessible (>0 counts) for the peak to be called accessible |

Value

Returns a vector of peak names
**AddChromatinModule**  
*Add chromatin module*

**Description**

Compute chromVAR deviations for groups of peaks. The goal of this function is similar to that of **AddModuleScore** except that it is designed for single-cell chromatin data. The chromVAR deviations for each group of peaks will be added to the object metadata.

**Usage**

```
AddChromatinModule(object, features, genome, assay = NULL, verbose = TRUE, ...)  
```

**Arguments**

- `object`: A Seurat object
- `features`: A named list of features to include in each module. The name of each element in the list will be used to name the modules computed, which will be stored in the object metadata.
- `genome`: A BSgenome object
- `assay`: Name of assay to use. If NULL, use the default assay.
- `verbose`: Display messages
- `...`: Additional arguments passed to RunChromVAR

**Value**

Returns a Seurat object

**AddMotifs**  
*Add DNA sequence motif information*

**Description**

Construct a Motif object containing DNA sequence motif information and add it to an existing Seurat object or ChromatinAssay. If running on a Seurat object, AddMotifs will also run RegionStats to compute the GC content of each peak and store the results in the feature metadata.
Usage

AddMotifs(object, ...)  

## Default S3 method:  
AddMotifs(object, genome, pfm, verbose = TRUE, ...)  

## S3 method for class 'ChromatinAssay'  
AddMotifs(object, genome, pfm, verbose = TRUE, ...)  

## S3 method for class 'Seurat'  
AddMotifs(object, genome, pfm, assay = NULL, verbose = TRUE, ...)  

Arguments

object A Seurat object or ChromatinAssay object  
... Additional arguments passed to other methods  
genome A BSgenome, DNAStringSet, FaFile, or string stating the genome build recognized by getBSgenome.  
pfm A PFMatrixList or PWMatrixList object containing position weight/frequency matrices to use  
verbose Display messages  
assay Name of assay to use. If NULL, use the default assay  

Value

When running on a ChromatinAssay or Seurat object, returns a modified version of the input object. When running on a matrix, returns a Motif object.

AggregateTiles

Quantify aggregated genome tiles

Description

Quantifies fragment counts per cell in fixed-size genome bins across the whole genome, then removes bins with less than a desired minimum number of counts in the bin, then merges adjacent tiles into a single region.

Usage

AggregateTiles(object, ...)  

## S3 method for class 'Seurat'  
AggregateTiles(  
  object,  
genome,
## AggregateTiles

```r
assay = NULL,
new.assay.name = "tiles",
min_counts = 5,
binsize = 5000,
verbose = TRUE,
...
)
```

### S3 method for class 'ChromatinAssay'

```r
AggregateTiles(
  object,
  genome,
  min_counts = 5,
binsize = 5000,
verbose = TRUE,
...
)
```

### Default S3 method:

```r
AggregateTiles(
  object,
  genome,
  cells = NULL,
min_counts = 5,
binsize = 5000,
verbose = TRUE,
...
)
```

### Arguments

- **object**
  A Seurat object or ChromatinAssay object

- **...**
  Additional arguments passed to other methods

- **genome**
  A vector of chromosome sizes for the genome. This is used to construct the genome bin coordinates. The can be obtained by calling `seqlengths` on a BSgenome-class object.

- **assay**
  Name of assay to use

- **new.assay.name**
  Name of new assay to create containing aggregated genome tiles

- **min_counts**
  Minimum number of counts for a tile to be retained prior to aggregation

- **binsize**
  Size of the genome bins (tiles) in base pairs

- **verbose**
  Display messages

- **cells**
  Cells to include

### Value

When running on a Seurat object, returns the Seurat object with a new ChromatinAssay added.
When running on a ChromatinAssay, returns a new ChromatinAssay containing the aggregated genome tiles.
When running on a fragment file, returns a sparse region x cell matrix.

---

**AlleleFreq**    
*Compute allele frequencies per cell*

**Description**
Collapses allele counts for each strand and normalize by the total number of counts at each nucleotide position.

**Usage**

```r
AlleleFreq(object, ...)  # Default S3 method:
AlleleFreq(object, variants, ...)  # S3 method for class 'Assay'
AlleleFreq(object, variants, assay = NULL, new.assay.name = "alleles", ...)  # S3 method for class 'Seurat'
```

**Arguments**

- `object`  
  A Seurat object, Assay, or matrix
- `...`  
  Arguments passed to other methods
- `variants`  
  A character vector of informative variants to keep. For example, c("627G>A", "709G>A", "1045G>A", "1793G>A").
- `assay`  
  Name of assay to use
- `new.assay.name`  
  Name of new assay to store variant data in

**Value**

Returns a Seurat object with a new assay containing the allele frequencies for the informative variants.
Description

Get the annotation from a ChromatinAssay

Usage

Annotation(object, ...)

Annotation(object, ...) <- value

## S3 method for class 'ChromatinAssay'
Annotation(object, ...)

## S3 method for class 'Seurat'
Annotation(object, ...)

## S3 replacement method for class 'ChromatinAssay'
Annotation(object, ...) <- value

## S3 replacement method for class 'Seurat'
Annotation(object, ...) <- value

Arguments

object  A Seurat object or ChromatinAssay object

...  Arguments passed to other methods

value  A value to set. Can be NULL, to remove the current annotation information, or a GRanges object. If a GRanges object is supplied and the genome information is stored in the assay, the genome of the new annotations must match the genome of the assay.

Value

Returns a GRanges object if the annotation data is present, otherwise returns NULL

Examples

Annotation(atac_small[['peaks']])

Annotation(atac_small)

genes <- Annotation(atac_small)
AnnotationPlot

```r
Annotation(atac_small["peaks"])) <- genes
genes <- Annotation(atac_small)
Annotation(atac_small) <- genes
```

---

AnnotationPlot

**Plot gene annotations**

**Description**

Display gene annotations in a given region of the genome.

**Usage**

```r
AnnotationPlot(object, region)
```

**Arguments**

- `object`  
  A *Seurat* object

- `region`  
  A genomic region to plot

**Value**

Returns a *ggplot* object

**Examples**

```r
AnnotationPlot(object = atac_small, region = c("chr1-29554-39554"))
```

---

as.ChromatinAssay

**Convert objects to a ChromatinAssay**

**Description**

Convert objects to a ChromatinAssay
Usage

as.ChromatinAssay(x, ...)

## S3 method for class 'Assay'
as.ChromatinAssay(
  x,
  ranges = NULL,
  seqinfo = NULL,
  annotation = NULL,
  motifs = NULL,
  fragments = NULL,
  bias = NULL,
  positionEnrichment = NULL,
  sep = c("-", "-"),
  ...
)

Arguments

x An object to convert to class ChromatinAssay
...
Arguments passed to other methods
ranges A GRanges object
seqinfo A Seqinfo object containing basic information about the genome used. Alternatively, the name of a UCSC genome can be provided and the sequence information will be downloaded from UCSC.
annotation Genomic annotation
motifs A Motif object
fragments A list of Fragment objects
bias Tn5 integration bias matrix
positionEnrichment A named list of position enrichment matrices.
sep Characters used to separate the chromosome, start, and end coordinates in the row names of the data matrix

atac_small A small example scATAC-seq dataset

Description
A subsetted version of 10x Genomics 10k human (hg19) PBMC scATAC-seq dataset

Usage

atac_small
AverageCounts

Format

A Seurat object with the following assays

- **peaks** A peak x cell dataset
- **bins** A 5 kb genome bin x cell dataset
- **RNA** A gene x cell dataset

Source

https://support.10xgenomics.com/single-cell-atac/datasets/1.1.0/atac_v1_pbmc_10k

<table>
<thead>
<tr>
<th>AverageCounts</th>
<th>Average Counts</th>
</tr>
</thead>
</table>

Description

Compute the mean counts per group of cells for a given assay

Usage

```r
AverageCounts(object, assay = NULL, group.by = NULL, verbose = TRUE)
```

Arguments

- **object** A Seurat object
- **assay** Name of assay to use. Default is the active assay
- **group.by** Grouping variable to use. Default is the active identities
- **verbose** Display messages

Value

Returns a dataframe

Examples

```r
AverageCounts(atac_small)
```
BigwigTrack  

Plot data from BigWig

Description

Create a BigWig track. Note that this function does not work on windows.

Usage

BigwigTrack(
  region, 
  bigwig, 
  smooth = 200, 
  type = "coverage", 
  y_label = "Score", 
  max.downsample = 3000, 
  downsample.rate = 0.1 
)

Arguments

region  
GRanges object specifying region to plot

bigwig  
Path to a bigwig file

smooth  
Number of bases to smooth data over (rolling mean). If NULL, do not apply smoothing.

type  
Plot type. Can be one of "line", "heatmap", or "coverage"

y_label  
Y-axis label

max.downsample  
Minimum number of positions kept when downsampling. Downsampling rate is adaptive to the window size, but this parameter will set the minimum possible number of positions to include so that plots do not become too sparse when the window size is small.

downsample.rate  
Fraction of positions to retain when downsampling. Retaining more positions can give a higher-resolution plot but can make the number of points large, resulting in larger file sizes when saving the plot and a longer period of time needed to draw the plot.
BinarizeCounts

Binarize counts

Description

Set counts >1 to 1 in a count matrix

Usage

BinarizeCounts(object, ...)

## Default S3 method:
BinarizeCounts(object, assay = NULL, verbose = TRUE, ...)

## S3 method for class 'Assay'
BinarizeCounts(object, assay = NULL, verbose = TRUE, ...)

## S3 method for class 'Seurat'
BinarizeCounts(object, assay = NULL, verbose = TRUE, ...)

Arguments

object A Seurat object

... Arguments passed to other methods

assay Name of assay to use. Can be a list of assays, and binarization will be applied to each.

verbose Display messages

Value

Returns a Seurat object

Examples

x <- matrix(data = sample(0:3, size = 25, replace = TRUE), ncol = 5)
BinarizeCounts(x)
BinarizeCounts(atac_small[['peaks']])
BinarizeCounts(atac_small)
<table>
<thead>
<tr>
<th>blacklist_ce10</th>
<th>Genomic blacklist regions for C. elegans ce10 (0-based)</th>
</tr>
</thead>
</table>

**Description**
Genomic blacklist regions for C. elegans ce10 (0-based)

**Usage**
blacklist_ce10

**Format**
A GRanges object

**Source**
https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z

<table>
<thead>
<tr>
<th>blacklist_ce11</th>
<th>Genomic blacklist regions for C. elegans ce11 (0-based)</th>
</tr>
</thead>
</table>

**Description**
Genomic blacklist regions for C. elegans ce11 (0-based)

**Usage**
blacklist_ce11

**Format**
A GRanges object

**Source**
https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z
**blacklist_dm3**

**Genomic blacklist regions for Drosophila dm3 (0-based)**

**Description**

Genomic blacklist regions for Drosophila dm3 (0-based)

**Usage**

blacklist_dm3

**Format**

A GRanges object

**Source**

https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z

---

**blacklist_dm6**

**Genomic blacklist regions for Drosophila dm6 (0-based)**

**Description**

Genomic blacklist regions for Drosophila dm6 (0-based)

**Usage**

blacklist_dm6

**Format**

A GRanges object

**Source**

https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z
<table>
<thead>
<tr>
<th>blacklist_hg19</th>
<th>Genomic blacklist regions for Human hg19 (0-based)</th>
</tr>
</thead>
</table>

**Description**
Genomic blacklist regions for Human hg19 (0-based)

**Usage**
blacklist_hg19

**Format**
A GRanges object

**Source**
https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z

<table>
<thead>
<tr>
<th>blacklist_hg38</th>
<th>Genomic blacklist regions for Human GRCh38</th>
</tr>
</thead>
</table>

**Description**
Genomic blacklist regions for Human GRCh38

**Usage**
blacklist_hg38

**Format**
A GRanges object

**Source**
https://github.com/Boyle-Lab/Blacklist
doi: 10.1038/s4159801945839z
blacklist_hg38_unified

*Unified genomic blacklist regions for Human GRCh38*

**Description**

Manually curated genomic blacklist regions for the hg38 genome by Anshul Kundaje and Anna Shcherbina. See [https://www.encodeproject.org/files/ENCFF356LFX/](https://www.encodeproject.org/files/ENCFF356LFX/) for a description of how this blacklist was curated.

**Usage**

blacklist_hg38_unified

**Format**

A GRanges object

**Author(s)**

Anshul Kundaje  
Anna Shcherbina

**Source**

[https://www.encodeproject.org/files/ENCFF356LFX/](https://www.encodeproject.org/files/ENCFF356LFX/)  
doi: 10.1038/s4159801945839z

blacklist_mm10  
*Genomic blacklist regions for Mouse mm10 (0-based)*

**Description**

Genomic blacklist regions for Mouse mm10 (0-based)

**Usage**

blacklist_mm10

**Format**

A GRanges object

**Source**

[https://github.com/Boyle-Lab/Blacklist](https://github.com/Boyle-Lab/Blacklist)  
doi: 10.1038/s4159801945839z
CallPeaks

Call peaks

Description

Call peaks using MACS. Fragment files linked to the specified assay will be used to call peaks. If multiple fragment files are present, all will be used in a single MACS invocation. Returns the .narrowPeak MACS output as a GRanges object.

Usage

CallPeaks(object, ...)

## S3 method for class 'Seurat'
CallPeaks(
  object,
  assay = NULL,
  group.by = NULL,
  idents = NULL,
  macs2.path = NULL,
  broad = FALSE,
  format = "BED",
  outdir = tempdir(),
  fragment.tempdir = tempdir(),
  combine.peaks = TRUE,
  effective.genome.size = 2.7e+09,
  extsize = 200,
  shift = -extsize/2,
  additional.args = NULL,
  name = Project(object),
  cleanup = TRUE,
  verbose = TRUE,
  ...
)

## S3 method for class 'ChromatinAssay'
CallPeaks(
  object,
  macs2.path = NULL,
  outdir = tempdir(),
  broad = FALSE,
  format = "BED",
  effective.genome.size = 2.7e+09,
  extsize = 200,
  shift = -extsize/2,
  additional.args = NULL,
  name = "macs2",
...
CallPeaks

```r
CallPeaks(
  object,
  macs2.path = NULL,
  outdir = tempdir(),
  broad = FALSE,
  format = "BED",
  effective.genome.size = 2.7e+09,
  extsize = 200,
  shift = -extsize/2,
  additional.args = NULL,
  name = "macs2",
  cleanup = TRUE,
  verbose = TRUE,
  ...
)
```

## Default S3 method:
CallPeaks(
  object,
  macs2.path = NULL,
  outdir = tempdir(),
  broad = FALSE,
  format = "BED",
  effective.genome.size = 2.7e+09,
  extsize = 200,
  shift = -extsize/2,
  additional.args = NULL,
  name = "macs2",
  cleanup = TRUE,
  verbose = TRUE,
  ...
)

### Arguments

- **object**: A Seurat object, ChromatinAssay object, Fragment object, or the path to fragment file/s.
- **...**: Arguments passed to other methods
- **assay**: Name of assay to use
- **group.by**: Grouping variable to use. If set, peaks will be called independently on each group of cells and then combined. Note that to call peaks using subsets of cells we first split the fragment file/s used, so using a grouping variable will require
extra time to split the files and perform multiple MACS peak calls, and will store additional files on-disk that may be large. Note that we store split fragment files in the temp directory (`tempdir`) by default, and if the program is interrupted before completing these temporary files will not be removed. If NULL, peaks are called using all cells together (pseudobulk).

- **idents**: List of identities to include if grouping cells (only valid if also setting the `group.by` parameter). If NULL, peaks will be called for all cell identities.
- **macs2.path**: Path to MACS program. If NULL, try to find MACS automatically.
- **broad**: Call broad peaks (`--broad` parameter for MACS)
- **format**: File format to use. Should be either "BED" or "BEDPE" (see MACS documentation).
- **outdir**: Path for output files
- **fragment.tempdir**: Path to write temporary fragment files. Only used if `group.by` is not NULL.
- **combine.peaks**: Controls whether peak calls from different groups of cells are combined using `GenomicRanges::reduce` when calling peaks for different groups of cells (`group.by` parameter). If FALSE, a list of `GRanges` object will be returned. Note that metadata fields such as the p-value, q-value, and fold-change information for each peak will be lost if combining peaks.
- **effective.genome.size**: Effective genome size parameter for MACS (`-g`). Default is the human effective genome size (2.7e9).
- **extsize**: `extsize` parameter for MACS. Only relevant if `format="BED"`
- **shift**: `shift` parameter for MACS. Only relevant if `format="BED"
- **additional.args**: Additional arguments passed to MACS. This should be a single character string
- **name**: Name for output MACS files. This will also be placed in the name field in the `GRanges` output.
- **cleanup**: Remove MACS output files
- **verbose**: Display messages

**Details**

See [https://macs3-project.github.io/MACS/](https://macs3-project.github.io/MACS/) for MACS documentation.

If you call peaks using MACS2 please cite: doi: 10.1186/gb200899r137

**Value**

Returns a `GRanges` object
Cells.Fragment

Set and get cell barcode information for a Fragment object

Description

This returns the names of cells in the object that are contained in the fragment file. These cell barcodes may not match the barcodes present in the fragment file. The Fragment object contains an internal mapping of the cell names in the ChromatinAssay object to the cell names in the fragment file, so that cell names can be changed in the assay without needing to change the cell names on disk.

Usage

## S3 method for class 'Fragment'
Cells(x, ...)

## S3 replacement method for class 'Fragment'
Cells(x, ...) <- value

Arguments

- **x**: A Fragment object
- **...**: Arguments passed to other methods
- **value**: A vector of cell names to store in the Fragment object

Details

To access the cell names that are stored in the fragment file itself, use GetFragmentData(object = x, name = "cells").

Cells<-  

Set and get cell barcode information for a Fragment object

Description

Set and get cell barcode information for a Fragment object

Usage

Cells(x, ...) <- value

Arguments

- **x**: A Seurat object
- **...**: Arguments passed to other methods
- **value**: A character vector of cell barcodes
CellsPerGroup

**Description**

Count the number of cells in each group

**Usage**

CellsPerGroup(object, group.by = NULL)

**Arguments**

- `object` A Seurat object
- `group.by` A grouping variable. Default is the active identities

**Value**

Returns a vector

**Examples**

CellsPerGroup(atac_small)

---

ChromatinAssay-class

**Description**

The ChromatinAssay object is an extended Assay for the storage and analysis of single-cell chromatin data.

**Slots**

- `ranges` A GRanges object describing the genomic location of features in the object
- `motifs` A Motif object
- `fragments` A list of Fragment objects.
- `seqinfo` A Seqinfo object containing basic information about the genome sequence used.
- `annotation` A GRanges object containing genomic annotations
- `bias` A vector containing Tn5 integration bias information (frequency of Tn5 integration at different kmers)
- `positionEnrichment` A named list of matrices containing positional enrichment scores for Tn5 integration (for example, enrichment at the TSS)
- `links` A GRanges object describing linked genomic positions, such as co-accessible sites or enhancer-gene regulatory relationships. This should be a GRanges object, where the start and end coordinates are the two linked genomic positions, and must contain a "score" metadata column.
**ClosestFeature**

**Description**

Find the closest feature to a given set of genomic regions

**Usage**

`ClosestFeature(object, regions, annotation = NULL, ...)`

**Arguments**

- **object**
  - A Seurat object
- **regions**
  - A set of genomic regions to query
- **annotation**
  - A GRanges object containing annotation information. If NULL, use the annotations stored in the object.
- **...**
  - Additional arguments passed to `StringToGRanges`

**Value**

Returns a dataframe with the name of each region, the closest feature in the annotation, and the distance to the feature.

**Examples**

```r
ClosestFeature(
  object = atac_small,
  regions = head(granges(atac_small))
)
```

**ClusterClonotypes**

**Find relationships between clonotypes**

**Description**

Perform hierarchical clustering on clonotype data

**Usage**

`ClusterClonotypes(object, assay = NULL, group.by = NULL)`
Arguments

- object: A Seurat object
- assay: Name of assay to use
- group.by: Grouping variable for cells

Value

Returns a list containing two objects of class hclust, one for the cell clustering and one for the feature (allele) clustering.

Description

This can be used to combine coverage plots, peak region plots, gene annotation plots, and linked element plots. The different tracks are stacked on top of each other and the x-axis combined.

Usage

CombineTracks(plotlist, expression.plot = NULL, heights = NULL, widths = NULL)

Arguments

- plotlist: A list of plots to combine. Must be from the same genomic region.
- expression.plot: Plot containing gene expression information. If supplied, this will be placed to the left of the coverage tracks and aligned with each track.
- heights: Relative heights for each plot. If NULL, the first plot will be 8x the height of the other tracks.
- widths: Relative widths for each plot. Only required if adding a gene expression panel. If NULL, main plots will be 8x the width of the gene expression panel.

Value

Returns a patchworked ggplot2 object

Examples

```r
p1 <- PeakPlot(atac_small, region = "chr1-29554-39554")
p2 <- AnnotationPlot(atac_small, region = "chr1-29554-39554")
CombineTracks(plotlist = list(p1, p2), heights = c(1, 1))
```
ConnectionsToLinks  Cicero connections to links

Description

Convert the output of Cicero connections to a set of genomic ranges where the start and end coordinates of the range are the midpoints of the linked elements. Only elements on the same chromosome are included in the output.

Usage

ConnectionsToLinks(conns, ccans = NULL, threshold = 0, sep = c("-", "-"))

Arguments

conns  A dataframe containing co-accessible elements. This would usually be the output of run_cicero or assemble_connections. Specifically, this should be a dataframe where the first column contains the genomic coordinates of the first element in the linked pair of elements, with chromosome, start, end coordinates separated by "-" characters. The second column should be the second element in the linked pair, formatted in the same way as the first column. A third column should contain the co-accessibility scores.

ccans  This is optional, but if supplied should be a dataframe containing the cis-co-accessibility network (CCAN) information generated by generate_ccans. Specifically, this should be a dataframe containing the name of the peak in the first column, and the CCAN that it belongs to in the second column.

threshold  Threshold for retaining a coaccessible site. Links with a value less than or equal to this threshold will be discarded.

sep  Separators to use for strings encoding genomic coordinates. First element is used to separate the chromosome from the coordinates, second element is used to separate the start from end coordinate.

Details

See the Cicero package for more information: https://bioconductor.org/packages/cicero/

Value

Returns a GRanges object
ConvertMotifID

Convert between motif name and motif ID

Description

Converts from motif name to motif ID or vice versa. To convert common names to IDs, use the name parameter. To convert IDs to common names, use the id parameter.

Usage

ConvertMotifID(object, ...)

## Default S3 method:
ConvertMotifID(object, name, id, ...)

## S3 method for class 'Motif'
ConvertMotifID(object, ...)

## S3 method for class 'ChromatinAssay'
ConvertMotifID(object, ...)

## S3 method for class 'Seurat'
ConvertMotifID(object, assay = NULL, ...)

Arguments

object A Seurat, ChromatinAssay, or Motif object
...
Arguments passed to other methods
name A vector of motif names
id A vector of motif IDs. Only one of name and id should be supplied
assay For Seurat object. Name of assay to use. If NULL, use the default assay

Value

Returns a character vector with the same length and order as the input. Any names or IDs that were not found will be stored as NA.
CountFragments  Count fragments

Description
Count total fragments per cell barcode present in a fragment file.

Usage
CountFragments(fragments, cells = NULL, max_lines = NULL, verbose = TRUE)

Arguments
- **fragments**: Path to a fragment file
- **cells**: Cells to include. If NULL, include all cells
- **max_lines**: Maximum number of lines to read from the fragment file. If NULL, read all lines in the file.
- **verbose**: Display messages

Value
Returns a data.frame

Examples
```r
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
counts <- CountFragments(fragments = fpath)
```

CountsInRegion  Counts in region

Description
Count reads per cell overlapping a given set of regions

Usage
CountsInRegion(object, assay, regions, ...)

Arguments
- **object**: A Seurat object
- **assay**: Name of a chromatin assay in the object to use
- **regions**: A GRanges object
- **...**: Additional arguments passed to findOverlaps
Value

Returns a numeric vector

Examples

CountsInRegion(
  object = atac_small,
  assay = 'bins',
  regions = blacklist_hg19
)

coverage.ChromatinAssay-method

Coverage of a ChromatinAssay object

Description

This is the coverage method for ChromatinAssay objects.

Usage

## S4 method for signature 'ChromatinAssay'
coverage(
  x,
  shift = 0L,
  width = NULL,
  weight = 1L,
  method = c("auto", "sort", "hash")
)

## S4 method for signature 'Seurat'
coverage(
  x,
  shift = 0L,
  width = NULL,
  weight = 1L,
  method = c("auto", "sort", "hash")
)

Arguments

x A ChromatinAssay object

shift How much each range should be shifted before coverage is computed. See coverage in the IRanges package.
width  Specifies the length of the returned coverage vectors. See coverage in the IRanges package.
weight  Assigns weight to each range in x. See coverage in the IRanges package.
method  See coverage in the IRanges package

Functions
• coverage,ChromatinAssay-method: method for ChromatinAssay objects
• coverage,Seurat-method: method for Seurat objects

See Also
• coverage-methods in the IRanges package.
• coverage-methods in the GenomicRanges package
• ChromatinAssay-class

CoverageBrowser  Genome browser

Description
Interactive version of the CoveragePlot function. Allows altering the genome position interactively. The current view at any time can be saved to a list of ggplot objects using the "Save plot" button, and this list of plots will be returned after ending the browser by pressing the "Done" button.

Usage
CoverageBrowser(object, region, assay = NULL, sep = c("-", "-"), ...)

Arguments
• object  A Seurat object
• region  A set of genomic coordinates
• assay  Name of assay to use
• sep  Separators for genomic coordinates if region supplied as a string rather than GRanges object
• ...  Parameters passed to CoveragePlot

Value
Returns a list of ggplot objects
CoveragePlot

Plot Tn5 insertion frequency over a region

Description

Plot frequency of Tn5 insertion events for different groups of cells within given regions of the genome.

Usage

CoveragePlot(
  object,
  region,
  features = NULL,
  assay = NULL,
  show.bulk = FALSE,
  expression.assay = "RNA",
  expression.slot = "data",
  annotation = TRUE,
  peaks = TRUE,
  peaks.group.by = NULL,
  ranges = NULL,
  ranges.group.by = NULL,
  ranges.title = "Ranges",
  region.highlight = NULL,
  links = TRUE,
  tile = FALSE,
  tile.size = 100,
  tile.cells = 100,
  bigwig = NULL,
  bigwig.type = "coverage",
  heights = NULL,
  group.by = NULL,
  window = 100,
  extend.upstream = 0,
  extend.downstream = 0,
  scale.factor = NULL,
  ymax = NULL,
  cells = NULL,
  idents = NULL,
  sep = c("-", "-"),
  max.downsample = 3000,
  downsample.rate = 0.1,
  ...
)
**CoveragePlot**

**Arguments**

- **object**: A Seurat object
- **region**: A set of genomic coordinates to show. Can be a GRanges object, a string encoding a genomic position, a gene name, or a vector of strings describing the genomic coordinates or gene names to plot. If a gene name is supplied, annotations must be present in the assay.
- **features**: A vector of features present in another assay to plot alongside accessibility tracks (for example, gene names).
- **assay**: Name of the assay to plot
- **show.bulk**: Include coverage track for all cells combined (pseudo-bulk). Note that this will plot the combined accessibility for all cells included in the plot (rather than all cells in the object).
- **expression.assay**: Name of the assay containing expression data to plot alongside accessibility tracks. Only needed if supplying `features` argument.
- **expression.slot**: Name of slot to pull expression data from. Only needed if supplying the `features` argument.
- **annotation**: Display gene annotations
- **peaks**: Display peaks
- **peaks.group.by**: Grouping variable to color peaks by. Must be a variable present in the feature metadata. If NULL, do not color peaks by any variable.
- **ranges**: Additional genomic ranges to plot
- **ranges.group.by**: Grouping variable to color ranges by. Must be a variable present in the metadata stored in the `ranges` genomic ranges. If NULL, do not color by any variable.
- **ranges.title**: Y-axis title for ranges track. Only relevant if `ranges` parameter is set.
- **region.highlight**: Region to highlight on the plot. Should be a GRanges object containing the coordinates to highlight. By default, regions will be highlighted in grey. To change the color of the highlighting, include a metadata column in the GRanges object named "color" containing the color to use for each region.
- **links**: Display links
- **tile**: Display per-cell fragment information in sliding windows.
- **tile.size**: Size of the sliding window for per-cell fragment tile plot
- **tile.cells**: Number of cells to display fragment information for in tile plot.
- **bigwig**: List of bigWig file paths to plot data from. Files can be remotely hosted. The name of each element in the list will determine the y-axis label given to the track.
- **bigwig.type**: Type of track to use for bigWig files ("line", "heatmap", or "coverage"). Should either be a single value, or a list of values giving the type for each individual track in the provided list of bigwig files.
heights  Relative heights for each track (accessibility, gene annotations, peaks, links).
group.by  Name of one or more metadata columns to group (color) the cells by. Default is
           the current cell identities
window  Smoothing window size
extend.upstream  Number of bases to extend the region upstream.
extend.downstream  Number of bases to extend the region downstream.
scale.factor  Scaling factor for track height. If NULL (default), use the median group scaling
               factor determined by total number of fragments sequences in each group.
ymax  Maximum value for Y axis. If NULL (default) set to the highest value among
       all the tracks.
cells  Which cells to plot. Default all cells
idents  Which identities to include in the plot. Default is all identities.
sep  Separators to use for strings encoding genomic coordinates. First element is
     used to separate the chromosome from the coordinates, second element is used
     to separate the start from end coordinate.
max.downsample  Minimum number of positions kept when downsampling. Downsampling rate
                 is adaptive to the window size, but this parameter will set the minimum possible
                 number of positions to include so that plots do not become too sparse when the
                 window size is small.
downsample.rate  Fraction of positions to retain when downsampling. Retaining more positions
                 can give a higher-resolution plot but can make the number of points large, resulting
                 in larger file sizes when saving the plot and a longer period of time needed
                 to draw the plot.
...  Additional arguments passed to `wrap_plots`

Details

Thanks to Andrew Hill for providing an early version of this function.

Value

Returns a `ggplot` object

Examples

```r
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(
  path = fpath,
  cells = colnames(atac_small),
  validate.fragments = FALSE
)
Fragments(atac_small) <- fragments
```
# Basic coverage plot
CoveragePlot(object = atac_small, region = c("chr1-713500-714500"))

# Show additional ranges
ranges.show <- StringToGRanges("chr1-713750-714000")
CoveragePlot(object = atac_small, region = c("chr1-713500-714500"), ranges = ranges.show)

# Highlight region
CoveragePlot(object = atac_small, region = c("chr1-713500-714500"), region.highlight = ranges.show)

# Change highlight color
ranges.show$color <- "orange"
CoveragePlot(object = atac_small, region = c("chr1-713500-714500"), region.highlight = ranges.show)

# Show expression data
CoveragePlot(object = atac_small, region = c("chr1-713500-714500"), features = "ELK1")

---

CreateChromatinAssay  Create ChromatinAssay object

Description

Create a ChromatinAssay object from a count matrix or normalized data matrix. The expected format of the input matrix is features x cells. A set of genomic ranges must be supplied along with the matrix, with the length of the ranges equal to the number of rows in the matrix. If a set of genomic ranges are not supplied, they will be extracted from the row names of the matrix.

Usage

CreateChromatinAssay(
  counts, 
  data, 
  min.cells = 0, 
  min.features = 0, 
  max.cells = NULL, 
  ranges = NULL, 
  motifs = NULL, 
  fragments = NULL, 
  genome = NULL, 
  annotation = NULL, 
  bias = NULL, 
  positionEnrichment = NULL, 
  sep = c("-", "-"), 
  validate.fragments = TRUE, 
  verbose = TRUE, 
  ...
)
### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>counts</td>
<td>Unnormalized data (raw counts)</td>
</tr>
<tr>
<td>data</td>
<td>Normalized data; if provided, do not pass counts</td>
</tr>
<tr>
<td>min.cells</td>
<td>Include features detected in at least this many cells. Will subset the counts</td>
</tr>
<tr>
<td>min.features</td>
<td>Include cells where at least this many features are detected.</td>
</tr>
<tr>
<td>max.cells</td>
<td>Include features detected in less than this many cells. Will subset the counts</td>
</tr>
<tr>
<td>ranges</td>
<td>A set of GRanges corresponding to the rows of the input matrix</td>
</tr>
<tr>
<td>motifs</td>
<td>A Motif object (not required)</td>
</tr>
<tr>
<td>fragments</td>
<td>Path to a tabix-indexed fragments file for the data contained in the input</td>
</tr>
<tr>
<td>genome</td>
<td>A Seqinfo object containing basic information about the genome used.</td>
</tr>
<tr>
<td>annotation</td>
<td>A set of GRanges containing annotations for the genome used</td>
</tr>
<tr>
<td>bias</td>
<td>A Tn5 integration bias matrix</td>
</tr>
<tr>
<td>positionEnrichment</td>
<td>A named list of matrices containing positional signal enrichment information for each cell. Should be a cell x position matrix, centered on an element of interest (for example, TSS sites).</td>
</tr>
<tr>
<td>sep</td>
<td>Separators to use for strings encoding genomic coordinates. First element is used to separate the chromosome from the coordinates, second element is used to separate the start from end coordinate. Only used if ranges is NULL.</td>
</tr>
<tr>
<td>validate.fragments</td>
<td>Check that cells in the assay are present in the fragment file.</td>
</tr>
<tr>
<td>verbose</td>
<td>Display messages</td>
</tr>
<tr>
<td>...</td>
<td>Additional arguments passed to CreateFragmentObject</td>
</tr>
</tbody>
</table>
CreateFragmentObject

Description

Create a Fragment object to store fragment file information. This object stores a 32-bit MD5 hash of the fragment file and the fragment file index so that any changes to the files on-disk can be detected. A check is also performed to ensure that the expected cells are present in the fragment file.

Usage

CreateFragmentObject(
  path,
  cells = NULL,
  validate.fragments = TRUE,
  verbose = TRUE,
  ...
)

Arguments

  path A path to the fragment file. The file should contain a tabix index in the same directory.

  cells A named character vector containing cell barcodes contained in the fragment file. This does not need to be all cells in the fragment file, but there should be no cells in the vector that are not present in the fragment file. A search of the file will be performed until at least one fragment from each cell is found. If NULL, don’t check for expected cells.

  Each element of the vector should be a cell barcode that appears in the fragment file, and the name of each element should be the corresponding cell name in the object.

  validate.fragments Check that expected cells are present in the fragment file.

  verbose Display messages

  ... Additional arguments passed to ValidateCells

Examples

fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
cells <- colnames(x = atac_small)
names(x = cells) <- paste0("test_", cells)
frags <- CreateFragmentObject(path = fpath, cells = cells, verbose = FALSE, tolerance = 0.5)
CreateMotifMatrix

Create motif matrix

Description

Create a motif x feature matrix from a set of genomic ranges, the genome, and a set of position weight matrices.

Usage

CreateMotifMatrix(
  features,
  pwm,
  genome,
  score = FALSE,
  use.counts = FALSE,
  sep = c("-", "-"),
  ...
)

Arguments

- **features**: A GRanges object containing a set of genomic features
- **pwm**: A PFMatrixList or PWMMatrixList object containing position weight/frequency matrices to use
- **genome**: Any object compatible with the genome argument in matchMotifs
- **score**: Record the motif match score, rather than presence/absence (default FALSE)
- **use.counts**: Record motif counts per region. If FALSE (default), record presence/absence of motif. Only applicable if score=FALSE.
- **sep**: A length-2 character vector containing the separators to be used when constructing matrix rownames from the GRanges
- **...**: Additional arguments passed to matchMotifs

Details

Requires that motifmatchr is installed https://www.bioconductor.org/packages/motifmatchr/.

Value

Returns a sparse matrix
CreateMotifObject

Examples

```r
## Not run:
library(JASPAR2018)
library(TFBSTools)
library(BSgenome.Hsapiens.UCSC.hg19)

pwm <- getMatrixSet(
  x = JASPAR2018,
  opts = list(species = 9606, all_versions = FALSE)
)
motif.matrix <- CreateMotifMatrix(
  features = granges(atac_small),
  pwm = pwm,
  genome = BSgenome.Hsapiens.UCSC.hg19
)

## End(Not run)
```

CreateMotifObject  
Create motif object

Description

Create a **Motif-class** object.

Usage

```r
CreateMotifObject(
  data = NULL,
  pwm = NULL,
  motif.names = NULL,
  positions = NULL,
  meta.data = NULL
)
```

Arguments

data  A motif x region matrix
pwm  A named list of position weight matrices or position frequency matrices matching the motif names in data. Can be of class PFMatrixList.
motif.names  A named list of motif names. List element names must match the names given in pwm. If NULL, use the names from the list of position weight or position frequency matrices. This can be used to set a alternative common name for the motif. If a PFMatrixList is passed to pwm, it will pull the motif name from the PFMatrixList.
positions  A GRangesList object containing exact positions of each motif.
meta.data  A data.frame containing metadata
DepthCor

Value

Returns a Motif object

Examples

```
motif.matrix <- matrix(
  data = sample(c(0,1),
  size = 100,
  replace = TRUE),
  ncol = 5
)
motif <- CreateMotifObject(data = motif.matrix)
```

DepthCor  

Plot sequencing depth correlation

Description

Compute the correlation between total counts and each reduced dimension component.

Usage

```
DepthCor(object, assay = NULL, reduction = "lsi", n = 10, ...)
```

Arguments

- **object**  
  A Seurat object
- **assay**  
  Name of assay to use for sequencing depth. If NULL, use the default assay.
- **reduction**  
  Name of a dimension reduction stored in the input object
- **n**  
  Number of components to use. If NULL, use all components.
- **...**  
  Additional arguments passed to cor

Value

Returns a ggplot object

Examples

```
DepthCor(object = atac_small)
```
**DownsampleFeatures**  

**Description**  
Randomly downsample features and assign to VariableFeatures for the object. This will select n features at random.

**Usage**  
DownsampleFeatures(object, assay = NULL, n = 20000, verbose = TRUE)

**Arguments**  
- **object**  
  A Seurat object
- **assay**  
  Name of assay to use. Default is the active assay.
- **n**  
  Number of features to retain (default 20000).
- **verbose**  
  Display messages

**Value**  
Returns a Seurat object with VariableFeatures set to the randomly sampled features.

**Examples**  
DownsampleFeatures(atac_small, n = 10)

---

**ExpressionPlot**  

**Plot gene expression**

**Description**  
Display gene expression values for different groups of cells and different genes. Genes will be arranged on the x-axis and different groups stacked on the y-axis, with expression value distribution for each group shown as a violin plot. This is designed to work alongside a genomic coverage track, and the plot will be able to be aligned with coverage tracks for the same groups of cells.

**Usage**  
ExpressionPlot(  
  object,  
  features,  
  assay = NULL,  
  group.by = NULL,  
  idents = NULL,  
  slot = "data"  
)
Arguments

- **object**: A Seurat object
- **features**: A list of features to plot
- **assay**: Name of the assay storing expression information
- **group.by**: A grouping variable to group cells by. If NULL, use the current cell identities
- **idents**: A list of identities to include in the plot. If NULL, include all identities
- **slot**: Which slot to pull expression data from

Examples

```r
ExpressionPlot(atac_small, features = "TSPAN6", assay = "RNA")
```

---

**Extend**

**Description**

Resize GenomicRanges upstream and or downstream. From [https://support.bioconductor.org/p/78652/](https://support.bioconductor.org/p/78652/)

**Usage**

```r
Extend(x, upstream = 0, downstream = 0, from.midpoint = FALSE)
```

**Arguments**

- **x**: A range
- **upstream**: Length to extend upstream
- **downstream**: Length to extend downstream
- **from.midpoint**: Count bases from region midpoint, rather than the 5' or 3' end for upstream and downstream respectively.

**Value**

Returns a `GRanges` object

**Examples**

```r
Extend(x = blacklist_hg19, upstream = 100, downstream = 100)
```
FeatureMatrix

Description

Construct a feature x cell matrix from a genomic fragments file

Usage

FeatureMatrix(
  fragments,
  features,
  cells = NULL,
  process_n = 2000,
  sep = c("-", "-"),
  verbose = TRUE
)

Arguments

fragments A list of Fragment objects. Note that if setting the cells parameter, the requested cells should be present in the supplied Fragment objects. However, if the cells information in the fragment object is not set (Cells(fragments) is NULL), then the fragment object will still be searched.

features A GRanges object containing a set of genomic intervals. These will form the rows of the matrix, with each entry recording the number of unique reads falling in the genomic region for each cell.

cells Vector of cells to include. If NULL, include all cells found in the fragments file

process_n Number of regions to load into memory at a time, per thread. Processing more regions at once can be faster but uses more memory.

sep Vector of separators to use for genomic string. First element is used to separate chromosome and coordinates, second separator is used to separate start and end coordinates.

verbose Display messages

Value

Returns a sparse matrix

Examples

fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(fpath)
FeatureMatrix(
  fragments = fragments,
  features = granges(atac_small)
)
FilterCells

Filter cells from fragment file

Description

Remove all fragments that are not from an allowed set of cell barcodes from the fragment file. This will create a new file on disk that only contains fragments from cells specified in the cells argument. The output file is block gzip-compressed and indexed, ready for use with Signac functions.

Usage

FilterCells(
  fragments,
  cells,
  outfile = NULL,
  buffer_length = 256L,
  verbose = TRUE
)

Arguments

fragments Path to a fragment file
cells A vector of cells to keep
outfile Name for output file
buffer_length Size of buffer to be read from the fragment file. This must be longer than the longest line in the file.
verbose Display messages

Examples

fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
tmpf <- tempfile(fileext = ".gz")
FilterCells(
  fragments = fpath,
  cells = head(colnames(atac_small)),
  outfile = tmpf
)
file.remove(tmpf)
FindClonotypes  

**Description**

Identify groups of related cells from allele frequency data. This will cluster the cells based on their allele frequencies, reorder the factor levels for the cluster identities by hierarchical clustering the collapsed (pseudobulk) cluster allele frequencies, and set the variable features for the allele frequency assay to the order of features defined by hierarchical clustering.

**Usage**

```r
FindClonotypes(
  object,
  assay = NULL,
  features = NULL,
  metric = "cosine",
  resolution = 1,
  k = 10,
  algorithm = 3
)
```

**Arguments**

- **object**: A Seurat object
- **assay**: Name of assay to use
- **features**: Features to include when constructing neighbor graph
- **metric**: Distance metric to use
- **resolution**: Clustering resolution to use. See `FindClusters`
- **k**: Passed to k.param argument in `FindNeighbors`
- **algorithm**: Community detection algorithm to use. See `FindClusters`

**Value**

Returns a Seurat object
FindMotifs

Description

Find motifs over-represented in a given set of genomic features. Computes the number of features containing the motif (observed) and compares this to the total number of features containing the motif (background) using the hypergeometric test.

Usage

FindMotifs(
  object,  
  features,  
  background = 40000,  
  assay = NULL,  
  verbose = TRUE,  
  ...  
)

Arguments

  object A Seurat object
  features A vector of features to test for enrichments over background
  background Either a vector of features to use as the background set, or a number specify
    the number of features to randomly select as a background set. If a number
    is provided, regions will be selected to match the sequence characteristics of
    the query features. To match the sequence characteristics, these characteristics
    must be stored in the feature metadata for the assay. This can be added using the
    RegionStats function. If NULL, use all features in the assay.
  assay Which assay to use. Default is the active assay
  verbose Display messages
  ... Arguments passed to MatchRegionStats.

Value

Returns a data frame

Examples

de.motif <- head(rownames(atac_small))
bg.peaks <- tail(rownames(atac_small))
FindMotifs(
  object = atac_small,  
  features = de.motif,  
  background = bg.peaks  
)
The `findOverlaps`, `countOverlaps` methods are available for `ChromatinAssay` objects. This allows finding overlaps between genomic ranges and the ranges stored in the ChromatinAssay.

### Usage

```r
## S4 method for signature 'Vector,ChromatinAssay'
findOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  select = c("all", "first", "last", "arbitrary"),
  ignore.strand = FALSE
)

## S4 method for signature 'ChromatinAssay,Vector'
findOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  select = c("all", "first", "last", "arbitrary"),
  ignore.strand = FALSE
)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
findOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  select = c("all", "first", "last", "arbitrary"),
  ignore.strand = FALSE
)

## S4 method for signature 'Vector,Seurat'
findOverlaps(
  query,
  subject,
```
maxgap = -1L,
minoverlap = 0L,
type = c("any", "start", "end", "within", "equal"),
select = c("all", "first", "last", "arbitrary"),
ignore.strand = FALSE
)

## S4 method for signature 'Seurat,Vector'
findOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  select = c("all", "first", "last", "arbitrary"),
  ignore.strand = FALSE
)

## S4 method for signature 'Seurat,Seurat'
findOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  select = c("all", "first", "last", "arbitrary"),
  ignore.strand = FALSE
)

## S4 method for signature 'Vector,ChromatinAssay'
countOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  ignore.strand = FALSE
)

## S4 method for signature 'ChromatinAssay,Vector'
countOverlaps(
  query,
  subject,
  maxgap = -1L,
  minoverlap = 0L,
  type = c("any", "start", "end", "within", "equal"),
  ignore.strand = FALSE
)
Arguments

query, subject  A ChromatinAssay object

maxgap, minoverlap, type, select, ignore.strand

See ?findOverlaps in the GenomicRanges and IRanges packages.
Details

If a ChromatinAssay is set as the default assay in a Seurat object, you can also call `findOverlaps` directly on the Seurat object.

Value

See `findOverlaps`

Functions

- `findOverlaps,ChromatinAssay,Vector-method`: method for ChromatinAssay, Vector
- `findOverlaps,Vector,Seurat-method`: method for Vector, Seurat
- `findOverlaps,Seurat,Vector-method`: method for Seurat, Vector
- `findOverlaps,Seurat,Seurat-method`: method for Seurat, Seurat
- `countOverlaps,ChromatinAssay,Vector-method`: method for ChromatinAssay, Vector
- `countOverlaps,Seurat,Vector-method`: method for Seurat, Vector
- `countOverlaps,Vector,Seurat-method`: method for Vector, Seurat
- `countOverlaps,Seurat,Seurat-method`: method for Seurat, Seurat

See Also

- `findOverlaps-methods` in the IRanges package.
- `findOverlaps-methods` in the GenomicRanges package
- ChromatinAssay-class

FindTopFeatures

Find most frequently observed features

Description

Find top features for a given assay based on total number of counts for the feature. Can specify a minimum cell count, or a lower percentile bound to determine the set of variable features. Running this function will store the total counts and percentile rank for each feature in the feature metadata for the assay. To only compute the feature metadata, without changing the variable features for the assay, set `min.cutoff=NA`. 
Usage

FindTopFeatures(object, ...)

## Default S3 method:
FindTopFeatures(object, assay = NULL, min.cutoff = "q5", verbose = TRUE, ...)

## S3 method for class 'Assay'
FindTopFeatures(object, assay = NULL, min.cutoff = "q5", verbose = TRUE, ...)

## S3 method for class 'Seurat'
FindTopFeatures(object, assay = NULL, min.cutoff = "q5", verbose = TRUE, ...)

Arguments

object A Seurat object

... Arguments passed to other methods

assay Name of assay to use

min.cutoff Cutoff for feature to be included in the VariableFeatures for the object. This can be a percentile specified as 'q' followed by the minimum percentile, for example 'q5' to set the top 95% most common features as the VariableFeatures for the object. Alternatively, this can be an integer specifying the minimum number of cells containing the feature for the feature to be included in the set of VariableFeatures. For example, setting to 10 will include features in >10 cells in the set of VariableFeatures. If NULL, include all features in VariableFeatures. If NA, VariableFeatures will not be altered, and only the feature metadata will be updated with the total counts and percentile rank for each feature.

verbose Display messages

Value

Returns a Seurat object

Examples

FindTopFeatures(object = atac_small[['peaks']][[)
FindTopFeatures(object = atac_small[['peaks']]])
FindTopFeatures(atac_small)

Footprint

Transcription factor footprinting analysis

Description

Compute the normalized observed/expected Tn5 insertion frequency for each position surrounding a set of motif instances.
Footprint

Usage

Footprint(object, ...) 

## S3 method for class 'ChromatinAssay'
Footprint(
  object,
  genome,
  motif.name = NULL,
  key = motif.name,
  regions = NULL,
  assay = NULL,
  upstream = 250,
  downstream = 250,
  compute.expected = TRUE,
  in.peaks = FALSE,
  verbose = TRUE,
  ...
)

## S3 method for class 'Seurat'
Footprint(
  object,
  genome,
  regions = NULL,
  motif.name = NULL,
  assay = NULL,
  upstream = 250,
  downstream = 250,
  in.peaks = FALSE,
  verbose = TRUE,
  ...
)

Arguments

object A Seurat or ChromatinAssay object
...
Arguments passed to other methods
genome A BSgenome object
motif.name Name of a motif stored in the assay to footprint. If not supplied, must supply a set of regions.
key Key to store positional enrichment information under.
regions A set of genomic ranges containing the motif instances
assay Name of assay to use
upstream Number of bases to extend upstream
downstream Number of bases to extend downstream
compute.expected  
Find the expected number of insertions at each position given the local DNA sequence context and the insertion bias of Tn5
in.peaks  
Restrict motifs to those that fall in peaks
verbose  
Display messages

Value

Returns a Seurat object

---

**FractionCountsInRegion**

*Fraction of counts in a genomic region*

**Description**

Find the fraction of counts per cell that overlap a given set of genomic ranges

**Usage**

```r
FractionCountsInRegion(object, regions, assay = NULL, ...)
```

**Arguments**

- **object**: A Seurat object
- **regions**: A GRanges object containing a set of genomic regions
- **assay**: Name of assay to use
- **...**: Additional arguments passed to CountsInRegion

**Value**

Returns a numeric vector

**Examples**

```r
## Not run:
FractionCountsInRegion(
  object = atac_small,
  assay = 'bins',
  regions = blacklist_hg19
)
## End(Not run)
```
The Fragment class is designed to hold information needed for working with fragment files.

**Slots**

- **path** Path to the fragment file on disk. See [https://support.10xgenomics.com/single-cell-atac/software/pipelines/latest/output/fragments](https://support.10xgenomics.com/single-cell-atac/software/pipelines/latest/output/fragments)
- **hash** A vector of two md5sums: first element is the md5sum of the fragment file, the second element is the md5sum of the index.
- **cells** A named vector of cells where each element is the cell barcode as it appears in the fragment file, and the name of each element is the corresponding cell barcode as stored in the ChromatinAssay object.

---

Plot fragment length histogram

**Description**

Plot the frequency that fragments of different lengths are present for different groups of cells.

**Usage**

```r
FragmentHistogram(
  object, 
  assay = NULL, 
  region = "chr1-1-2000000", 
  group.by = NULL, 
  cells = NULL, 
  log.scale = FALSE, 
  ...
)
```

**Arguments**

- **object** A Seurat object
- **assay** Which assay to use. Default is the active assay.
- **region** Genomic range to use. Default is first two megabases of chromosome 1. Can be a GRanges object, a string, or a vector of strings.
- **group.by** Name of one or more metadata columns to group (color) the cells by. Default is the current cell identities
cells: Which cells to plot. Default all cells
log.scale: Display Y-axis on log scale. Default is FALSE.
...
Arguments passed to other functions

Value

Returns a `ggplot` object

Examples

```r
epath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
Fragments(atac_small) <- CreateFragmentObject(
  path = epath,
  cells = colnames(atac_small),
  validate.fragments = FALSE
)
FragmentHistogram(object = atac_small, region = "chr1-10245-780007")
```

Description

Get the Fragment objects

Usage

```r
Fragments(object, ...)

Fragments(object, ...) <- value

## S3 method for class 'ChromatinAssay'
Fragments(object, ...)

## S3 method for class 'Seurat'
Fragments(object, ...)

## S3 replacement method for class 'ChromatinAssay'
Fragments(object, ...) <- value

## S3 replacement method for class 'Seurat'
Fragments(object, ...) <- value
```
Arguments

object  A Seurat object or ChromatinAssay object
...  Arguments passed to other methods
value  A Fragment object or list of Fragment objects

Value

Returns a list of Fragment objects. If there are no Fragment objects present, returns an empty list.

Examples

Fragments(atac_small[["peaks"]])
Fragments(atac_small)

fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(
  path = fpath,
  cells = colnames(atac_small),
  validate.fragments = FALSE
)
Fragments(atac_small[["bins"]]) <- fragments

fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(
  path = fpath,
  cells = colnames(atac_small),
  validate.fragments = FALSE
)
Fragments(atac_small) <- fragments

FRiP

Calculate fraction of reads in peaks per cell

Description

Calculate fraction of reads in peaks per cell

Usage

FRiP(object, assay, total.fragments, col.name = "FRiP", verbose = TRUE)

Arguments

object  A Seurat object
assay  Name of the assay containing a peak x cell matrix
total.fragments  Name of a metadata column containing the total number of sequenced fragments for each cell. This can be computed using the CountFragments function.
col.name  Name of column in metadata to store the FRiP information.
verbose  Display messages
GeneActivity

Value

Returns a Seurat object

Examples

FRiP(object = atac_small, assay = 'peaks', total.fragments = "fragments")

Description

Compute counts per cell in gene body and promoter region.

Usage

GeneActivity(
  object,
  assay = NULL,
  features = NULL,
  extend.upstream = 2000,
  extend.downstream = 0,
  biotypes = "protein_coding",
  max.width = 5e+05,
  gene.id = FALSE,
  verbose = TRUE,
  ...
)

Arguments

object A Seurat object
assay Name of assay to use. If NULL, use the default assay
features Genes to include. If NULL, use all protein-coding genes in the annotations stored in the object
extend.upstream Number of bases to extend upstream of the TSS
extend.downstream Number of bases to extend downstream of the TTS
biotypes Gene biotypes to include. If NULL, use all biotypes in the gene annotation.
max.width Maximum allowed gene width for a gene to be quantified. Setting this parameter can avoid quantifying extremely long transcripts that can add a relatively long amount of time. If NULL, do not filter genes based on width.
gene.id Record gene IDs in output matrix rather than gene name.
verbose Display messages
... Additional options passed to FeatureMatrix
Description

Construct a bin x cell matrix from a fragments file.

Usage

GenomeBinMatrix(
  fragments,
  genome,
  cells = NULL,
  binsize = 5000,
  process_n = 2000,
  sep = c("-", "-"),
  verbose = TRUE
)

Arguments

fragments Path to tabix-indexed fragments file or a list of Fragment objects
genome A vector of chromosome sizes for the genome. This is used to construct the genome bin coordinates. The can be obtained by calling seqlengths on a BSeqenome-class object.
cells Vector of cells to include. If NULL, include all cells found in the fragments file
binsize Size of the genome bins to use
process_n Number of regions to load into memory at a time, per thread. Processing more regions at once can be faster but uses more memory.
sep Vector of separators to use for genomic string. First element is used to separate chromosome and coordinates, second separator is used to separate start and end coordinates.
verbose Display messages
GetCellsInRegion

Details
This function bins the genome and calls FeatureMatrix to construct a bin x cell matrix.

Value
Returns a sparse matrix

Examples

```r
generate <- 780007
names(generate) <- 'chr1'
frpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(frpath)
GenomeBinMatrix(
  fragments = fragments,
  genome = generate,
  binsize = 1000
)
```
GetFootprintData

Description

Extract footprint data for a set of transcription factors or metafeatures. This function will pull accessibility data for a given feature (e.g., a TF), and perform background normalization for each identity class. This is the data that’s used to create TF footprinting plots with the PlotFootprint function.

Usage

GetFootprintData(
  object,
  features,
  assay = NULL,
  group.by = NULL,
  idents = NULL
)

Arguments

object A Seurat object
features A vector of features to extract data for
assay Name of assay to use
group.by A grouping variable
idents Set of identities to group cells by

Value

Returns a matrix

---

GetFragmentData

Description

Extract data from a Fragment-class object

Usage

GetFragmentData(object, slot = "path")

Arguments

object A Fragment object
slot Information to pull from object (path, hash, cells, prefix, suffix)
GetGRangesFromEnsDb  
Extract genomic ranges from EnsDb object

Description

Pulls the transcript information for all chromosomes from an EnsDb object. This wraps `crunch` and applies the extractor function to all chromosomes present in the EnsDb object.

Usage

```r
GetGRangesFromEnsDb(
  ensdb,
  standard.chromosomes = TRUE,
  biotypes = c("protein_coding", "lincRNA", "rRNA", "processed_transcript"),
  verbose = TRUE
)
```

Arguments

- `ensdb`: An EnsDb object
- `standard.chromosomes`: Keep only standard chromosomes
- `biotypes`: Biotypes to keep
- `verbose`: Display messages

GetIntersectingFeatures  
Find intersecting regions between two objects

Description

Intersects the regions stored in the rownames of two objects and returns a vector containing the names of rows that intersect for each object. The order of the row names return corresponds to the intersecting regions, i.e. the nth feature of the first vector will intersect the nth feature in the second vector. A distance parameter can be given, in which case features within the given distance will be called as intersecting.

Usage

```r
GetIntersectingFeatures(
  object.1,
  object.2,
  assay.1 = NULL,
  assay.2 = NULL,
  distance = 0,
  verbose = TRUE
)
```
Arguments

object.1 The first Seurat object
object.2 The second Seurat object
assay.1 Name of the assay to use in the first object. If NULL, use the default assay
assay.2 Name of the assay to use in the second object. If NULL, use the default assay
distance Maximum distance between regions allowed for an intersection to be recorded. Default is 0.
verbose Display messages

Value

Returns a list of two character vectors containing the row names in each object that overlap each other.

Examples

GetIntersectingFeatures(
  object.1 = atac_small,
  object.2 = atac_small,
  assay.1 = 'peaks',
  assay.2 = 'bins'
)

GetLinkedGenes

Get genes linked to peaks

Description

Find genes linked to a given set of peaks

Usage

GetLinkedGenes(object, features, assay = NULL, min.abs.score = 0)

Arguments

object A Seurat object
features A list of peaks to find linked genes for
assay Name of assay to use. If NULL, use the default assay
min.abs.score Minimum absolute value of the link score for a link to be returned

See Also

GetLinkedPeaks
GetLinkedPeaks

Get peaks linked to genes

Description

Find peaks linked to a given set of genes

Usage

GetLinkedPeaks(object, features, assay = NULL, min.abs.score = 0)

Arguments

object A Seurat object
features A list of genes to find linked peaks for
assay Name of assay to use. If NULL, use the default assay
min.abs.score Minimum absolute value of the link score for a link to be returned

See Also

GetLinkedGenes

GetMotifData

Retrieve a motif matrix

Description

Get motif matrix for given assay

Usage

GetMotifData(object, ...)

## S3 method for class 'Motif'
GetMotifData(object, slot = "data", ...)

## S3 method for class 'ChromatinAssay'
GetMotifData(object, slot = "data", ...)

## S3 method for class 'Seurat'
GetMotifData(object, assay = NULL, slot = "data", ...)
**GetTSSPositions**

Find transcriptional start sites

Get the TSS positions from a set of genomic ranges containing gene positions. Ranges can contain exons, introns, UTRs, etc, rather than the whole transcript. Only protein coding gene biotypes are included in output.

**Usage**

GetTSSPositions(ranges, biotypes = "protein_coding")

**Arguments**

- **ranges**
  
  A GRanges object containing gene annotations.

- **biotypes**
  
  Gene biotypes to include. If NULL, use all biotypes in the supplied gene annotation.
granges-methods

Access genomic ranges for ChromatinAssay objects

Description

Methods for accessing GRanges object information stored in a ChromatinAssay object.

Usage

```r
## S4 method for signature 'ChromatinAssay'
granges(x, use.names = TRUE, use.mcols = FALSE, ...)
```

```r
## S4 method for signature 'Seurat'
granges(x, use.names = TRUE, use.mcols = FALSE, ...)
```

Arguments

- `x` A ChromatinAssay object
- `use.names` Whether the names on the genomic ranges should be propagated to the returned object.
- `use.mcols` Not supported for ChromatinAssay objects
- `...` Additional arguments

Value

Returns a GRanges object

Functions

- `granges`, `Seurat-method`: method for Seurat objects

See Also

- `granges` in the GenomicRanges package.
- `ChromatinAssay-class`

Examples

```r
granges(atac_small)
```
GRangesToString  
GRanges to String

Description
Convert GRanges object to a vector of strings

Usage
GRangesToString(grange, sep = c("-", "-"))

Arguments
  grange  A GRanges object
  sep     Vector of separators to use for genomic string. First element is used to separate
           chromosome and coordinates, second separator is used to separate start and end
           coordinates.

Value
Returns a character vector

Examples
GRangesToString(grange = blacklist_hg19)

head.Fragment  
Return the first rows of a fragment file

Description
Returns the first n rows of a fragment file. This allows the content of a fragment file to be inspected.

Usage
## S3 method for class 'Fragment'
head(x, n = 6L, ...)

Arguments
  x         a Fragment object
  n         an integer specifying the number of rows to return from the fragment file
  ...      additional arguments passed to read.table

Value
The first n rows of a fragment file as a data.frame with the following columns: chrom, start, end, barcode, readCount.
Identify Variants  Identify mitochondrial variants

Description

Identify mitochondrial variants present in single cells.

Usage

IdentifyVariants(object, ...)  

## Default S3 method: 
IdentifyVariants( 
  object, 
  refallele, 
  stabilize_variance = TRUE, 
  low_coverage_threshold = 10, 
  verbose = TRUE, 
  ... 
)

## S3 method for class 'Assay'  
IdentifyVariants(object, refallele, ...)  

## S3 method for class 'Seurat'  
IdentifyVariants(object, refallele, assay = NULL, ...)

Arguments

object  
A Seurat object

...  
Arguments passed to other methods

refallele  
A dataframe containing reference alleles for the mitochondrial genome.

stabilize_variance  
Stabilize variance

low_coverage_threshold  
Low coverage threshold

verbose  
Display messages

assay  
Name of assay to use. If NULL, use the default assay.

Value

Returns a dataframe
Examples

```r
## Not run:
data.dir <- "path/to/data/directory"
mgatk <- ReadMGATK(dir = data.dir)
variant.df <- IdentifyVariants(
  object = mgatk$counts,
  refallele = mgatk$refallele
)

## End(Not run)
```

---

**InsertionBias**

*Compute Tn5 insertion bias*

**Description**

Counts the Tn5 insertion frequency for each DNA hexamer.

**Usage**

```r
InsertionBias(object, ...)
```

---

**Arguments**

- `object`: A Seurat or ChromatinAssay object
- `...`: Additional arguments passed to `StringToGRanges`
- `genome`: A BSgenome object
- `region`: Region to use when assessing bias. Default is human chromosome 1.
- `verbose`: Display messages
- `assay`: Name of assay to use

**Value**

Returns a Seurat object
Examples

```r
## Not run:
library(BSgenome.Mmusculus.UCSC.mm10)

region.use <- GRanges(
  seqnames = c('chr1', 'chr2'),
  IRanges(start = c(1,1), end = c(195471971, 182113224))
)

InsertionBias(
  object = atac_small,
  genome = BSgenome.Mmusculus.UCSC.mm10,
  region = region.use
)

## End(Not run)
```

inter-range-methods  
*Inter-range transformations for ChromatinAssay objects*

Description

The `range`, `reduce`, `gaps`, `disjoin`, `isDisjoint`, `disjointBins` methods are available for `ChromatinAssay` objects.

Usage

```r
## S4 method for signature 'ChromatinAssay'
range(x, ..., with.revmap = FALSE, na.rm = FALSE)

## S4 method for signature 'Seurat'
range(x, ..., with.revmap = FALSE, na.rm = FALSE)

## S4 method for signature 'ChromatinAssay'
reduce(x, drop.empty.ranges = FALSE, ...)

## S4 method for signature 'Seurat'
reduce(x, drop.empty.ranges = FALSE, ...)

## S4 method for signature 'ChromatinAssay'
gaps(x, start = NA, end = NA)

## S4 method for signature 'Seurat'
gaps(x, start = NA, end = NA)

## S4 method for signature 'ChromatinAssay'
disjoin(x, ...)
```
## S4 method for signature 'Seurat'
disjoin(x, ...)

## S4 method for signature 'ChromatinAssay'
isDisjoint(x, ...)

## S4 method for signature 'Seurat'
isDisjoint(x, ...)

## S4 method for signature 'ChromatinAssay'
disjointBins(x, ...)

## S4 method for signature 'Seurat'
disjointBins(x, ...)

### Arguments

- **x**: A `ChromatinAssay` object
- **...**: Additional arguments
- **with.revmap**: See `inter-range-methods` in the `IRanges` packages
- **na.rm**: Ignored
- **drop.empty.ranges**: See `?IRanges{inter-range-methods}`
- **start, end**: See `?IRanges{inter-range-methods}`

### Functions

- `range,Seurat-method`: method for Seurat objects
- `reduce,ChromatinAssay-method`: method for ChromatinAssay objects
- `reduce,Seurat-method`: method for Seurat objects
- `gaps,ChromatinAssay-method`: method for ChromatinAssay objects
- `gaps,Seurat-method`: method for Seurat objects
- `disjoin,ChromatinAssay-method`: method for ChromatinAssay objects
- `disjoin,Seurat-method`: method for Seurat objects
- `isDisjoint,ChromatinAssay-method`: method for ChromatinAssay objects
- `isDisjoint,Seurat-method`: method for Seurat objects
- `disjointBins,ChromatinAssay-method`: method for ChromatinAssay objects
- `disjointBins,Seurat-method`: method for Seurat objects

### See Also

- `inter-range-methods` in the `IRanges` package.
- `inter-range-methods` in the `GenomicRanges` package
- `ChromatinAssay-class`
IntersectMatrix

Intersect genomic coordinates with matrix rows

Description

Remove or retain matrix rows that intersect given genomic regions

Usage

IntersectMatrix(
  matrix,
  regions,
  invert = FALSE,
  sep = c("-", "-"),
  verbose = TRUE,
  ...
)

Arguments

matrix A matrix with genomic regions in the rows
regions A set of genomic regions to intersect with regions in the matrix. Either a vector of strings encoding the genomic coordinates, or a GRanges object.
invert Discard rows intersecting the genomic regions supplied, rather than retain.
sep A length-2 character vector containing the separators to be used for extracting genomic coordinates from a string. The first element will be used to separate the chromosome name from coordinates, and the second element used to separate start and end coordinates.
verbose Display messages
... Additional arguments passed to findOverlaps

Value

Returns a sparse matrix

Examples

counts <- matrix(data = rep(0, 12), ncol = 2)
rownames(counts) <- c("chr1-565107-565550", "chr1-569174-569639",
"chr1-713460-714823", "chr1-752422-753038",
"chr1-762106-763359", "chr1-779589-780271")
IntersectMatrix(matrix = counts, regions = blacklist_hg19)
### Jaccard

#### Calculate the Jaccard index between two matrices

**Description**

Finds the Jaccard similarity between rows of the two matrices. Note that the matrices must be binary, and any rows with zero total counts will result in an NaN entry that could cause problems in downstream analyses.

**Usage**

```r
Jaccard(x, y)
```

**Arguments**

- `x` The first matrix
- `y` The second matrix

**Details**

This will calculate the raw Jaccard index, without normalizing for the expected similarity between cells due to differences in sequencing depth.

**Value**

Returns a matrix

**Examples**

```r
x <- matrix(data = sample(c(0, 1), size = 25, replace = TRUE), ncol = 5)
Jaccard(x = x, y = x)
```

---

### LinkPeaks

#### Link peaks to genes

**Description**

Find peaks that are correlated with the expression of nearby genes. For each gene, this function computes the correlation coefficient between the gene expression and accessibility of each peak within a given distance from the gene TSS, and computes an expected correlation coefficient for each peak given the GC content, accessibility, and length of the peak. The expected coefficient values for the peak are then used to compute a z-score and p-value.
Usage

```
LinkPeaks(
  object,
  peak.assay,
  expression.assay,
  expression.slot = "data",
  gene.coords = NULL,
  distance = 5e+05,
  min.distance = NULL,
  min.cells = 10,
  method = "pearson",
  genes.use = NULL,
  n_sample = 200,
  pvalue_cutoff = 0.05,
  score_cutoff = 0.05,
  gene.id = FALSE,
  verbose = TRUE
)
```

Arguments

- `object`: A Seurat object
- `peak.assay`: Name of assay containing peak information
- `expression.assay`: Name of assay containing gene expression information
- `expression.slot`: Name of slot to pull expression data from
- `gene.coords`: GRanges object containing coordinates of genes in the expression assay. If NULL, extract from gene annotations stored in the assay.
- `distance`: Distance threshold for peaks to include in regression model
- `min.distance`: Minimum distance between peak and TSS to include in regression model. If NULL (default), no minimum distance is used.
- `min.cells`: Minimum number of cells positive for the peak and gene needed to include in the results.
- `method`: Which correlation coefficient to compute. Can be "pearson" (default), "spearman", or "kendall".
- `genes.use`: Genes to test. If NULL, determine from expression assay.
- `n_sample`: Number of peaks to sample at random when computing the null distribution.
- `pvalue_cutoff`: Minimum p-value required to retain a link. Links with a p-value equal or greater than this value will be removed from the output.
- `score_cutoff`: Minimum absolute value correlation coefficient for a link to be retained
- `gene.id`: Set to TRUE if genes in the expression assay are named using gene IDs rather than gene names.
- `verbose`: Display messages
LinkPlot

Details

This function was inspired by the method originally described by SHARE-seq (Sai Ma et al. 2020, Cell). Please consider citing the original SHARE-seq work if using this function: doi: 10.1016/j.cell.2020.09.056

Value

Returns a Seurat object with the Links information set. This is a granges object accessible via the Links function, with the following information:

- score: the correlation coefficient between the accessibility of the peak and expression of the gene
- zscore: the z-score of the correlation coefficient, computed based on the distribution of correlation coefficients from a set of background peaks
- pvalue: the p-value associated with the z-score for the link
- gene: name of the linked gene
- peak: name of the linked peak

Description

Display links between pairs of genomic elements within a given region of the genome.

Usage

LinkPlot(object, region, min.cutoff = 0)

Arguments

- object: A Seurat object
- region: A genomic region to plot
- min.cutoff: Minimum absolute score for link to be plotted.

Value

Returns a ggplot object
**Get or set links information**

**Description**

Get or set the genomic link information for a Seurat object or ChromatinAssay.

**Usage**

```
Links(object, ...)  
```

```
Links(object, ...) <- value
```

```r
## S3 method for class 'ChromatinAssay'
Links(object, ...)
```

```r
## S3 method for class 'Seurat'
Links(object, ...)
```

```r
## S3 replacement method for class 'ChromatinAssay'
Links(object, ...) <- value
```

```r
## S3 replacement method for class 'Seurat'
Links(object, ...) <- value
```

**Arguments**

- `object`: A Seurat object
- `...`: Arguments passed to other methods
- `value`: A `GRanges` object

**Examples**

```r
Links(atac_small[['peaks']])
Links(atac_small)
links <- Links(atac_small)
Links(atac_small[['peaks']]) <- links
links <- Links(atac_small)
Links(atac_small) <- links
```
### LookupGeneCoords

*Get gene coordinates*

**Description**

Extract the coordinates of the longest transcript for a gene stored in the annotations within an object.

**Usage**

```r
LookupGeneCoords(object, gene, assay = NULL)
```

**Arguments**

- `object`: A Seurat object
- `gene`: Name of a gene to extract
- `assay`: Name of assay to use

**Examples**

```r
LookupGeneCoords(atac_small, gene = "MIR1302-10")
```

### MatchRegionStats

*Match DNA sequence characteristics*

**Description**

Return a vector if genomic regions that match the distribution of a set of query regions for any given set of characteristics, specified in the input `meta.feature` dataframe.

**Usage**

```r
MatchRegionStats(
  meta.feature,
  query.feature,
  features.match = c("GC.percent"),
  n = 10000,
  verbose = TRUE,
  ...
)
```
Motif-class

Arguments

**meta.feature**  
A dataframe containing DNA sequence information for features to choose from.

**query.feature**  
A dataframe containing DNA sequence information for features to match.

**features.match**  
Which features of the query to match when selecting a set of regions. A vector of column names present in the feature metadata can be supplied to match multiple characteristics at once. Default is GC content.

**n**  
Number of regions to select, with characteristics matching the query.

**verbose**  
Display messages.

...  
Arguments passed to other functions.

Details

For each requested feature to match, a density distribution is estimated using the `density` function, and a set of weights for each feature in the dataset estimated based on the density distribution. If multiple features are to be matched (for example, GC content and overall accessibility), a joint density distribution is then computed by multiplying the individual feature weights. A set of features with characteristics matching the query regions is then selected using the `sample` function, with the probability of randomly selecting each feature equal to the joint density distribution weight.

Value

Returns a character vector.

Examples

```r
metafeatures <- Seurat::GetAssayData(  
  object = atac_small[['Varpeaks']], slot = 'Varmeta.features'
)
query.feature <- metafeatures[1:10, ]
features.choose <- metafeatures[11:nrow(metafeatures), ]
MatchRegionStats(  
  meta.feature = features.choose,
  query.feature = query.feature,
  features.match = "percentile",
  n = 10
)
```

Motif-class

The Motif class

Description

The Motif class is designed to store DNA sequence motif information, including motif PWMs or PFM$s, motif positions, and metadata.
**Slots**

- data: A sparse, binary, feature x motif matrix. Columns correspond to motif IDs, rows correspond to genomic features (peaks or bins). Entries in the matrix should be 1 if the genomic feature contains the motif, and 0 otherwise.
- pwm: A named list of position weight matrices
- motif.names: A list containing the name of each motif
- positions: A GRangesList object containing exact positions of each motif.
- meta.data: A dataframe for storage of additional information related to each motif. This could include the names of proteins that bind the motif.

---

**MotifPlot**

*Plot DNA sequence motif*

**Description**

Plot position weight matrix or position frequency matrix for different DNA sequence motifs.

**Usage**

MotifPlot(object, motifs, assay = NULL, use.names = TRUE, ...)

**Arguments**

- object: A Seurat object
- motifs: A list of motifs to plot
- assay: Name of the assay to use
- use.names: Use motif names stored in the motif object
- ...: Additional parameters passed to ggseqlogo

**Value**

Returns a ggplot object

**Examples**

motif.obj <- Seurat::GetAssayData(atac_small, slot = "motifs")
MotifPlot(atac_small, motifs = head(colnames(motif.obj)))
Motifs

Get or set a motif information

Description

Get or set the Motif object for a Seurat object or ChromatinAssay.

Usage

```r
Motifs(object, ...)
Motifs(object, ...) <- value
## S3 method for class 'ChromatinAssay'
Motifs(object, ...)
## S3 method for class 'Seurat'
Motifs(object, ...)
## S3 replacement method for class 'ChromatinAssay'
Motifs(object, ...) <- value
## S3 replacement method for class 'Seurat'
Motifs(object, ...) <- value
```

Arguments

- `object` A Seurat object
- `...` Arguments passed to other methods
- `value` A `Motif` object

Examples

```r
Motifs(atac_small["peaks"])  # Get motif information
Motifs(atac_small)
motifs <- Motifs(atac_small)
Motifs(atac_small["peaks"]) <- motifs
motifs <- Motifs(atac_small)
Motifs(atac_small) <- motifs
```
nearest-methods

Find the nearest range neighbors for ChromatinAssay objects

Description

The precede, follow, nearest, distance, distanceToNearest methods are available for ChromatinAssay objects.

Usage

```r
## S4 method for signature 'ANY,ChromatinAssay'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ANY'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,Seurat'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,ANY'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,Seurat'
precede(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,ChromatinAssay'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ANY'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,Seurat'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,ANY'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,Seurat'
follow(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,ChromatinAssay'
```

nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ANY'
nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,Seurat'
nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,ANY'
nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'Seurat,Seurat'
nearest(x, subject, select = c("arbitrary", "all"), ignore.strand = FALSE)

## S4 method for signature 'ANY,ChromatinAssay'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'ChromatinAssay,ANY'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'ANY,Seurat'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'Seurat,ANY'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'Seurat,Seurat'
distance(x, y, ignore.strand = FALSE, ...)

## S4 method for signature 'ANY,ChromatinAssay'
distanceToNearest(x, subject, ignore.strand = FALSE, ...)

## S4 method for signature 'ChromatinAssay,ANY'
distanceToNearest(x, subject, ignore.strand = FALSE, ...)

## S4 method for signature 'ChromatinAssay,ChromatinAssay'
distanceToNearest(x, subject, ignore.strand = FALSE, ...)

## S4 method for signature 'ANY,Seurat'
distanceToNearest(x, subject, ignore.strand = FALSE, ...)

## S4 method for signature 'Seurat,ANY'

distanceToNearest(x, subject, ignore.strand = FALSE, ...)

## S4 method for signature 'Seurat,Seurat'
distanceToNearest(x, subject, ignore.strand = FALSE, ...)

Arguments

x    A query ChromatinAssay object
subject The subject GRanges or ChromatinAssay object. If missing, x is used as the subject.
select Logic for handling ties. See nearest-methods in the GenomicRanges package.
ignore.strand Logical argument controlling whether strand information should be ignored.
y    For the distance method, a GRanges object or a ChromatinAssay object
... Additional arguments for methods

Functions

- precede,ChromatinAssay,ANY-method: method for ChromatinAssay, ANY
- precede,ANY,Seurat-method: method for ANY, Seurat
- precede,Seurat,ANY-method: method for Seurat, ANY
- precede,Seurat,Seurat-method: method for Seurat, Seurat
- follow,ANY,ChromatinAssay-method: method for ANY, ChromatinAssay
- follow,ChromatinAssay,ANY-method: method for ChromatinAssay, ANY
- follow,ANY,Seurat-method: method for ANY, Seurat
- follow,Seurat,ANY-method: method for Seurat, ANY
- follow,Seurat,Seurat-method: method for Seurat, Seurat
- nearest,ANY,ChromatinAssay-method: method for ANY, ChromatinAssay
- nearest,ChromatinAssay,ANY-method: method for ChromatinAssay, ANY
- nearest,ANY,Seurat-method: method for ANY, Seurat
- nearest,Seurat,ANY-method: method for Seurat, ANY
- nearest,Seurat,Seurat-method: method for Seurat, Seurat
- distance,ANY,ChromatinAssay-method: method for ANY, ChromatinAssay
- distance,ChromatinAssay,ANY-method: method for ChromatinAssay, ANY
NucleosomeSignal

Description

Calculate the strength of the nucleosome signal per cell. Computes the ratio of fragments between 147 bp and 294 bp (mononucleosome) to fragments < 147 bp (nucleosome-free)

Usage

NucleosomeSignal(
  object,
  assay = NULL,
  n = ncol(object) * 5000,
  verbose = TRUE,
  ...
)

Arguments

object A Seurat object
assay Name of assay to use. Only required if a fragment path is not provided. If NULL, use the active assay.
n Number of lines to read from the fragment file. If NULL, read all lines. Default scales with the number of cells in the object.
verbose Display messages
... Arguments passed to other functions
Value

Returns a Seurat object with added metadata for the ratio of mononucleosomal to nucleosome-free fragments per cell, and the percentile rank of each ratio.

Examples

```r
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
Fragments(atac_small) <- CreateFragmentObject(
  path = fpath,
  cells = colnames(atac_small),
  tolerance = 0.5
)
NucleosomeSignal(object = atac_small)
```

PeakPlot

Plot peaks in a genomic region

Description

Display the genomic ranges in a ChromatinAssay object that fall in a given genomic region

Usage

```r
PeakPlot(
  object,
  region,
  assay = NULL,
  peaks = NULL,
  group.by = NULL,
  color = "dimgrey"
)
```

Arguments

- **object**: A Seurat object
- **region**: A genomic region to plot
- **assay**: Name of assay to use. If NULL, use the default assay.
- **peaks**: A GRanges object containing peak coordinates. If NULL, use coordinates stored in the Seurat object.
- **group.by**: Name of variable in feature metadata (if using ranges in the Seurat object) or genomic ranges metadata (if using supplied ranges) to color ranges by. If NULL, do not color by any metadata variable.
- **color**: Color to use. If group.by is not NULL, this can be a custom color scale (see examples).
Value

Returns a ggplot object

Examples

# plot peaks in assay
PeakPlot(atac_small, region = "chr1:710000-715000")

# manually set color
PeakPlot(atac_small, region = "chr1:710000-715000", color = "red")

# color by a variable in the feature metadata
PeakPlot(atac_small, region = "chr1:710000-715000", group.by = "count")

PlotFootprint

Plot motif footprinting results

Description

Plot motif footprinting results

Usage

PlotFootprint(
  object,
  features,
  assay = NULL,
  group.by = NULL,
  idents = NULL,
  label = TRUE,
  repel = TRUE,
  show.expected = TRUE,
  normalization = "subtract",
  label.top = 3,
  label.idents = NULL
)

Arguments

  object A Seurat object
  features A vector of features to plot
  assay Name of assay to use
  group.by A grouping variable
  idents Set of identities to include in the plot
**label**  TRUE/FALSE value to control whether groups are labeled.

**repe**  Repel labels from each other

**show.expected**  Plot the expected Tn5 integration frequency below the main footprint plot

**normalization**  Method to normalize for Tn5 DNA sequence bias. Options are "subtract", "divide", or NULL to perform no bias correction.

**label.top**  Number of groups to label based on highest accessibility in motif flanking region.

**label.idents**  Vector of identities to label. If supplied, label.top will be ignored.

---

**ReadMGATK**  Read MGATK output

### Description

Read output files from MGATK ([https://github.com/caleblareau/mgatk](https://github.com/caleblareau/mgatk)).

### Usage

```r
ReadMGATK(dir, verbose = TRUE)
```

### Arguments

- **dir**  Path to directory containing MGATK output files
- **verbose**  Display messages

### Value

Returns a list containing a sparse matrix (counts) and two dataframes (depth and refallele).

- The sparse matrix contains read counts for each base at each position and strand.
- The depth dataframe contains the total depth for each cell. The refallele dataframe contains the reference genome allele at each position.

### Examples

```r
## Not run:
data.dir <- system.file("extdata", "test_mgatk", package="Signac")
gatk <- ReadMGATK(dir = data.dir)

## End(Not run)
```
RegionStats

Compute base composition information for genomic ranges

Description

Compute the GC content, region lengths, and dinucleotide base frequencies for regions in the assay and add to the feature metadata.

Usage

RegionStats(object, ...)

## Default S3 method:
RegionStats(object, genome, verbose = TRUE, ...)

## S3 method for class 'ChromatinAssay'
RegionStats(object, genome, verbose = TRUE, ...)

## S3 method for class 'Seurat'
RegionStats(object, genome, assay = NULL, verbose = TRUE, ...)

Arguments

object A Seurat object, Assay object, or set of genomic ranges

... Arguments passed to other methods

genome A BSgenome object

verbose Display messages

assay Name of assay to use

Value

Returns a dataframe

Examples

## Not run:
library(BSgenome.Hsapiens.UCSC.hg19)
RegionStats(
  object = rownames(atac_small),
  genome = BSgenome.Hsapiens.UCSC.hg19
)

## End(Not run)

## Not run:
library(BSgenome.Hsapiens.UCSC.hg19)
RegionStats(
  object = atac_small[['peaks']],

## Not run:
library(BSgenome.Hsapiens.UCSC.hg19)
RegionStats(
  object = rownames(atac_small),
  genome = BSgenome.Hsapiens.UCSC.hg19
)
```r
### End(Not run)
### Not run:
library(BSgenome.Hsapiens.UCSC.hg19)
RegionStats(
  object = atac_small,
  assay = 'bins',
  genome = BSgenome.Hsapiens.UCSC.hg19
)
### End(Not run)

RunChromVAR

## S3 method for class 'ChromatinAssay'
RunChromVAR(object, genome, motif.matrix = NULL, verbose = TRUE, ...)

## S3 method for class 'Seurat'
RunChromVAR(
  object, genome, motif.matrix = NULL, assay = NULL, new.assay.name = "chromvar", ...
)

### Arguments

<table>
<thead>
<tr>
<th>argument</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>A Seurat object</td>
</tr>
<tr>
<td>...</td>
<td>Additional arguments passed to <code>getBackgroundPeaks</code></td>
</tr>
<tr>
<td>genome</td>
<td>A BSgenome, DNAStringSet, FaFile, or string stating the genome build recognized by <code>getBSgenome</code></td>
</tr>
<tr>
<td>motif.matrix</td>
<td>A peak x motif matrix. If NULL, pull the peak x motif matrix from a Motif object stored in the assay.</td>
</tr>
</tbody>
</table>
```

**Description**

Wrapper to run `chromVAR` on an assay with a motif object present. Will return a new Seurat assay with the motif activities (the deviations in chromatin accessibility across the set of regions) as a new assay.

**Usage**

```r
RunChromVAR(object, ...)
```

```r
### S3 method for class 'ChromatinAssay'
RunChromVAR(object, genome, motif.matrix = NULL, verbose = TRUE, ...)

### S3 method for class 'Seurat'
RunChromVAR(
  object, genome, motif.matrix = NULL, assay = NULL, new.assay.name = "chromvar", ...
)
```
RunSVD

Run singular value decomposition

Description

Run partial singular value decomposition using irlba

Usage

RunSVD(object, ...)

## Default S3 method:
RunSVD(
  object,
  assay = NULL,
  n = 50,
  scale.embeddings = TRUE,
  reduction.key = "LSI_",
  scale.max = NULL,
  verbose = TRUE,
  assay = NULL,
  n = 50,
  scale.embeddings = TRUE,
  reduction.key = "LSI_",
  scale.max = NULL,
  verbose = TRUE,
```
irlba.work = n * 3,
...
)

## S3 method for class 'Assay'
RunSVD(
  object,
  assay = NULL,
  features = NULL,
  n = 50,
  reduction.key = "LSI_",
  scale.max = NULL,
  verbose = TRUE,
  ...
)

## S3 method for class 'Seurat'
RunSVD(
  object,
  assay = NULL,
  features = NULL,
  n = 50,
  reduction.key = "LSI_",
  reduction.name = "lsi",
  scale.max = NULL,
  verbose = TRUE,
  ...
)
```

### Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>object</td>
<td>A Seurat object</td>
</tr>
<tr>
<td>...</td>
<td>Arguments passed to other methods</td>
</tr>
<tr>
<td>assay</td>
<td>Which assay to use. If NULL, use the default assay</td>
</tr>
<tr>
<td>n</td>
<td>Number of singular values to compute</td>
</tr>
<tr>
<td>scale.embeddings</td>
<td>Scale cell embeddings within each component to mean 0 and SD 1 (default TRUE)</td>
</tr>
<tr>
<td>reduction.key</td>
<td>Key for dimension reduction object</td>
</tr>
<tr>
<td>scale.max</td>
<td>Clipping value for cell embeddings. Default (NULL) is no clipping.</td>
</tr>
<tr>
<td>verbose</td>
<td>Print messages</td>
</tr>
<tr>
<td>irlba.work</td>
<td>work parameter for irlba. Working subspace dimension, larger values can speed convergence at the cost of more memory use.</td>
</tr>
<tr>
<td>features</td>
<td>Which features to use. If NULL, use variable features</td>
</tr>
<tr>
<td>reduction.name</td>
<td>Name for stored dimension reduction object. Default 'svd'</td>
</tr>
</tbody>
</table>
RunTFIDF

Value

Returns a Seurat object

Examples

```r
x <- matrix(data = rnorm(100), ncol = 10)
RunSVD(x)
RunSVD(atac_small[['peaks']])
RunSVD(atac_small)
```

---

RunTFIDF

**Compute the term-frequency inverse-document-frequency**

Description

Run term frequency inverse document frequency (TF-IDF) normalization on a matrix.

Usage

```r
RunTFIDF(object, ...)
```

## Default S3 method:
```r
RunTFIDF(
  object,
  assay = NULL,
  method = 1,
  scale.factor = 10000,
  idf = NULL,
  verbose = TRUE,
  ...
)
```

## S3 method for class 'Assay'
```r
RunTFIDF(
  object,
  assay = NULL,
  method = 1,
  scale.factor = 10000,
  idf = NULL,
  verbose = TRUE,
  ...
)
```

## S3 method for class 'Seurat'
```r
RunTFIDF(
  object,
  assay = NULL,
```
method = 1,
scale.factor = 10000,
idf = NULL,
verbose = TRUE,

Arguments

object A Seurat object

... Arguments passed to other methods

assay Name of assay to use

method Which TF-IDF implementation to use. Choice of:

• 1: The TF-IDF implementation used by Stuart & Butler et al. 2019 (doi: 10.1101/460147). This computes \( \log(TF \times IDF) \).

• 2: The TF-IDF implementation used by Cusanovich & Hill et al. 2018 (doi: 10.1016/j.cell.2018.06.052). This computes \( TF \times (\log(IDF)) \).

• 3: The log-TF method used by Andrew Hill. This computes \( \log(TF) \times \log(IDF) \).

• 4: The 10x Genomics method (no TF normalization). This computes \( IDF \).

scale.factor Which scale factor to use. Default is 10000.

idf A precomputed IDF vector to use. If NULL, compute based on the input data matrix.

verbose Print progress

Details

Four different TF-IDF methods are implemented. We recommend using method 1 (the default).

Value

Returns a Seurat object

References

https://en.wikipedia.org/wiki/Latent_semantic_analysis#Latent_semantic_indexing

Examples

mat <- matrix(data = rbinom(n = 25, size = 5, prob = 0.2), nrow = 5)
RunTFIDF(object = mat)
RunTFIDF(atac_small[['Var.peaks']])
RunTFIDF(object = atac_small)
seqinfo-methods

Access and modify sequence information for ChromatinAssay objects

Description

Methods for accessing and modifying Seqinfo object information stored in a ChromatinAssay object.

Usage

```r
## S4 method for signature 'ChromatinAssay'
seqinfo(x)
## S4 replacement method for signature 'ChromatinAssay'
seqinfo(x) <- value
## S4 method for signature 'ChromatinAssay'
seqlevels(x)
## S4 replacement method for signature 'ChromatinAssay'
seqlevels(x) <- value
## S4 method for signature 'ChromatinAssay'
seqnames(x)
## S4 replacement method for signature 'ChromatinAssay'
seqnames(x) <- value
## S4 method for signature 'ChromatinAssay'
seqlengths(x)
## S4 replacement method for signature 'ChromatinAssay'
seqlengths(x) <- value
## S4 method for signature 'ChromatinAssay'
genome(x)
## S4 replacement method for signature 'ChromatinAssay'
genome(x) <- value
## S4 method for signature 'ChromatinAssay'
isCircular(x)
## S4 replacement method for signature 'ChromatinAssay'
isCircular(x) <- value
## S4 method for signature 'Seurat'
```
seqinfo(x)
## S4 replacement method for signature 'Seurat'
seqinfo(x) <- value

## S4 method for signature 'Seurat'
seqlevels(x)
## S4 replacement method for signature 'Seurat'
seqlevels(x) <- value

## S4 method for signature 'Seurat'
seqnames(x)
## S4 replacement method for signature 'Seurat'
seqnames(x) <- value

## S4 method for signature 'Seurat'
seqlengths(x)
## S4 replacement method for signature 'Seurat'
seqlengths(x) <- value

## S4 method for signature 'Seurat'
genome(x)
## S4 replacement method for signature 'Seurat'
genome(x) <- value

## S4 method for signature 'Seurat'
isCircular(x)
## S4 replacement method for signature 'Seurat'
isCircular(x) <- value

**Arguments**

x A ChromatinAssay object
value A Seqinfo object or name of a UCSC genome to store in the ChromatinAssay

**Functions**

- seqlevels,ChromatinAssay-method: get method for ChromatinAssay objects
- seqnames,ChromatinAssay-method: get method for ChromatinAssay objects
SetMotifData

- `seqlengths`, `ChromatinAssay-method`: get method for `ChromatinAssay` objects
- `genome`, `ChromatinAssay-method`: get method for `ChromatinAssay` objects
- `isCircular`, `ChromatinAssay-method`: get method for `ChromatinAssay` objects
- `isCircular<-`, `ChromatinAssay-method`: set method for `ChromatinAssay` objects
- `seqinfo`, `Seurat-method`: get method for `Seurat` objects
- `seqinfo<-`, `Seurat-method`: set method for `Seurat` objects
- `seqlevels`, `Seurat-method`: get method for `Seurat` objects
- `seqlevels<-`, `Seurat-method`: set method for `Seurat` objects
- `seqnames`, `Seurat-method`: get method for `Seurat` objects
- `seqnames<-`, `Seurat-method`: set method for `Seurat` objects
- `seqlengths`, `Seurat-method`: get method for `Seurat` objects
- `seqlengths<-`, `Seurat-method`: set method for `Seurat` objects
- `genome`, `Seurat-method`: get method for `Seurat` objects
- `genome<-`, `Seurat-method`: set method for `Seurat` objects
- `isCircular`, `Seurat-method`: get method for `Seurat` objects
- `isCircular<-`, `Seurat-method`: set method for `Seurat` objects

See Also

- `seqinfo` in the `GenomeInfoDb` package.
- `ChromatinAssay-class`

---

**SetMotifData**  
*Set motif data*

**Description**

Set motif matrix for given assay

**Usage**

```r
SetMotifData(object, ...)  
## S3 method for class 'Motif'
SetMotifData(object, slot, new.data, ...)

## S3 method for class 'ChromatinAssay'
SetMotifData(object, slot, new.data, ...)

## S3 method for class 'Seurat'
SetMotifData(object, assay = NULL, ...)
```
SplitFragments

Arguments

- **object**: A Seurat object
- **...**: Arguments passed to other methods
- **slot**: Name of slot to use
- **new.data**: motif matrix to add. Should be matrix or sparse matrix class
- **assay**: Name of assay whose data should be set

Value

Returns a **Seurat** object

Examples

```r
motif.obj <- Seurat::GetAssayData(
  object = atac_small[['peaks']], slot = "motifs"
)
SetMotifData(object = motif.obj, slot = 'data', new.data = matrix())
SetMotifData(
  object = atac_small[['peaks']], slot = 'data', new.data = matrix()
)
motif.matrix <- GetMotifData(object = atac_small)
SetMotifData(
  object = atac_small, assay = 'peaks', slot = 'data', new.data = motif.matrix
)
```

Description

Splits a fragment file into separate files for each group of cells. If splitting multiple fragment files containing common cell types, fragments originating from different files will be appended to the same file for one group of cell identities.

Usage

```r
SplitFragments(
  object,
  assay = NULL,
  group.by = NULL,
  idents = NULL,
  outdir = getwd(),
  file.suffix = "",
  append = TRUE,
  buffer_length = 256L,
  verbose = TRUE
)
```
StringToGRanges

Arguments

- **object**: A Seurat object
- **assay**: Name of assay to use
- **group.by**: Name of grouping variable to group cells by
- **idents**: List of identities to include
- **outdir**: Directory to write output files
- **file.suffix**: Suffix to add to all file names (before file extension). If splitting multiple fragment files without the append option set to TRUE, an additional numeric suffix will be added to each file (eg. .1, .2).
- **append**: If splitting multiple fragment files, append cells from the same group (eg cluster) to the same file. Note that this can cause the output file to be unsorted.
- **buffer_length**: Size of buffer to be read from the fragment file. This must be longer than the longest line in the file.
- **verbose**: Display messages

StringToGRanges  String to GRanges

Description

Convert a genomic coordinate string to a GRanges object

Usage

StringToGRanges(regions, sep = c("-", "-"), ...)

Arguments

- **regions**: Vector of genomic region strings
- **sep**: Vector of separators to use for genomic string. First element is used to separate chromosome and coordinates, second separator is used to separate start and end coordinates.
  
  ... Additional arguments passed to makeGRangesFromDataFrame

Value

Returns a GRanges object

Examples

```r
regions <- c('chr1-1-10', 'chr2-12-3121')
StringToGRanges(regions = regions)
```
**subset.Motif**

**Subset a Motif object**

**Description**

Returns a subset of a Motif-class object.

**Usage**

```r
## S3 method for class 'Motif'
subset(x, features = NULL, motifs = NULL, ...)

## S3 method for class 'Motif'
x[i, j, ...]
```

**Arguments**

- `x` : A Motif object
- `features` : Which features to retain
- `motifs` : Which motifs to retain
- `...` : Arguments passed to other methods
- `i` : Which columns to retain
- `j` : Which rows to retain

**Value**

Returns a subsetted Motif object

**See Also**

subset

**Examples**

```r
motif.obj <- Seurat::GetAssayData(
  object = atac_small[['peaks']], slot = "motifs"
)
subset(x = motif.obj, features = head(rownames(motif.obj), 10))
motif.obj <- Seurat::GetAssayData(
  object = atac_small, assay = 'peaks', slot = 'motifs'
)
motif.obj[1:10,1:10]
```
SubsetMatrix

SubsetMatrix rows and columns

Description

Subset the rows and columns of a matrix by removing rows and columns with less than the specified number of non-zero elements.

Usage

SubsetMatrix(
  mat,
  min.rows = 1,
  min.cols = 1,
  max.row.val = 10,
  max.col.val = NULL
)

Arguments

mat A matrix
min.rows Minimum number of non-zero elements for the row to be retained
min.cols Minimum number of non-zero elements for the column to be retained
max.row.val Maximum allowed value in a row for the row to be retained. If NULL, don’t set any limit.
max.col.val Maximum allowed value in a column for the column to be retained. If NULL, don’t set any limit.

Value

Returns a matrix

Examples

SubsetMatrix(mat = volcano)
theme_browser  Genome browser theme

Description

Theme applied to panels in the CoveragePlot function.

Usage

theme_browser(..., legend = TRUE)

Arguments

...  Additional arguments
legend  Display plot legend

Examples

PeakPlot(atac_small, region = "chr1:710000-715000") + theme_browser()

TilePlot  Plot integration sites per cell

Description

Plots the presence/absence of Tn5 integration sites for each cell within a genomic region.

Usage

TilePlot(
  object,
  region,
  sep = c("-", "-"),
  tile.size = 100,
  tile.cells = 100,
  extend.upstream = 0,
  extend.downstream = 0,
  assay = NULL,
  cells = NULL,
  group.by = NULL,
  order.by = "total",
  idents = NULL
)
Arguments

object
A Seurat object

region
A set of genomic coordinates to show. Can be a GRanges object, a string encoding a genomic position, a gene name, or a vector of strings describing the genomic coordinates or gene names to plot. If a gene name is supplied, annotations must be present in the assay.

sep
Separators to use for strings encoding genomic coordinates. First element is used to separate the chromosome from the coordinates, second element is used to separate the start from end coordinate.

tile.size
Size of the sliding window for per-cell fragment tile plot

tile.cells
Number of cells to display fragment information for in tile plot.

extend.upstream
Number of bases to extend the region upstream.

extend.downstream
Number of bases to extend the region downstream.

assay
Name of assay to use

cells
Which cells to plot. Default all cells

group.by
Name of grouping variable to group cells by. If NULL, use the current cell identities

order.by
Option for determining how cells are chosen from each group. Options are "total" or "random". "total" will select the top cells based on total number of fragments in the region, "random" will select randomly.

idents
List of cell identities to include in the plot. If NULL, use all identities.

Value

Returns a ggplot object

Examples

```r
fpath <- system.file("extdata", "fragments.tsv.gz", package="Signac")
fragments <- CreateFragmentObject(
  path = fpath,
  cells = colnames(atac_small),
  validate.fragments = FALSE
)
Fragments(atac_small) <- fragments
TilePlot(object = atac_small, region = c("chr1-713500-714500"))
```
TSSEnrichment

Compute TSS enrichment score per cell

Description

Compute the transcription start site (TSS) enrichment score for each cell, as defined by ENCODE:

Usage

TSSEnrichment(
  object,
  tss.positions = NULL,
  n = NULL,
  fast = TRUE,
  assay = NULL,
  cells = NULL,
  process_n = 2000,
  verbose = TRUE
)

Arguments

object  A Seurat object

tss.positions  A GRanges object containing the TSS positions. If NULL, use the genomic
                annotations stored in the assay.

n  Number of TSS positions to use. This will select the first _n_ TSSs from the set.
               If NULL, use all TSSs (slower).

fast  Just compute the TSS enrichment score, without storing the base-resolution ma-
          trix of integration counts at each site. This reduces the memory required to store
          the object but does not allow plotting the accessibility profile at the TSS.

assay  Name of assay to use

cells  A vector of cells to include. If NULL (default), use all cells in the object

process_n  Number of regions to process at a time if using fast option.

verbose  Display messages

Details

The computed score will be added to the object metadata as "TSS.enrichment".

Value

Returns a Seurat object
Examples

```r
## Not run:
fp <- system.file("extdata", "fragments.tsv.gz", package="Signac")
Fragments(atac_small) <- CreateFragmentObject(
  path = fp,
  cells = colnames(atac_small),
  tolerance = 0.5
)
TSSEnrichment(object = atac_small)

## End(Not run)
```

---

**TSSPlot**  
*Plot signal enrichment around TSSs*

## Description

Plot the normalized TSS enrichment score at each position relative to the TSS. Requires that `TSSEnrichment` has already been run on the assay.

## Usage

```r
TSSPlot(object, assay = NULL, group.by = NULL, idents = NULL)
```

## Arguments

- **object**: A Seurat object
- **assay**: Name of the assay to use. Should have the TSS enrichment information for each cell already computed by running `TSSEnrichment`
- **group.by**: Set of identities to group cells by
- **idents**: Set of identities to include in the plot

## Value

Returns a `ggplot2` object
**UnifyPeaks**

**Unify genomic ranges**

**Description**
Create a unified set of non-overlapping genomic ranges from multiple Seurat objects containing single-cell chromatin data.

**Usage**

```r
UnifyPeaks(object.list, mode = "reduce")
```

**Arguments**

- `object.list`: A list of Seurat objects or ChromatinAssay objects
- `mode`: Function to use when combining genomic ranges. Can be "reduce" (default) or "disjoin". See `reduce` and `disjoin` for more information on these functions.

**Value**

Returns a GRanges object

**Examples**

```r
UnifyPeaks(object.list = list(atac_small, atac_small))
```

**UpdatePath**

Update the file path for a Fragment object

**Description**

Change the path to a fragment file store in a Fragment object. Path must be to the same file that was used to create the fragment object. An MD5 hash will be computed using the new path and compared to the hash stored in the Fragment object to verify that the files are the same.

**Usage**

```r
UpdatePath(object, new.path, verbose = TRUE)
```

**Arguments**

- `object`: A Fragment object
- `new.path`: Path to the fragment file
- `verbose`: Display messages
**ValidateCells**

**Validate cells present in fragment file**

**Description**

Search for a fragment from each cell that should exist in the fragment file. Will iterate through chunks of the fragment file until at least one fragment from each cell barcode requested is found.

**Usage**

```
ValidateCells(
  object,
  cells = NULL,
  tolerance = 0.5,
  max.lines = 5e+07,
  verbose = TRUE
)
```

**Arguments**

- **object** A `Fragment` object
- **cells** A character vector containing cell barcodes to search for. If NULL, use the cells stored in the Fragment object.
- **tolerance** Fraction of input cells that can be unseen before returning TRUE. For example, `tolerance = 0.01` will return TRUE when 99 have observed fragments in the file. This can be useful if there are cells present that have much fewer total counts, and would require extensive searching before a fragment from those cells are found.
- **max.lines** Maximum number of lines to read in without finding the required number of cells before returning FALSE. Setting this value avoids having to search the whole file if it becomes clear that the expected cells are not present. Setting this value to NULL will enable an exhaustive search of the entire file.
- **verbose** Display messages

**ValidateFragments**

**Validate Fragment object**

**Description**

Verify that the cells listed in the object exist in the fragment file and that the fragment file or index have not changed since creating the fragment object.

**Usage**

```
ValidateFragments(object, verbose = TRUE, ...)
```
### ValidateHash

**Validate hashes for Fragment object**

**Description**

Validate hashes for Fragment object

**Usage**

```
ValidateHash(object, verbose = TRUE)
```

**Arguments**

- **object**: A Fragment object
- **verbose**: Display messages

### VariantPlot

**Plot strand concordance vs. VMR**

**Description**

Plot the Pearson correlation between allele frequencies on each strand versus the log10 mean-variance ratio for the allele.

**Usage**

```
VariantPlot(
  variants,
  min.cells = 2,
  concordance.threshold = 0.65,
  vmr.threshold = 0.01
)
```

**Arguments**

- **variants**: A dataframe containing variant information. This should be computed using `IdentifyVariants`
- **min.cells**: Minimum number of high-confidence cells detected with the variant for the variant to be displayed.
- **concordance.threshold**: Strand concordance threshold
- **vmr.threshold**: Mean-variance ratio threshold
Index

* assay
  Annotation, 10
  as.ChromatinAssay, 11
  ChromatinAssay-class, 24
  CreateChromatinAssay, 35
  Fragments, 55
  GetFragmentData, 60
  Links, 75
  Motifs, 79
* coverage
  coverage, ChromatinAssay-method, 30
* datasets
  atac_small, 12
  blacklist_ce10, 16
  blacklist_ce11, 16
  blacklist_dm3, 17
  blacklist_dm6, 17
  blacklist_hg19, 18
  blacklist_hg38, 18
  blacklist_hg38_unified, 19
  blacklist_mm10, 19
* data
  atac_small, 12
  blacklist_ce10, 16
  blacklist_ce11, 16
  blacklist_dm3, 17
  blacklist_dm6, 17
  blacklist_hg19, 18
  blacklist_hg38, 18
  blacklist_hg38_unified, 19
  blacklist_mm10, 19
* dimension_reduction
  Jaccard, 72
  RunSVD, 89
* footprinting
  Footprint, 51
  GetFootprintData, 60
  InsertionBias, 68
  PlotFootprint, 85
* fragments
  Cells.Fragment, 23
  CountFragments, 29
  CreateFragmentObject, 37
  FilterCells, 44
  Fragment-class, 54
  Fragments, 55
  head.Fragment, 66
  SplitFragments, 96
  UpdatePath, 104
  ValidateCells, 105
  ValidateFragments, 105
  ValidateHash, 106
* granges
  granges-methods, 65
* inter_range
  inter-range-methods, 69
* links
  ConnectionsToLinks, 27
  GetLinkedGenes, 62
  GetLinkedPeaks, 63
  LinkPeaks, 72
  LinkPlot, 74
  Links, 75
* mito
  AlleleFreq, 9
  ClusterClonotypes, 25
  FindClonotypes, 45
  IdentifyVariants, 67
  ReadMGATK, 86
  VariantPlot, 106
* motifs
  AddMotifs, 6
  ConvertMotifID, 28
  CreateMotifMatrix, 38
  CreateMotifObject, 39
  FindMotifs, 46
  GetMotifData, 63
  MatchRegionStats, 76
INDEX

CallPeaks, 20
Cells.Fragment, 23
Cells<-, 23
Cells<-.Fragment (Cells.Fragment), 23
CellsPerGroup, 24
ChromatinAssay, 8, 9, 12, 30, 35, 47, 49, 65, 69, 70, 80, 82, 93, 94
ChromatinAssay (ChromatinAssay-class), 24
ChromatinAssay-class, 24, 31, 50, 65, 70, 83, 95
chromVAR, 88
ClosestFeature, 25
ClusterClonotypes, 25
CombineTracks, 26
ConnectionsToLinks, 27
ConvertMotifID, 28
cor, 40
CountFragments, 29, 56
countOverlaps (findOverlaps-methods), 47
countOverlaps, ChromatinAssay, ChromatinAssay-method (findOverlaps-methods), 47
countOverlaps, ChromatinAssay, Vector-method (findOverlaps-methods), 47
countOverlaps, Seurat, Seurat-method (findOverlaps-methods), 47
countOverlaps, Seurat, Vector-method (findOverlaps-methods), 47
countOverlaps, Vector, ChromatinAssay-method (findOverlaps-methods), 47
countOverlaps, Vector, Seurat-method (findOverlaps-methods), 47
CountsInRegion, 29, 53
cov, 30, 31
coversion, ChromatinAssay-method, 30
coversion, ChromatinAssay-method, 30
coversion, Seurat-method, 30
coversion-methods, 31
CoverageBrowser, 31
CoveragePlot, 31, 32, 100
CreateChromatinAssay, 35
CreateFragmentObject, 36, 37
CreateMotifMatrix, 38
CreateMotifObject, 39
crunch, 61
density, 77
DepthCor, 40
disjoin, 104
disjoin (inter-range-methods), 69
disjoin, ChromatinAssay-method (inter-range-methods), 69
disjoin, Seurat-method (inter-range-methods), 69
disjointBins (inter-range-methods), 69
disjointBins, ChromatinAssay-method (inter-range-methods), 69
disjointBins, Seurat-method (inter-range-methods), 69
distance (nearest-methods), 80
distance, ANY, ChromatinAssay-method (nearest-methods), 80
distance, ANY, Seurat-method (nearest-methods), 80
distance, ChromatinAssay, ANY-method (nearest-methods), 80
distance, ChromatinAssay, ChromatinAssay-method (nearest-methods), 80
distance, Seurat, ANY-method (nearest-methods), 80
distance, Seurat, Seurat-method (nearest-methods), 80
distanceToNearest (nearest-methods), 80
distanceToNearest, ANY, ChromatinAssay-method (nearest-methods), 80
distanceToNearest, ANY, Seurat-method (nearest-methods), 80
distanceToNearest, ChromatinAssay, ANY-method (nearest-methods), 80
distanceToNearest, ChromatinAssay, ChromatinAssay-method (nearest-methods), 80
distanceToNearest, Seurat, ANY-method (nearest-methods), 80
distanceToNearest, Seurat, Seurat-method (nearest-methods), 80
DownsampleFeatures, 41
ExpressionPlot, 41
Extend, 42
FeatureMatrix, 43, 57, 59
FilterCells, 44
FindClonotypes, 45
FindClusters, 45
FindMotifs, 46
FindNeighbors, 45
findOverlaps, 29, 49, 50, 71
findOverlaps(findOverlaps-methods), 47
findOverlaps,ChromatinAssay,ChromatinAssay-method
(findOverlaps-methods), 47
findOverlaps,ChromatinAssay,Vector-method
(findOverlaps-methods), 47
findOverlaps,Seurat,Seurat-method
(findOverlaps-methods), 47
findOverlaps,Seurat,Vector-method
(findOverlaps-methods), 47
findOverlaps,Vector,ChromatinAssay-method
(findOverlaps-methods), 47
findOverlaps,Vector,Seurat-method
(findOverlaps-methods), 47
findOverlaps-methods, 47, 50
FindTopFeatures, 50
follow (nearest-methods), 80
follow, ANY, ChromatinAssay-method
(nearest-methods), 80
follow, ANY, Seurat-method
(nearest-methods), 80
follow, ChromatinAssay, ANY-method
(nearest-methods), 80
follow, ChromatinAssay, ChromatinAssay-method
(nearest-methods), 80
follow, Seurat, ANY-method
(nearest-methods), 80
follow, Seurat, Seurat-method
(nearest-methods), 80
Footprint, 51
FractionCountsInRegion, 53
Fragment, 12, 23, 24, 36, 43, 56, 58, 60, 104–106
Fragment(Fragment-class), 54
Fragment-class, 54
FragmentHistogram, 54
 Fragments, 36, 55
 Fragments<- (Fragments), 55
FRiP, 56
gaps (inter-range-methods), 69
gaps,ChromatinAssay-method
 (inter-range-methods), 69
gaps,Seurat-method
 (inter-range-methods), 69
GeneActivity, 57
gene (seqinfo-methods), 93
genome, ChromatinAssay-method
(seqinfo-methods), 93
genome, Seurat-method (seqinfo-methods), 93
method<-,ChromatinAssay-method
(seqinfo-methods), 93
genome<-,Seurat-method
(seqinfo-methods), 93
GenomeBinMatrix, 58
getBackgroundPeaks, 88
GetCellsInRegion, 59
GetFootprintData, 60
GetFragmentData, 60
GetGRangesFromEnsDb, 61
GetIntersectingFeatures, 61
GetLinkedGenes, 62
GetLinkedPeaks, 63
GetMotifData, 63
GetTSSPositions, 64
 ggplot, 11, 31, 34, 40, 55, 74, 78, 85, 101
 ggplot2, 103
 ggseqlogo, 78
GRanges, 10, 22, 24, 27, 36, 42, 65, 75, 82
 granges, 65, 74
 granges (granges-methods), 65
 granges,ChromatinAssay-method
 (granges-methods), 65
 granges,Seurat-method
 (granges-methods), 65
 granges-methods, 65
GRangesList, 39, 78
GRangesToString, 66
hclust, 26
head.Fragment, 66
IdentifyVariants, 67, 106
InsertionBias, 68
inter-range-methods, 69, 70
IntersectMatrix, 71
IRanges, 70
irlba, 89, 90
isCircular (seqinfo-methods), 93
isCircular,ChromatinAssay-method
(seqinfo-methods), 93
isCircular,Seurat-method
(seqinfo-methods), 93
isCircular<-, ChromatinAssay-method (seqinfo-methods), 93
isCircular<-, Seurat-method (seqinfo-methods), 93
isDisjoint (inter-range-methods), 69
isDisjoint, ChromatinAssay-method (inter-range-methods), 69
isDisjoint, Seurat-method (inter-range-methods), 69
Jaccard, 72
LinkPeaks, 72
LinkPlot, 74
Links, 74, 75
Links<- (Links), 75
LookupGeneCoords, 76
makeGRangesFromDataFrame, 97
matchMotifs, 38
MatchRegionStats, 46, 76
Motif, 6, 12, 24, 40, 79, 98
Motif (Motif-class), 77
Motif-class, 77
MotifPlot, 78
Motifs, 79
Motifs<- (Motifs), 79

nearest (nearest-methods), 80
nearest, ANY, ChromatinAssay-method (nearest-methods), 80
nearest, ANY, Seurat-method (nearest-methods), 80
nearest, ChromatinAssay, ANY-method (nearest-methods), 80
nearest, ChromatinAssay, ChromatinAssay-method (nearest-methods), 80
nearest, Seurat, ANY-method (nearest-methods), 80
nearest, Seurat, Seurat-method (nearest-methods), 80
nearest-methods, 80, 83
NucleosomeSignal, 83
PeakPlot, 84
PFMatrixList, 38
PlotFootprint, 85
precede (nearest-methods), 80
precede, ANY, ChromatinAssay-method (nearest-methods), 80
precede, ANY, Seurat-method (nearest-methods), 80
precede, ChromatinAssay, ANY-method (nearest-methods), 80
precede, ChromatinAssay, ChromatinAssay-method (nearest-methods), 80
precede, Seurat, ANY-method (nearest-methods), 80
precede, Seurat, Seurat-method (nearest-methods), 80
PWWMatrixList, 38
range (inter-range-methods), 69
range, ChromatinAssay-method (inter-range-methods), 69
range, Seurat-method (inter-range-methods), 69
read.table, 66
ReadMGATK, 86
reduce, 104
reduce (inter-range-methods), 69
reduce, ChromatinAssay-method (inter-range-methods), 69
reduce, Seurat-method (inter-range-methods), 69
RegionStats, 6, 46, 87
RunChromVAR, 88
RunSVD, 89
RunTFIDF, 91

sample, 77
Seqinfo, 12, 24, 36, 93, 94
seqinfo, 95
seqinfo (seqinfo-methods), 93
seqinfo, ChromatinAssay-method (seqinfo-methods), 93
seqinfo, Seurat-method (seqinfo-methods), 93
seqinfo-methods, 93
seqinfo<-, ChromatinAssay-method (seqinfo-methods), 93
seqinfo<-, Seurat-method (seqinfo-methods), 93
seqinfo-methods, 93
seqlengths, 58
seqlengths (seqinfo-methods), 93
seqlengths, ChromatinAssay-method (seqinfo-methods), 93
seqlengths, Seurat-method (seqinfo-methods), 93
seqlengths<-,ChromatinAssay-method
  (seqinfo-methods), 93
seqlengths<-,Seurat-method
  (seqinfo-methods), 93
seqlevels (seqinfo-methods), 93
seqlevels,ChromatinAssay-method
  (seqinfo-methods), 93
seqlevels,Seurat-method
  (seqinfo-methods), 93
seqlevels<-,ChromatinAssay-method
  (seqinfo-methods), 93
seqlevels<-,Seurat-method
  (seqinfo-methods), 93
seqnames (seqinfo-methods), 93
seqnames,ChromatinAssay-method
  (seqinfo-methods), 93
seqnames,Seurat-method
  (seqinfo-methods), 93
seqnames<-,ChromatinAssay-method
  (seqinfo-methods), 93
seqnames<-,Seurat-method
  (seqinfo-methods), 93
SetMotifData, 95
Seurat, 9, 11, 15, 40, 41, 45, 50, 51, 53, 57,
  64, 74, 84, 89, 91, 92, 96, 102
Signac (Signac-package), 4
Signac-package, 4
SplitFragments, 96
StringToGRanges, 25, 68, 97
subset, 98
subset (subset.Motif), 98
subset.Motif, 98
SubsetMatrix, 99
tempdir, 22
theme_browser, 100
TilePlot, 100
TSSEnrichment, 102, 103
TSSPlot, 103

UnifyPeaks, 104
UpdatePath, 104

ValidateCells, 105, 106
ValidateFragments, 105
ValidateHash, 106
VariableFeatures, 41
VariantPlot, 106
wrap_plots, 34